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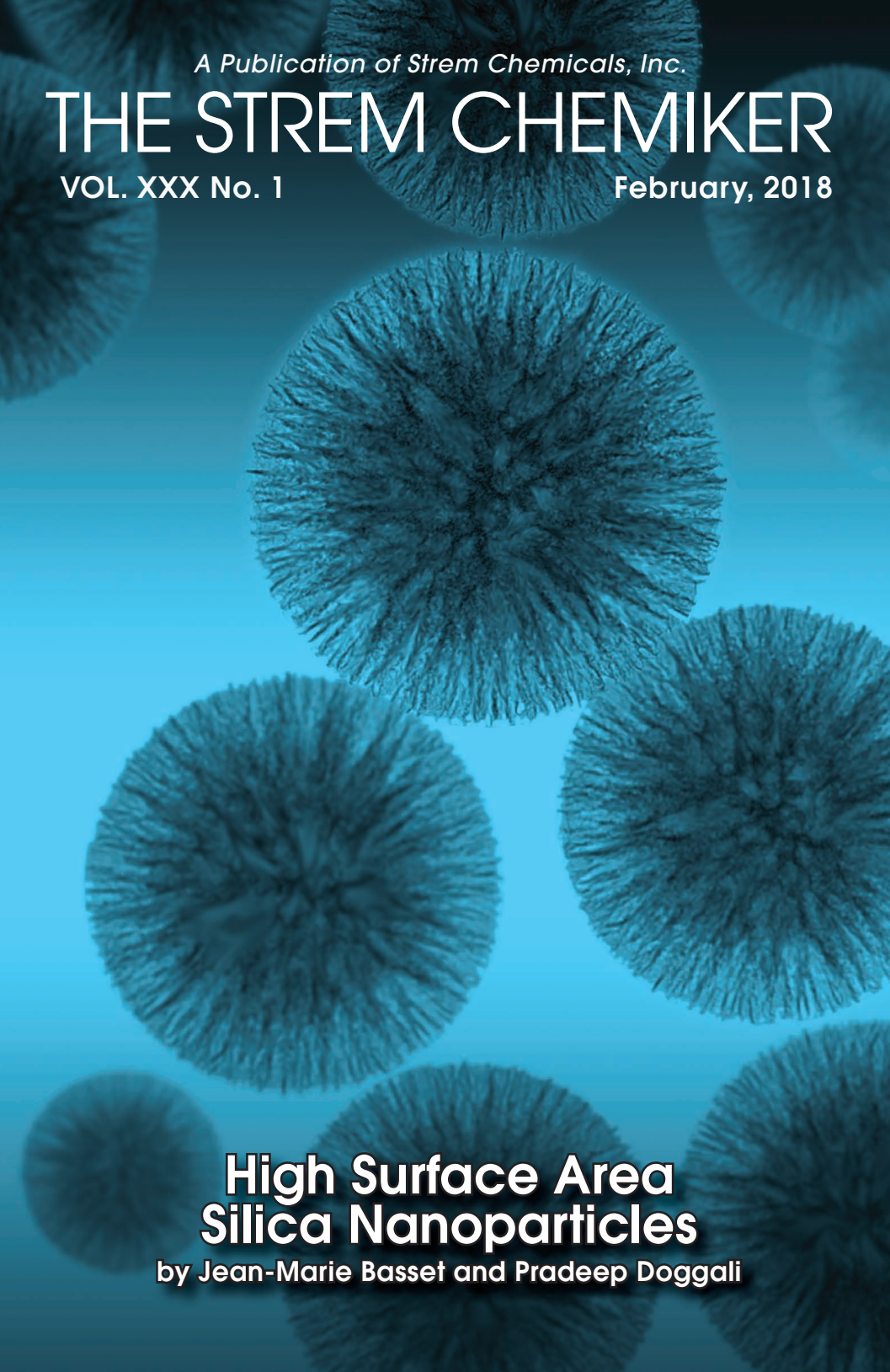

High Surface Area Silica Nanoparticles

by Jean-Marie Basset and Pradeep Doggali

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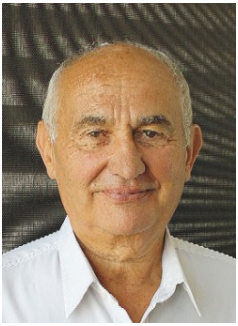
Glossary of Terms

$[\alpha]_D$	.....	Specific rotation
AAS	.....	Atomic Absorption Standard
ACS	.....	Conforms to American Chemical Society specifications
air sensitive	.....	Product may chemically react with atmospheric oxygen or carbon dioxide at ambient conditions. Handle and store under an inert atmosphere of nitrogen or argon.
amp	.....	Ampouled
b.p.	.....	Boiling point in °C at 760mm, unless otherwise noted
d.	.....	Density
dec.	.....	Decomposes
elec. gr.	.....	Electronic Grade, suitable for electronic applications
f.p.	.....	Flash point in °F
gran.	.....	Granular
heat sensitive	.....	Product may chemically degrade if stored for prolonged periods of time at ambient temperatures or higher. Store at 5°C or lower.
hydrate	.....	Unspecified water content which may vary slightly from lot to lot
hygroscopic	.....	Product may absorb water if exposed to the atmosphere for prolonged periods of time (dependent on humidity and temperature). Handle and store under an inert atmosphere of nitrogen or argon.
light sensitive	.....	Product may chemically degrade if exposed to light
liq.	.....	Liquid
m.p.	.....	Melting point in °C
moisture sensitive	.....	Product may chemically react with water. Handle and store under an inert atmosphere of nitrogen or argon.
NMR grade		Suitable as a Nuclear Magnetic Resonance reference standard
optical grade	.....	For optical applications
pwdr.	.....	Powder
primary standard	.....	Used to prepare reference standards and standardize volumetric solutions
PURATREM	.....	Product has a minimum purity of 99.99% (metals basis)
purified	.....	A grade higher than technical, often used where there are no official standards
P. Vol.	.....	Pore volume
pyrophoric	.....	Product may spontaneously ignite if exposed to air at ambient conditions
reagent	.....	High purity material, generally used in the laboratory for detecting, measuring, examining or analyzing other substances
REO	.....	Rare Earth Oxides. Purity of a specific rare-earth metal expressed as a percentage of total rare-earths oxides.
SA	.....	Surface area
store cold	.....	Product should be stored at -18°C or 4°C, unless otherwise noted (see product details)
subl.	.....	Sublimes
superconductor grade	.....	A high purity, analyzed grade, suitable for preparing superconductors
tech. gr.	.....	Technical grade for general industrial use
TLC	.....	Suitable for Thin Layer Chromotography
v.p.	.....	Vapor pressure mm of Hg
xtl.	.....	Crystalline

About Purity

Chemical purity	.....	is reported after the chemical name, e.g. Ruthenium carbonyl, 99%
Metals purity	.....	is reported in parentheses with the respective element, e.g. Gallium (III) bromide, anhydrous, granular (99.999%-Ga) PURATREM where 100% minus the metal purity is equal to the maximum allowable percentage of trace metal impurity

Biographical Sketches



Prof. Jean-Marie Basset, Ph.D.

Prof. Jean-Marie Basset is a Distinguished Professor in the Physical Sciences and Engineering Division at King Abdullah University of Science & Technology (KAUST). From his start at KAUST in 2009 until October 2017 he served as Director of the KAUST Catalysis Center (KCC) of which he was also a founding member. He continues his work today at the KCC in Chemical Science.

Catalysis is a strategic domain for the world and particularly Saudi Arabia. It is a critical enabling science for the Kingdom's energy future. Improvement in catalytic processes across the chemical and petroleum industries will increase resources, energy utilization efficiencies and reduce waste. The need for breakthroughs within the crucial domains of catalysis are imperative to meet the energy challenges "beyond petroleum" such as the use of CO_2 Natural Gas, CO utilization, and efficient photocatalysts for water splitting. Prof. Basset has been working to meet some of these challenges and help to catalysis field to advance from catalyst discovery to catalysis by design. He has recently developed a theory to predict any catalytic reaction on the basis of the catalysis by design using single site catalysis.

Before his move to KAUST, Prof. Basset served as the Research Director at the Centre National de la Recherche Scientifique (CNRS) since 1987. He first came to CNRS in 1971 and occupied several positions in his tenure including vice-director of the Institute of Catalysis (Lyon). He founded the consortium "Actane" on alkane activation with 11 university labs and 5 different companies. He founded his Laboratory of Surface Organometallic Chemistry in 1994. During this time he was also acting Scientific Director of the School of Chemistry, Physics and Electronics (CPE) at the University of Lyon in France (1992-1994). Prof. Basset's Lyon lab was home to over 50 scientists, including Nobel Laureate Yves Chauvin. This lab has trained over 450 chemists through three-year scholarship programs.

He has written more than 600 publications in international journals and holds 70 patents most of which are protected internationally.

Prof. Basset's achievements include:

- *2011 Member of the European Academy of Sciences and Arts (AUS)*
- *2008 Doctor Honoris Causa, University of Xiamen (CN)*
- *2008 Doctor Honoris Causa, TUM (DE)*
- *2006 Augustine Award of the ORCS (USA)*
- *2005 Distinguished Achievements Award of IMPI (USA)*
- *2003 Chevalier dans l'Ordre National du Mérite (FR)*
- *2003 Member of the European Academy of Sciences (EU)*
- *2002 "Visiting Professor University of Hokkaido" (JAP)*
- *2001 Member of the French Academy of Technologies (FR)*
- *1999 "August-Wilhem-Von-Hofman-Vorselung" Lecturer (DE)*
- *1998 Academy of Sciences Award, Prix de l'Institut Français du Pétrole (FR)*
- *1998 Seaborg Lecturer in Inorganic Chemistry (Université de Berkeley) (USA)*
- *1997 Procope Award for French –German collaboration (FR)*
- *1997 Société Française de Chimie (Grand Prix) Prix Süe 1997 (FR)*
- *1993 Corresponding member of the de French Academy of Sciences (FR)*
- *1992 Grammaticakis Neuman Award of the French Academy of Sciences (FR)*
- *1991 Max Plank Award with W. Herrmann (DE)*
- *1987 Japan Society for the Promotion of Sciences Award (JAP)*
- *1987 Alexander Von Humboldt Award (DE)*
- *1984 Pacific Coast Lecturer West Coast (USA)*

Biographical Sketches

Dr. Pradeep Kumar Doggali

Dr. Pradeep Kumar Doggali is a Postdoctoral Fellow at King Abdullah University of Science and Technology (KAUST), Saudi Arabia. He completed his Master of Science in Chemistry (Specialization: Industrial Chemistry) in the year 2007 from Jawaharlal Nehru Technological University (JNTU), Hyderabad, India. That same year, he joined the National Environmental Engineering Research Institute (NEERI), a laboratory of Council of Scientific and Industrial Research (CSIR) in India to pursue his doctoral studies. His research work focused on developing Perovskite and Mixed Oxide type catalytic materials for coal combustion and post combustion control of carbon monoxide (CO) and particulate matter (PM) emissions. During his Ph.D. studies, he was on deputation to Kyushu University, Japan as a visiting research student (2009) at the Laboratory of Prof. Y. Teraoka. There he worked on transition metal-based perovskite type catalysts for the control of diesel soot emissions from vehicles and stationary sources like generator sets. In 2012 he joined the R&D unit of Larson and Toubro (L&T) Power Limited (Vadodara, India) as a Research Executive. At L&T, Dr. Doggali contributed in the development of suitable biomass additives for the clean combustion of coal for gasification based systems.

As a Research Consultant in KAUST (2013), he worked on developing shape, size and morphology controlled nano structured metal oxides and mixed oxides using template assisted routes. Dr. Doggali's postdoctoral work (2015) is primarily in the area of developing improved methods to synthesize Nano Fibrous Silica (KCC-1) to make it suitable for a variety of industrial applications. He is also developing various nanoparticle supported KCC-1 based catalysts for different reactions of significance for use in energy and environmental fields. He was conferred with DST (Department of Science and Technology), India, Young Scientist award in the year 2015.

Awards:

- *GLOBAL-COE Internship Award at Kyushu University, Japan*
- *Best business plan presentation award at Technology Led Entrepreneurship Program of Indian Institute of Chemical Technology (CSIR-IICT) by the faculty of Indian Institute of Management (IIM)*
- *Best Oral presentation award on "Enviro 2025-Challenges, Interventions & Mitigations" held at NEERI, Nagpur, India.*
- *Awarded Senior Research Fellowship (SRF) by CSIR (Council of Scientific and Industrial Research, Government of India).*

High Surface Area Fibrous Silica Nanoparticles (KCC-1)

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KAUST Catalysis Center
4700 King Abdullah University of Science & Technology (KAUST),
Thuwal 23955-6900, Saudi Arabia

Introduction

Given the growing demand for silica materials for various applications including catalysis, drug delivery, bio sensing, liquid chromatography, coating & paints, optically active materials, as well as in cosmetics, much research has been carried out to control the shape, structure, and pore-size leading to various types of mesoporous silica materials. However, the performance, and therefore the applicability, of mesoporous silica has been hindered by the limitation in accessibility to the active sites within the porous structure for many reasons, such as clogging of the pores by the sintering of active metals and also by accumulation of the carbonaceous by products inside the pores or at the external surface of porous materials. The morphology of the mesoporous silica could also influence the way drugs gets encapsulated and their subsequent release. Therefore, development and fabrication of novel silica materials with unique morphology that leads to high performances, which results in super efficiency is imperative to meet the emerging applications.

KAUST's novel fibrous silica nanospheres (KCC-1)[1] offers a unique alternative shape, other than porosity, that has never before been seen in silica materials: a fibrous surface morphology arranged in three dimensional structure to form spheres. Unlike traditional pore-based silica, these nanospheres possess a fibrous structure that increases accessibility to most of the available surface area; this, for example, increases catalytic activity significantly. KCC-1 has been attracting the attention of researchers all over the world owing to its unique morphology and high surface area and therefore, making it ideal for use in a wide variety of catalytic reactions, sorbent and biological applications such as immobilization of enzymes and delivering DNAs.

A range of Nano catalysts synthesized using KCC-1 as a support have been showing excellent catalytic activity for various reactions of industrial importance. As a catalyst support/sorbent/carrier, KCC-1 has been demonstrating superior activity as compared to commercially available mesoporous silica materials such as MCM-41 and SBA-15. Some of these KCC-1 based materials and their corresponding reactions are included in Table.1.

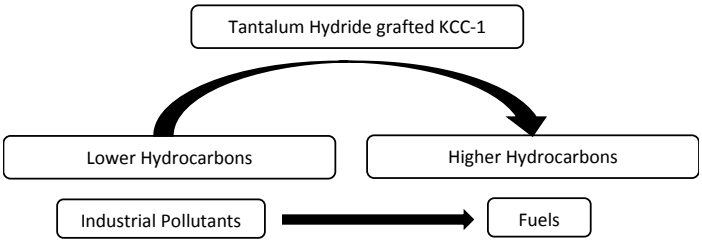
S.N	KCC-1 based material/catalyst/sorbent	Catalytic reaction/sorbent application/ carrier for DNAs and genes	Reference
1.	Tantalum hydride catalyst supported on KCC-1	Hydrometathesis of olefins	2
2.	Ruthenium (Ru) nanoparticles supported on KCC-1	Hydrogenolysis of Propane	3
3.	KCC-1 based silver nanocatalyst	Hydrogenation of dimethyl oxalate (DMO)	4
4.	Amine-functionalized KCC-1	CO_2 Capture	5
5.	Nitridated KCC-1	Knoevenagel condensation and transesterification	6
6.	KCC-1 nanospheres	CO_2 methanation	7
7.	KCC-1 supported Ag catalysts	CO oxidation	8
8.	Palladium nanoparticles supported on KCC-1	hydrogenation of alkenes and α,β-unsaturated carbonyl compounds	9
9.	KCC-1 nanoparticles	Synthesis of triazolo[1,2-a] indazole-triones	10
10.	Manganese (Mn) incorporated KCC-1	catalytic ozonation of oxalic acid	11
11.	Amine-grafted KCC-1	As a carrier to transport and deliver DNAs & genes	12
12.	Atomic layer deposited (ALD) TiO_2 on KCC-1	Photocatalytic dye degradation	13

Table 1.

Our group at catalysis research center (KCC) of KAUST has been working on catalytic applications using KCC-1 for different reactions. Successful attempts have been made in studying KCC-1 based catalysts for olefin and alkane metathesis, C-C Coupling, H_2 production from natural gas, oxidation reactions and photocatalytic water splitting. Our research work on above mentioned application using KCC-1 is briefly discussed.

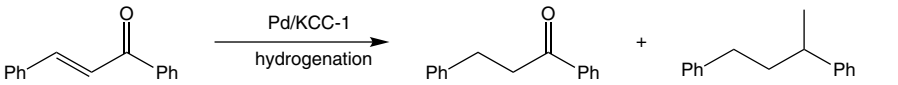
I) Hydro-metathesis of olefins

Hydro-metathesis is a catalytic reaction of transition metal hydride, which in the presence of hydrogen catalyzes the direct conversion of olefins into alkanes having higher and lower numbers of carbon atoms. In this work, Tantalum hydride grafted on KCC-1 transforms an olefin in the presence of hydrogen at moderate temperatures into the expected corresponding alkane, and also transforms the same olefin into alkanes having a higher and lower number of carbon atoms. The catalytic hydro-metathesis of propylene (1:1 mixture of olefin and hydrogen) was performed and compared with 1-butene hydro-metathesis on a micropilot equipped with a stainless steel reactor at atmospheric pressure at 150˚C . The reactions proceeded efficiently with 37–40% conversion of propylene and 48-51% of 1-butene. In the case of propylene, in addition to the expected hydrogenation product propane, butane (35–40%) and ethane (40%) were the major products formed, with methane, iso-butane, and pentanes as the minor products. In case of 1-butene, major products formed include butane, propane (47–61%) and hexanes (13– 25%) whereas ethane, propylene, pentanes, and heptanes formed as minor products. Remarkably, in both cases catalyst possessed high stability and regeneration ability[2]. Graphical representation of the process is presented below.



II) Hydrogenation of alkenes

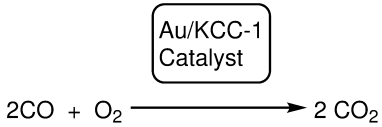
Hydrogenation of alkenes and α,β-unsaturated carbonyl compounds have been studied using an efficient KCC-1 based catalyst (palladium nanoparticles supported on KCC-1). This resulted excellent yields of the corresponding products with very high chemo-selectivity in the case of α,β-unsaturated carbonyl compounds. We have observed the superior performance of KCC-1 in comparison with commercial mesoporous silica supports like MCM-41 and SBA-15 under identical conditions. These results are attributed to superior accessibility of catalytically active sites along with high loading and excellent dispersion of palladium in case of KCC-1[10].



1,3-diphenyl-2-propene-1-one 1,3-diphenyl-2-propane-1-one Butane-1,3-diyldibenzene

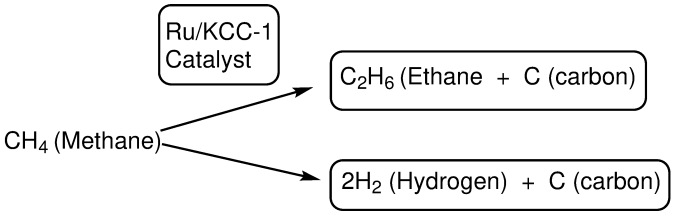
III) Influence of metal particle (Au nanoparticles) size on catalytic CO oxidation

In order to study the possible advantage of using the fibrous nature of KCC-1, we synthesized gold nanoparticles (Au NPs) with different size and supporting them on KCC-1. The activity of the resulting catalysts was and tested for CO oxidation reaction. It is evidenced by the HR-TEM studies that the size and the location of the Au NPs on the support observed to be dependent on the method of synthesis. The catalytic activity of the Au NPs proved to be size dependent. We have also observed that larger Au NPs of Au/KCC-1- NH_2 were not able to penetrate the pores of KCC-1 and showed only limited catalytic activity. In this study, it was possible to place highly dispersed Au NPs with uniform size inside the fibers of KCC-1-NH_2 by grafting $HAuCl_4$ on Au/KCC-1-NH_2 followed by reduction[14].



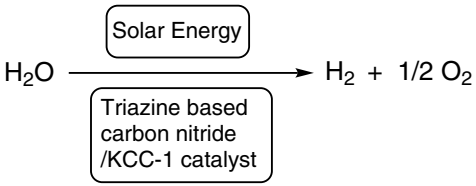
IV) Coupling of methane to ethane and hydrogen

We have developed a method to selectively produce hydrogen and ethane from methane by thermocatalytic decomposition of methane using Ru nanoparticles supported on Nano fibrous Silica (KCC-1) catalyst. These catalysts have been synthesized by post modification of KCC-1 with amine groups using APTS (3-aminopropyl triethoxysilane) followed by supporting nanoparticles on KCC-1. In this work, suitable temperatures and pressures have been found to produce a product having either hydrogen with solid carbon or ethane with solid carbon. The novelty of this approach also associated with the catalyst system that is efficient to produce the hydrogen and ethane as mentioned above with feed gas comprising less than 1000 ppm water. Also, the formation of hydrogen and ethane has not produced carbon dioxide (CO_2) but a just carbon. Based on the structure of the carbon (formed in this reaction), it can have applications as carbon graphite/ carbon fiber/ carbon nanotube[15].



V) Photocatalytic water splitting

We have also been successful in utilizing fibrous nature of KCC-1 for photocatalytic reactions. Triazine-based carbon nitride (CN) synthesis in the presence of KCC-1, resulted in favorable effects to advance photocatalytic stability. The photocatalyst synthesized using this approach yielded a HER photocatalyst with a significant AQE of 22.1 ± 3% at 400 nm for solar to HER. The improved lifetime for the ground-state bleaching of the excited charge carriers was evidenced by time-resolved transient absorption spectroscopy. The synthesized CN/KCC-1 photocatalyst has been consistent with the higher photocatalytic performance than that of CN without KCC-1[16].

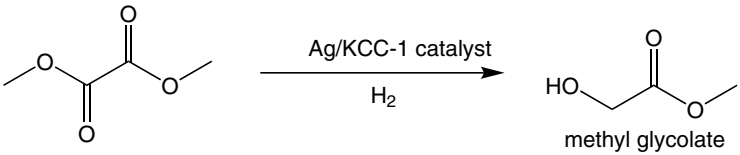


Experiments are also in progress to test KCC-1 for different industrially important reactions considering its superior performance as compared to conventional silica supports.

Several researchers all over the globe have successfully utilized KCC-1 for various applications after our discovery of KCC-1 in 2010. Therefore, work carried out by research groups from other institutions has been discussed to sum-up the highlights of some potential applications of KCC-1.

VI) Hydrogenation of dimethyl oxalate (DMO) to Methylene Glycol (MG)

Mengyao Ouyang et al. studied Ag/KCC-1 nanocatalyst for hydrogenation of dimethyl oxalate (DMO) to Methyl Glycolate (MG) and they compared the activity of Ag/KCC-1 with Ag/SBA-15 and Ag/MCM- 41. The results showed that dispersion of metals was completely dependent on the nature silica support used, which results in different dispersion and accessibility of active sites. Authors concluded that KCC-1 with hierarchical pore channels has higher accessible internal surface area and therefore displays high catalytic activity[4].

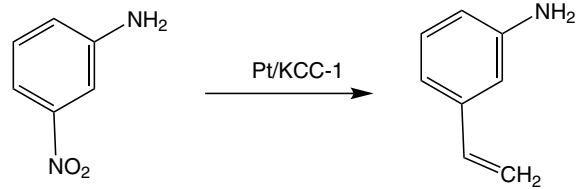


dimethyl oxalate

methyl glycolate

VII) Hydrogenation of functionalized aromatic compounds

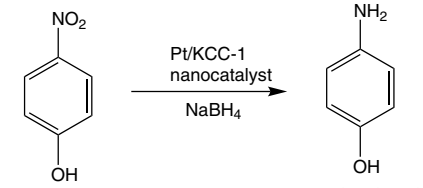
M. Dhiman et al. synthesized ultrasmall platinum (Pt) nanoparticles on PEI (polyethylenimine) functionalized KCC-1 (KCC-1-PEI/Pt) and studied their activity for hydrogenation of 3-nitrostyrene. Authors observed an extraordinary selectivity for the said reaction and Pt (1%) supported on PEI functionalized KCC-1 was found to be selective towards reduction to 3-vinylaniline. On the other hand, 10% and 5% Pt loaded on KCC-1-PEI demonstrated high activity and selectivity towards 3-ethylaniline. It was observed that among studied catalysts KCC-1-PEI/Pt (1%) was found to be an efficient catalyst for the hydrogenation of a variety of substituted aromatic compounds. From obtained results it was described, how selectivity can be tuned just by changing the particle size of Pt nanoparticles. In this study, most active sites were observed to be subnanometer particles and pseudo-single atoms of Pt [17].



3-nitroaniline

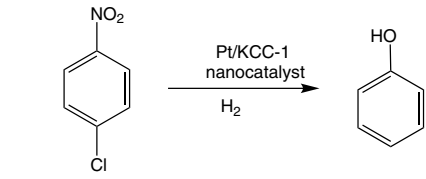
3-vinylaniline

X. Le et al. investigated palladium supported KCC-1 catalyst for reduction of nitrophenols (4-NP) and hydrodeclorination of chlorophenols (4-CP). In order to synthesize catalysts, Pd precursor was added the functionalized KCC-1 followed by reduction with NaBH4. The Pd nanoparticles were well dispersed on fibers of KCC-1 and showed good catalytic activity for both the reactions. The higher catalytic activities was explained on the basis of morphological characteristics of the support which favors uniform dispersion and accessibility to Pd nanoparticles[18].



4-nitrophenol

4-aminophenol

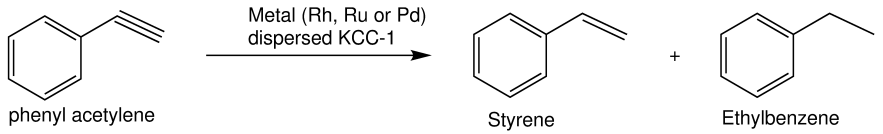


1-chloro-4-nitrobenzene

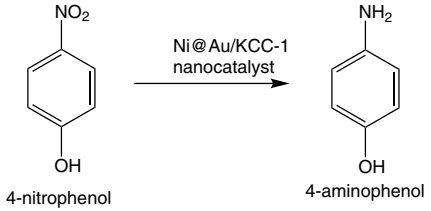
phenol

In another one of their studies, X. Le et al. have explored magnetically retrievable core-shell catalyst $Pd/Fe_3O_4@SiO_2@KCC-1$. The catalytic performance of the synthesized catalyst was determined by reduction reaction of 4-nitrophenol (4-NP) to 4-aminophenol (4-AP). The reduction rate was more for $Pd/Fe_3O_4@SiO_2@KCC-1$ as compared to Pd on other supports. The catalyst was also tested for Suzuki coupling reaction and found to have good stability and reusability (up to five cycles)[19]. M. Dhiman et al.

reported a facile way for synthesis of metal nanoparticles (Rh, Ru, Pd) supported on KCC-1, wherein they used PEI as a pseudochelator. Their studies revealed that the use of PEI had an edge over complex dendrimer, making the process relatively inexpensive. The catalytic activities of synthesized catalysts (KCC-1-PEI/Rh, KCC-1-PEI/Ru, and KCC-1-PEI/Pd) were tested for hydrogenation of phenylacetylene and styrene. The activity of KCC-1-PEI/Rh was more for both hydrogenation of phenylacetylene and styrene, as compared to that of KCC-1-PEI/Ru, and KCC-1-PEI/Pd. The difference in the activity of these catalysts was attributed to varying adsorption coefficients for the different metal atoms. The higher activities exhibited by studied catalysts was explained on the basis of easy accessibility to metal atoms with KCC-1 despite PEI infiltration. KCC-1-PEI/Rh and KCC-1-PEI/Ru also showed excellent stability, which was maintained almost up to five cycles without any deterioration[20].



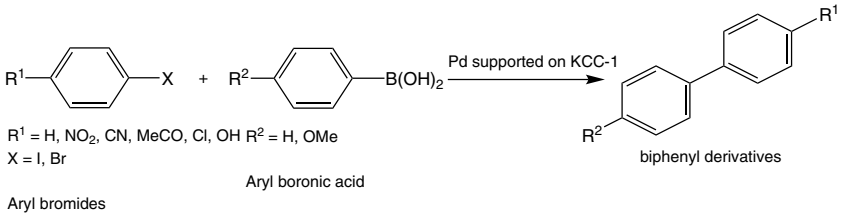
X. Le et al. also Studied Ni@Au core–shell nanoparticles supported KCC-1 for the reduction of 4-nitrophenol to 4-aminophenol in the presence of NaBH4. The examined catalyst showed superior catalytic activity in comparison with to Ni@Au NPs. This was explained by the high accessibility provided by KCC-1 and also due to the less aggregation of Ni@Au NPs on the KCC-1 nano-silica support. The Ni@Au/KCC-1 was also found to be an excellent catalysts to reduce 2-nitroaniline to o-Phenylenediamine. In this study, Ni@Au NPs as the active sites reduced the use of Au content not effecting the catalytic activity. Also possess paramagnetic nature, which makes the catalyst easy to recover for reuse. Authors have also shown that Ni@Au/KCC-1 can be reused at least ten times without significant reduction in catalytic activity. The sustainable activity was attributed to the inhibition of leaching of Ni@Au NPs from the mercaptopropyl groups functionalized KCC-1[21].



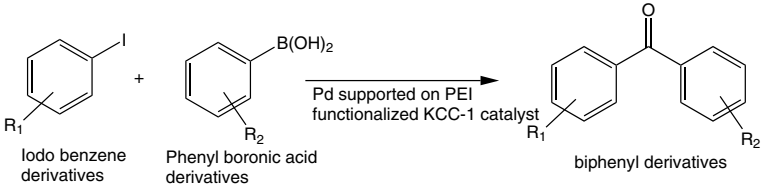
VIII) C-C bond forming reactions

Several research group have demonstrated use of KCC-1 for various catalytic reactions including, Suzuki coupling[22], Suzuki–Miyaura cross-coupling[23], Knoevenagel Condensation[6] and also synthesizing various industrially important organic compounds.

Fihri et al. investigated Pd nanoparticles supported KCC-1 for Suzuki coupling of aromatic halides. In order to prepare the catalysts, KCC-1 was first functionalized with amine groups using 3-aminopropyltriethoxysilane to obtain KCC-1-NH_2. Later, the functionalized surface was treated with $PdCl_2$ to prepare KCC-1-NH_2/Pd. Authors found that the synthesized catalyst was active for different aryl bromides and iodides with aryl boronic acids and demonstrates good to excellent yields. It was possible to easily recover the catalyst from the reaction mixture and researchers reused it for a number of cycles with no significant change in the catalyst activity. Thus authors confirms the heterogeneity and good stability of this catalyst system. TEM investigations carried out in this study indicates no change in the morphology of fresh and used catalyst, which indicated no Ostwald ripening[22].

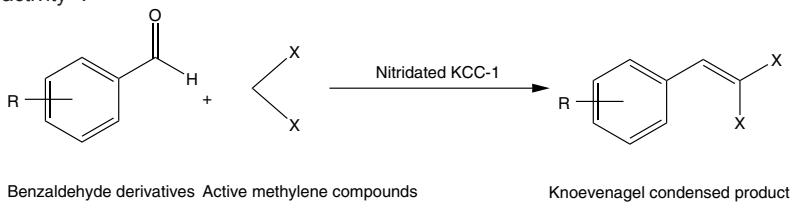


P. Gautam et al. synthesized palladium nanoparticles (Pd NPs) supported on KCC-1 and developed an economically viable and sustainable protocol for the carbonylative Suzuki–Miyaura cross coupling reaction. Pd nano particles supported on KCC-1 demonstrates the turnover number (TON) 28- times and a turnover frequency (TOF) 51-times greater than the best Palladium supported catalyst reported for the carbonylative cross-coupling between 4-iodoanisole and phenylboronic acid. Catalysts tested in this study could be recycled up to ten times with negligible loss in activity till eighth cycle[23].



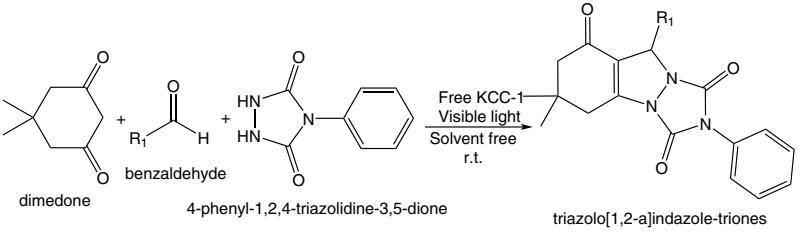
IX) Knoevenagel condensation

M.Bouhrara et al. synthesized Nitridated KCC-1 (solid base) by ammonolysis under a flow of ammonia (NH_3). It was found that the synthesized catalyst is highly active for Knoevenagel condensation reactions of different aldehydes. Tested catalysts in this research work were active for the transesterification of esters with a wide range of alcohols compared to the reported catalysts. Authors explained the improvement in activity by the presence of both basic (amines) and acidic (silanols) sites and more importantly excellent accessibility of these sites in case of KCC-1. The unique structure of KCC-1 assists the substrates to easily penetrate and interact with basic amine and helps in improving the catalytic activity[6].

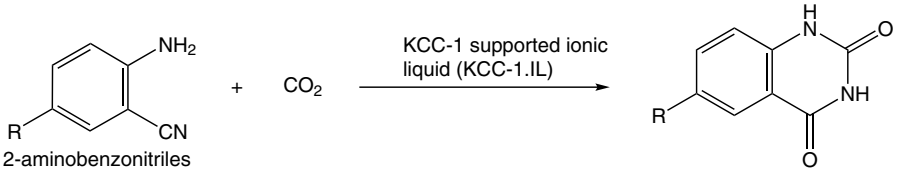


X) Synthesizing different organic compounds

S.M. Sadeghzadeh explored KCC-1 based catalysts for construction of different organic compounds. Author reported a green and efficient method for synthesis of various triazolo [1,2-a]indazole-triones using KCC-1 catalyst at room temperature under solvent free conditions by visible light. Nano-SiO_2, MCM-41, SBA-15 were also tested for synthesis of triazolo [1,2-a]indazole-triones using the same conditions. It was observed that the yields of the desired product was fair to good with Nano-SiO_2, MCM-41, SBA-15. However, KCC-1 shows excellent yields for the same reaction. Non-negligible activity observed using KCC-1 was explained based on its shape, composition and morphology[10].



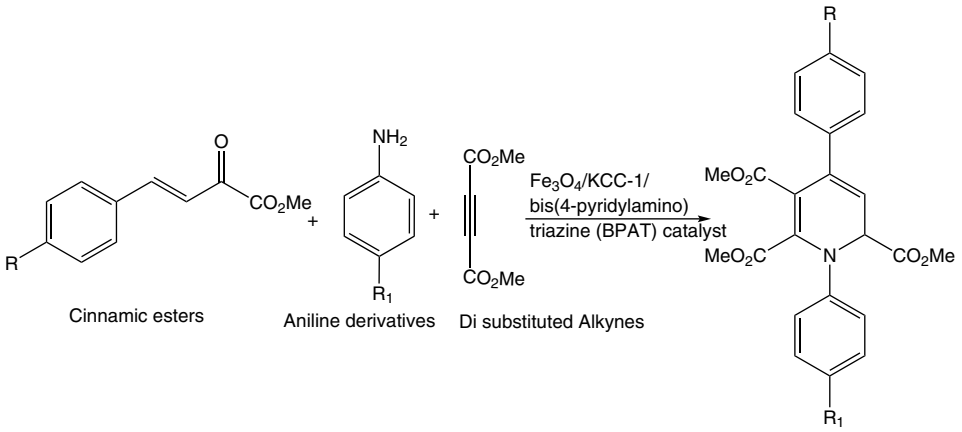
In a different study, S.M. Sadeghzadeh synthesized ionic liquid functionalized KCC-1 and their activity was tested for the synthesis of quinazoline-2,4 (1H, 3H)-diones from CO_2 and 2-aminobenzonitriles under mild conditions. Author compared the catalytic performance of ionic liquid functionalized KCC-1 and literature reported catalysts. Results in this study clearly indicate that the synthesized catalysts show good to excellent yields at lower temperature with small amount of catalyst, lower pressure of carbon dioxide and shorter reaction time. The synthesis was shown to be green, low-cost and was effective for the development of other materials[24].



2-aminobenzonitriles

quinazoline-2,4(1H,3H)-dione

The author also investigated Fe_3O_4/KCC-1/BPAT MNPs core–shell nanocomposite for the synthesis of N-substituted 1,4-dihydropyridines with excellent yield under mild reaction condition. It was found that the studied catalyst was non-toxic, green and economically viable and recyclable for the synthesis of N-substituted 1,4-dihydropyridines[25].



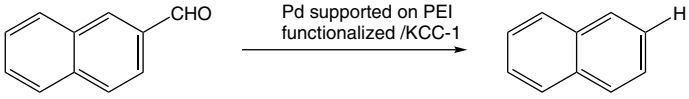
Cinnamic esters

Aniline derivatives

Di substituted Alkynes

N-substituted 1,4-dihydropyridines

P. K. Kundu et al. studied KCC-1-PEI/Pd catalysts for decarbonylation of aldehydes, wherein they developed an efficient heterogeneous catalytic protocol for the decarbonylation of a variety of aldehydes with complete conversion to products. By doing this, authors have found an easy way for product purification (without chromatography) using KCC-1-PEI/Pd catalyst. The developed method in this study not only limited to aromatic aldehydes, but the decarbonylation of hetero aromatic, alkane, and alkenylaldehyde derivatives. Authors found that the studied catalyst have excellent recyclability even after eightcyles, which proves the sustainability of the studied catalyst system[26].

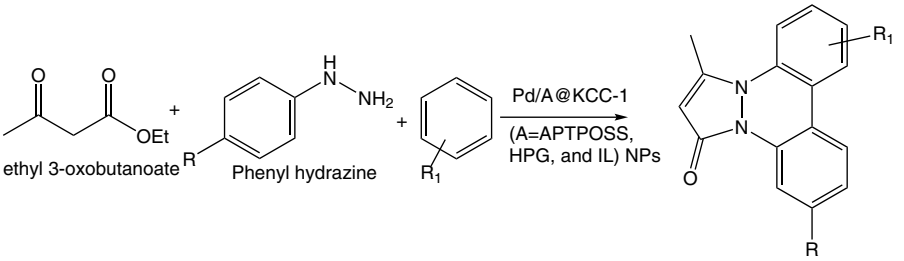


2-naphthaldehyde

naphthalene

S. Sadeghzadeh synthesized palladium nanoparticles (Pd NPs) dispersed on KCC-1 functionalized with different groups such as APTPOSS@KCC-1, hyperbranched polyglycerol@KCC-1 (HPG@KCC-1), and ionic liquid@KCC-1 (IL@KCC-1). These catalysts are evaluated for synthesis of benzo[c] pyrazolo[1,2-a]cinnolin-1-one. It was observed that APTPOSS@KCC-1 displayed good catalytic

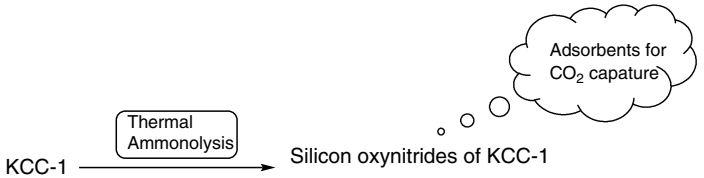
reaction and also exhibited excellent reusability in the catalytic reaction. The high activity of APTPOSS functionalized KCC-1 was attributed to its high accessibility and minimum aggregation. Also its tolerance to leaching of the nanoparticles[27].



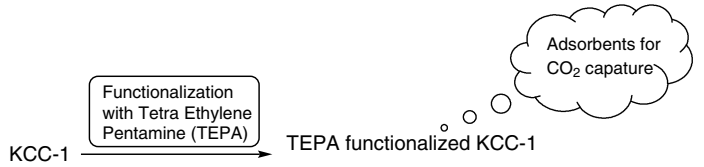
benzo[c]pyrazolo[1,2-a]cinnolin-1-one

XI) Adsorbent for CO_2 capture

U. Patil et al. studied the use of silicon oxynitrides as adsorbents for CO_2 capture. In this investigation authors synthesized three series of functionalized materials based on KCC-1, SBA-15 and MCM-41 with Si–NH_2 groups in a single step process via thermal ammonolysis. Authors demonstrates that studied materials overcome several limitations associated with conventional aminegrafted mesoporous silica. Adsorbents prepared by ammonalysis shows good CO_2 capture capacity, faster adsorption–desorption kinetics as well as effective regeneration and reuse. Also the studied materials demonstrate excellent thermal and mechanical stability[28]. Graphical representation of the process is presented below.

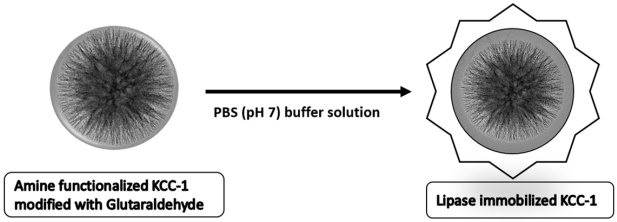


B. Singh et al. synthesized KCC-1 based hybrid materials functionalized by different amine molecules using physisorption and covalent attachment. Synthesized materials were tested for their CO_2 capture capacity. Among the studied materials, the tetraethylene pentamine (TEPA) based KCC-1 (KCC-1-TEPAads) showed superior capacity in comparison with MCM-41 in terms of textural stability, CO_2 capture capacity, rate of adsorption as well as thermal stability. KCC-1-TEPAads demonstrates the adsorption capacity of 91.5 mmol g-1, whereas MCM-41-TEPAads CO_2 capture capacity was observed to be only 73.1 mmol g-1. These results clearly indicate the superior stability of the KCC-1-based sorbents as compared to the conventional mesoporous materials[5]. Graphical representation of the above mentioned process is shown below.

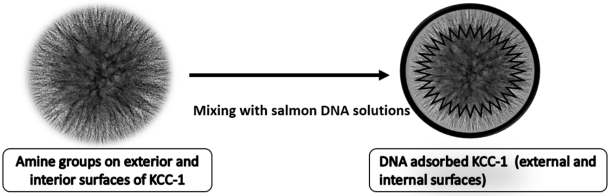


XII) Biological applications like immobilization of enzymes and DNA adsorption studies

Zafar Ali et al. also studied the immobilization of lipase on KCC-1. Author's method of synthesis, activation, and optimization of immobilization conditions, produced better resistance to temperature and pH inactivation as compared to the free lipase. Therefore, it widened the reaction pH and temperature regions, with the optimum pH and temperature of 7.5 and 40◦C, respectively. The immobilized Lipase i.e Candida Ragusa (ICRL) showed above 81% of the initial activity even after 28 days. Also 80% activity after 8 repeated cycles. Authors also demonstrated the ICRL improved storage stability, reusability as well as 700 U/g of protein as immobilization efficiency[29]. Graphical representation of Immobilization of enzyme on KCC-1 is shown below.

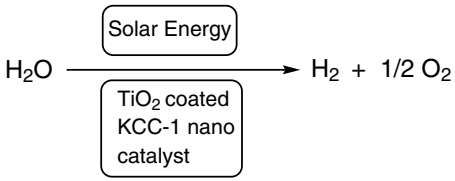


Xiaoxi Huang et al. performed DNA adsorption studies on a series of KCC-1- and MCM-41-based nanomaterials that are functionalized with organoamine groups. Authors observed higher adsorption capacities for KCC-1 based materials as compared to MCM-41 based nanomaterials. It was explained that DNA adsorption reaches saturation once the outer surfaces of the MCM-41 nanoparticles are occupied by the DNA molecules, leaving their inner channel spaces to play negligible role in the adsorption of DNA molecules. However, due to the unique fibrous morphology, KCC-1-based nanomaterials absorb DNAs efficiently both on their external and internal surfaces. Cellular toxicity tests performed in this study demonstrates the biocompatibility of KCC-1[12]. Graphical representation of DNA adsorbed KCC-1 is shown below.

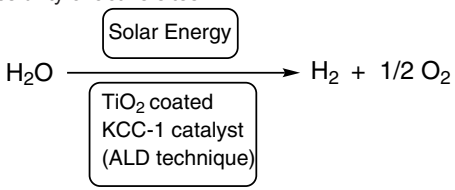


XIII) Photo catalysis

Bayal et al. also reported a new method to fabricate TiO_2 on the fibers of KCC-1. The synthesized KCC-1/TiO_2 photocatalyst showed a very high yield of H_2 (26.4 mmolh-1g-1 TiO_2) in presence of UV light. The yield reported in this research study was one of the best reported so far for photocatalytic H_2 generation. In addition, authors do not observe decrease in photocatalytic activity of KCC-1/TiO_2, unlike conventional mesoporous silica materials and this effect was attributed to open morphology of KCC-1[30].

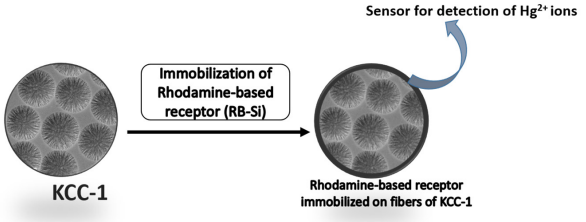


R. Singh et al. designed and synthesized KCC-1 based photo catalysts by coating TiO_2 on fibers of KCC-1 using atomic layer deposition (ALD). Catalysts developed by authors showed superior catalytic activity for photocatalytic dye degradation in comparison to MCM-41 and SBA- 15 based TiO_2 catalysts synthesized with aid of ALD as well as literature reported silica-supported TiO_2 catalysts. Authors have described the advantages of KCC-1/TiO_2 catalysts over MCM-41 and SBA-15 based TiO_2. Some of these include uniform and conformal coating, less reduction in surface, enhanced light harvesting properties and better accessibility of active sites[13].



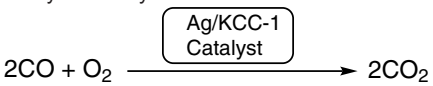
XIV) Optical sensing properties

KCC-1 has been also explored as sensor with optical sensing properties and is used for detection of Hg^{2+} detection with very good selectivity, and sensitivity. The sensor was developed by immobilizing the rhodamine-based receptor (RB-Si) within the fibers of KCC-1. Authors observed that spirolactam ring opening of the rhodamine groups are the main reason for the fluorescence enhancement responses of RB-KCC-1 and obtained a detection limit of 9.05×10^{-7}. Based on the results obtained authors conclude that the synthesized materials are potential candidates for the detection and effective removal of Hg^{2+} in biological, environmental, and industrial fields[31]. The below figure indicates the Graphical representation of RB-Si Immobilized KCC-1 acted as a sensor for the detection of Hg^{+2} ions.



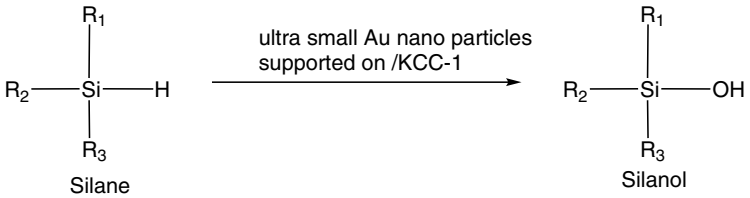
XV) Effect of pore structure of silica on CO oxidation activity

J. Xu et al. studied the CO oxidation reaction using different Ag supported on mesoporous supports such as MCM-41, SBA-15 and KCC-1. Authors observed that the morphology of the supports influence the dispersion of Ag nanoparticles, consequently shows difference in catalytic activity. It was mentioned that when KCC-1 was used, the migration and agglomeration of Ag particles can be effectively hindered by the open access mesopores. Authors therefore conclude that in comparison with SBA-15 and MCM-41, KCC-1 shows very high catalytic activity[8].



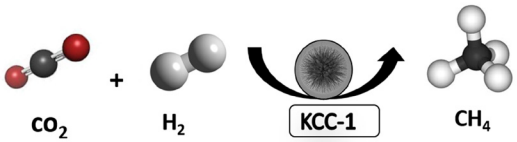
XVI) Oxidation of organosilanes to silanols

M. Dhiman et al. reported ultrasmall and pseudo single atoms of gold supported on KCC-1 for the oxidation of organosilanes to silanols with high Turnover Number (TON), which is nearly half a million (591,000) for dimethylphenyl silane as a model substrate). The Extraordinary catalytic activity and stability in this study was attributed to dispersion of ultrasmall nanoparticles and pseudo-single atoms of Au as well as Auδ+ species on fibers of KCC-1. This oxidation was carried out only at 45°C using water as an oxidant and hydrogen was observed to be the by-product in this study. Authors also mention that, it was possible to easily separate Au based KCC-1 catalyst and they are stable for several cycles. These results clearly indicates the reusability of catalyst[32].



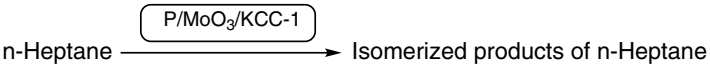
XVII) CO_2 methanation

Hamid et al. studied the catalytic activity of KCC-1 for CO_2 methanation and found that KCC-1 is a probable candidate for the examined reaction as compared to MCM-41. The high activity of KCC-1 was attributed to the presence of abundant oxygen vacancy facilitating the CO_2 adsorption/dissociation. With the help of IR studies, it was also explained that KCC-1 has significantly higher basicity in addition to oxygen vacancy than that of MCM-41. These two properties of the catalysts were explained as reasons for improved catalytic performance of the catalyst. KCC-1 in this research work show good stability throughout 90 h of reaction due to the resistance towards Ostwald ripening[7]. Graphical representation of CO_2 methanation using KCC-1 is presented below.



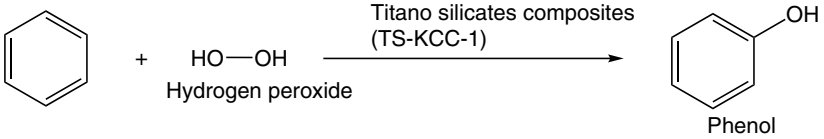
XVIII) n-Heptane isomerization

Fatah et al. synthesized Molybdenum oxide (MoO_3) supported KCC-1 and phosphorus (P) loaded on MoO_3/KCC-1 (P/MoO_3/KCC-1) and studied its activity for n-Heptane isomerization. Synthesis was carried out by mixing the MoO_3 and KCC-1 powder in a ball mill equipment. For doing this, an agate container having 300 cm^3 volume and six-piece of 20 mm diameter agate ball (weight of approximately 11 g each) were used. Authors found a slight change in the morphology after the addition of MoO_3 and modification with H_3PO_4. It was also observed MoO_3/KCC-1 shows excellent catalytic activity for n-heptane isomerization. This was attributed to the high amount and high accessibility of the active sites as well as the high dispersion of MoO_3[33]. Graphical representation of the process is presented below.



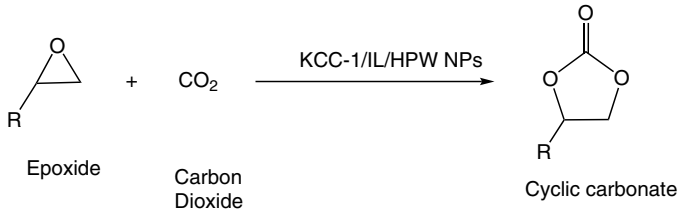
XIX) Benzene hydroxylation and 1-hexene epoxidation reactions

Yang et al. prepared nanosized monodispersed amphiphilic titanosilicate composite (TS-1@KCC-1) materials, which exhibited superior thermal stability as well as catalytic activity. These surface active titanosilicates were evaluated for their activity in benzene hydroxylation and 1-hexene epoxidation reactions. They observed that $Rh(OH)_3$ species supported TS-1@KCC-1 exhibited higher catalytic activity in benzene hydroxylation with hydrogen peroxide under Pickering Interface Catalysis (PIC) in comparison with phase-boundary catalysis (PBC). The PIC reaction system in this study demonstrates excellent chemical stability and reasonable reusability.[34]



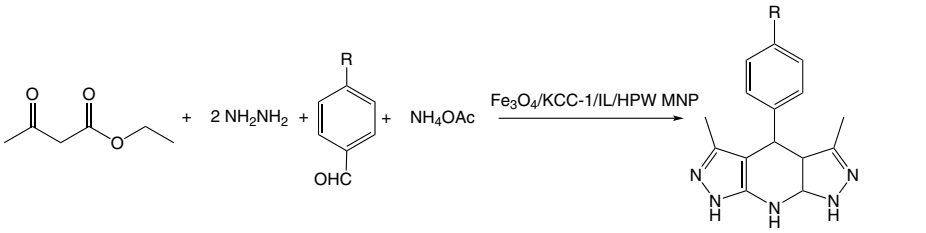
XX) Synthesis of cycliccarbonate from carbon dioxide and epoxides

S.M. Sadeghzadeh also studied the KCC-1 supported heteropolyacid-based ionic liquid (KCC-1/IL/HPW) for the synthesis of cycliccarbonate from carbon dioxide and epoxides under mild conditions. Authors observed increase in catalytic efficiency of IL/HPW after immobilization onto KCC-1 NPs and KCC-1/IL/HPW NPs are found to be recovered from the reaction mixture during the work-up procedure. Also the recycled catalyst was reused for ten consecutive cycles and observed to be active without any significant loss in catalytic activity. The developed method of synthesis in this study indicate a green and low-cost protocol for making heteropolyacid-based catalysts and is also promising for developing similar type of materials[35].



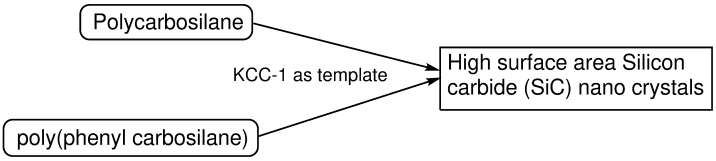
XXI) Synthesis of tetrahydrodipyrazolo pyridines

Using the developed heteropolyacid-based ionic liquid (KCC-1/IL/HPW) catalyst S.M. Sadeghzadeh also investigated the synthesis of tetrahydrodipyrazolo pyridines. Catalyst was found to be active for the studied reaction and also it was possible to recover and reuse it several times without any significant decrease in activity and selectivity. The high activity of the catalyst was attributed to high accessibility of active sites available with KCC-1 based catalyst[36].



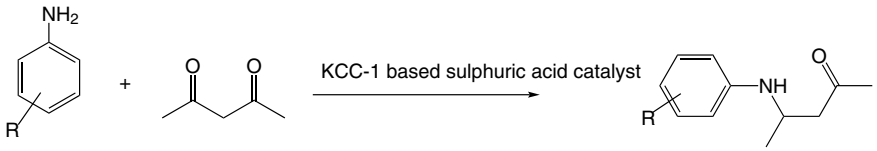
XXII) Synthesis of high surface area Silicon carbides (SIC)

Eunjin Jung et al. made an attempt to make high-surface area SiC spheres by the nano casting technology using a KCC-1 as a template. Polycarbosilane and poly(phenyl carbosilane) were used as the precursor for silicon carbide and it was possible to obtain hollow spheres by the inversion of a template structure. In this work, poly (phenyl carbosilane) worked as a binding agent due to its higher molecular weight. Fibrous strcture of KCC-1 was obtained for hollow spheres of silicon carbides. The resulting fibrous hollow spheres possessed SiC nano crystals and also shows 407 m^2/g BET surface area[37]. Graphical representation of the process that describes the synthesis of high surface area Silicon carbides (SIC) is shown below.

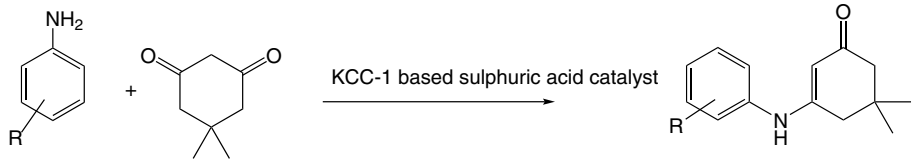


XXIII) Synthesis of β-enaminones

Z. N. Siddiqui et al. developed an efficient protocol for the preparation of β-enaminones using KCC-1 sulphuric acid catalyst. Synthesis of KCC-1 sulfuric acid (KCC-1-SA) was carried out by dispersing KCC-1 (1.0 g) in CH_2Cl_2 (10 mL) in a flask. This was achieved by first dissolving chlorosulfonic acid (8 mmol) in CH_2Cl_2 (10 mL) and the resulting solution was added to the KCC-1 suspension through a constant-pressure dropping funnel under stirring for around 30 min at room temperature. After this addition, the resulting mixture was stirred for another 30 min at room temperature. The obtained brown solid was collected by filtration and it was washed with ether (50 mL). Procedure was concluded with a drying step at room temperature. Authors carried out the reactions under thermal solvent-free conditions and after a few minutes they obtained excellent yields. It was concluded that the amount of catalyst used is very low and the followed methodology that is environmentally benign in comparison with H_2SO_4, in terms of the amount, hazardous nature and reaction conditions. It was possible to recover the catalyst and is recyclable up to seven cycles without much loss in activity[38].



R - H, p-OMe, m-NO_2, p-Cl, p-OH, p-CH_3

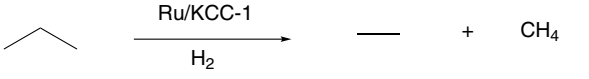


Aniline Di-ketone b-enaminone

R - H, p-OMe, m-NO_2, m-NO_2, p-Cl, p-OH, p-CH_3

XXIV) Hydrogenolysis of Alkanes

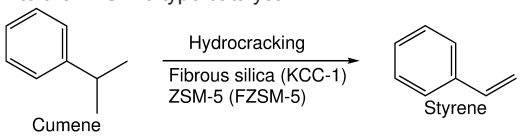
Fihri et al. studied Ru nanoparticle supported on KCC-1 for the hydrogenolysis of propane and ethane. It was observed from the TEM images that Ru nanopartciles are fully loaded on fibers of KCC-1. Authors proved that KCC-1 showed better catalytic performance as compared to conventional mesoporous silica materials such as MCM-41 and SBA-15. This examination was carried out by loading comparable Ru content on aforementioned supports and testing under identical conditions. It was also explained that the superior catalytic activity of KCC-1 based catalyst is attributed to high accessibility of Ru supported on KCC-1. In addition, high activity of Ru/KCC-1 catalyst was explained through HR-TEM studies. Authors mention that in case of Ru/KCC-1 hexagonal shaped nanoparticles were present having several corners and sharp edges and these possess reactive atoms with lowest coordination numbers. Catalyst based on KCC-1 was observed to be stable with excellent lifetime. Deactivation was not observed even after 8 days[3].



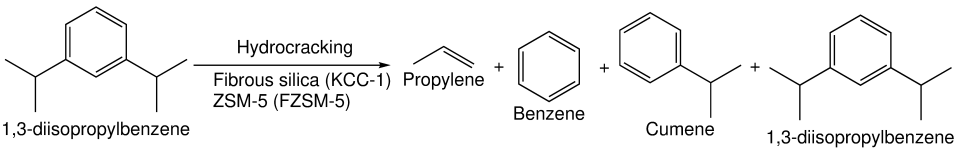
Propane Ethane Methane

XXV) Cumene hydrocracking

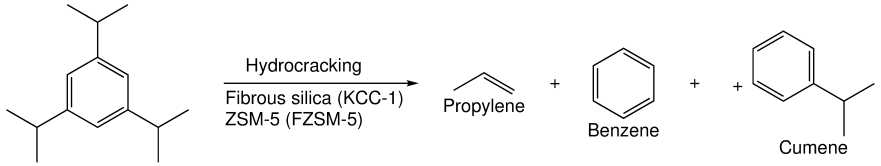
M. L. Firmansyah et al. prepared ZSM-5 zeoilte with KCC-1 by combining a microemulsion technique with zeolite seed-assisted crystallization. The resulting material (FZSM-5) possessed very good physicochemical properties such as high surface area, fibrous morphology and strong acid sites. Authors explained that the cumene hydrocracking activity of the material could be attributed to the large number of active sites as well as their high accessibility. High dispersion of the metal particle was also observed, which was mainly due to the large surface area of the FZSM-5 type catalyst. The catalytic activity for cumene hydrocracking and EB dehydrogenation was enhanced by the protonation and introduction of Pt into the FZSM-5 type catalyst[39].



Cumene Styrene



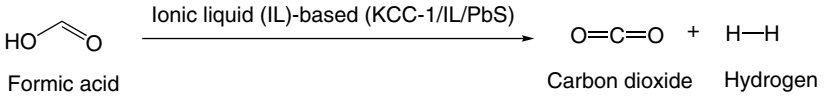
1,3-diisopropylbenzene 1,3-diisopropylbenzene



1,3,5-Triisopropylbenzene

XXVI) Dehydrogenation of aqueous solutions of HCOOH/HCOONa

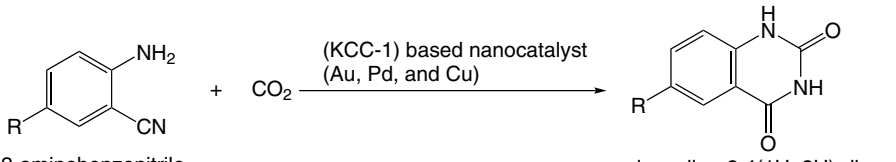
S.M. Sadeghzadeh synthesized a novel PbS (lead sulphide) containing Ionic liquid IL-based KCC-1 catalysts (KCC-1/IL/PbS) and studied their catalytic applications in dehydrogenation of aqueous solutions of HCOOH/HCOONa to H_2 and CO_2 gas. It was found that the activity was due to dendritic fibrous morphology of the KCC-1 as well as the synergistic effect between KCC-1/IL and the small PbS NPs. Catalysts investigated in this study could be recovered and reused at least ten times with no decrease in activity[40].



Formic acid — Carbon dioxide — Hydrogen

XXVII) Spidery catalyst for the synthesis of quinazoline-2,4(1H,3H)-diones

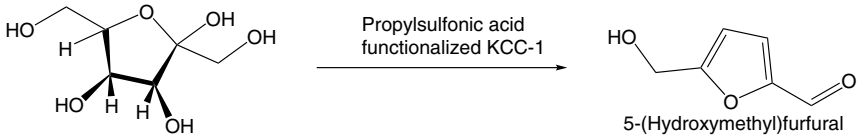
S.M. Sadeghzadeh synthesized multi-carboxylic hyperbranched polyglycerol groups (HPG) functionalized KCC-1 and nanocatalysts based on noble metal (Au, Pd, and Cu) were developed with the functionalized KCC-1. These resulting catalysts observed to be having ultrasmall size and monodisperse particles with uniform distribution, and high loading capacity. With the help of synthesized catalysts, an economically viable and green protocol was developed for reaction of CO_2 with 2-aminobenzonitrile to obtain quinazoline-2,4(1H, 3H)-diones. Authors examined the impact of HPG by synthesizing catalyst with HPG functionalization and without HPG functionalization i.e KCC-1/HPG/X (X = Au, Pd, Cu) and KCC-1/X (X = Au, Pd, Cu). It was observed that the amount of motionless nanoparticles in KCC-1/HPG/X were about twice that in KCC-1/X. From the results, the effectiveness of HPG functionalization on KCC-1 was demonstrated[41].



2-aminobenzonitrile — quinazoline-2,4(1H, 3H)-dione

XXVIII) Production of 5 hydroxymethylfurfural (HMF)

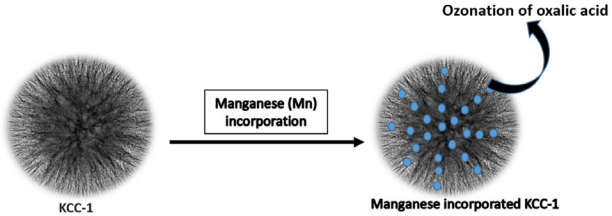
N. Chermahini et al. functionalized KCC-1 with propylsulfonic acid groups (Pr-SO_3H) and investigated resulting catalysts efficiency for the production of 5 hydroxymethylfurfural (HMF) by the dehydration of fructose. Authors achieved 67.71% yield and 68.32% selectivity for the HMF at a 99.11% fructose conversion. Although the acid loading on the catalyst surface was low, the results observed in this study are better as compared to the reported studies. It was explained that the catalyst was reusable and can be synthesized by an environmentally friendly process for the heterogeneous catalytic manufacture of 5-HMF[42].



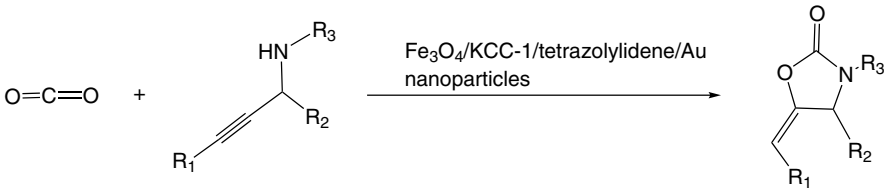
(2S,3*S*,4R,5*R*)-2,5-bis(hydroxymethyl)tetrahydrofuran-2,3,4-triol — 5-(Hydroxymethyl)furfural

XXIX) Ozonation of oxalic acid

S. Afzala et al. investigated the Manganese incorporated fibrous silica nanosphere (MnOx-0.013/KCC-1) for ozonation of oxalic acid. Synthesized catalysts show excellent activity and stability with minimum Mn leaching in comparison to MnOx loaded on MCM-41. The high catalytic activity of studied catalysts was attributed to the generation of hydroxyl radical. Authors mentioned that surfacehydroxyl groups observed with the help of phosphates and ATR-FTIR were found to be active sites[43]. Graphical representation of Mn loaded KCC-1 used for ozonation of oxalic acid is shown below.



S.M. Sadeghzadeh studied gold (III) phosphorus complex containing HPG-based KCC-1 and tested its catalytic activity for the cyclization of propargylic amines with CO_2 to provide 2-oxazolidinones. It was observed that hot filtration tests and selective catalyst poison examinations showed the presence of soluble Au species during the reaction process. However, recovery studies demonstrated that no significant decrease has occurred in the activity and metal content of recovered KCC-1/IL/Au. On the other hand catalysts were able to be recovered and reused at least ten times with no loss in activity and selectivity. Through the obtained results it was concluded that superior effectiveness of HPG@KCC-1/PPh_2/Au nanocatalyst was attributed to isolated HPG units incorporated in the fibers of KCC-1, which could control the mechanistic aspects through preventing the formation of agglomerated gold (III) phosphorus complex and stabilization of active catalytic gold species[44].

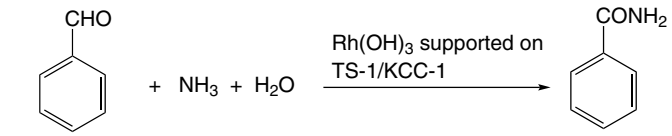


Propargylic amine derivatives

2-oxazolidinone

XXX) One-pot synthesis of benzamide

Hong-gen Peng et al. Synthesized a core–shell material consisting of KCC-1 and encapsulated TS-1 zeolite (Si/Ti=40) in a microemulsion system. $Rh(OH)_3$ species were supported on KCC-1 and the resulting bifunctional $Rh(OH)_3$/TS-1@KCC-1 catalyst was used for obtaining primary amides from aldehyde, NH_3 and H_2O_2 through one-pot ammoximation and rearrangement(benzamide from benzaldehyde). Authors explained that Titanosilicates are potential candidates for catalyzing the oxidation of NH_3 with H_2O_2 to yield the hydroxylamine intermediate. The formed intermediate again reacts with aldehydes or ketones via non-catalytic oximation to produce oximes. In this study, the $Rh(OH)_3$ species are considered to be the catalytic sites for the rearrangement of aldehyde oximes to amides. The synthesized TS-1@KCC-1 catalyst was also found to have superior hydrothermal and mechanical stability and is a robust support for dispersing and stabilizing the $Rh(OH)_3$ species[45].



Benzaldehyde

Benzamide

Catalog Products of KCC-1

Different grades of KCC-1 products have been included in the catalogue and these products based on their varied properties can have different applications in catalysis, paints& coatings, cosmetics and drug delivery. Table.1 indicates the particle size, specific surface area and pore volume of different grades of KCC-1. Figure (1-6) show the Transition Electron Microscopy (TEM) images of KCC-1 product portfolio.

Category	Grade	Particle size (nm)	Spec.Surface Area (m^2/g)	Pore Volume (cm^3/g)
Large	KCC-1 L1	~900-1000	~ 700	~1.40
	KCC-1 L2	~900-1000	~ 600	~1.20
	KCC-1 L3	~900-1000	~ 550	~0.80
Medium	KCC-1 M1	~400-450	~ 400	~0.50
	KCC-1 M2	~300-350	~ 600	~0.60
Small	KCC-1 S1	~ 130-190	~380	~ 0.80

Table.2: Summary of properties of KCC-1 product portfolio

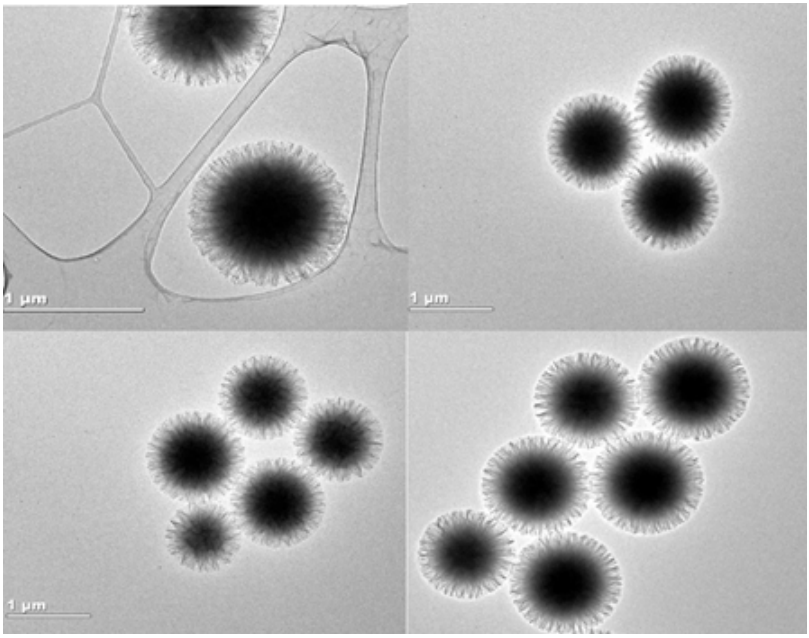


Figure.1: Transition Electron Microscopy images of KCC-1 (L1 grade)

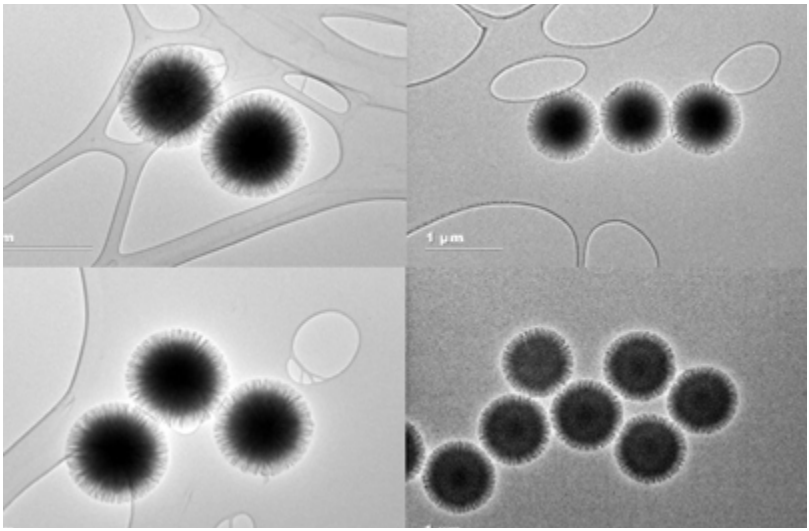


Figure.2: Transition Electron Microscopy images of KCC-1 (L2 grade)

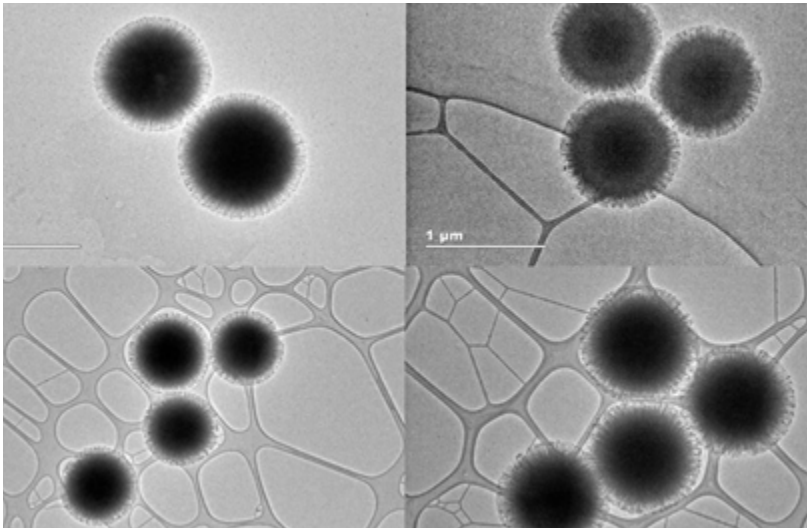


Figure 3: Transition Electron Microscopy images of KCC-1 (L3 grade)

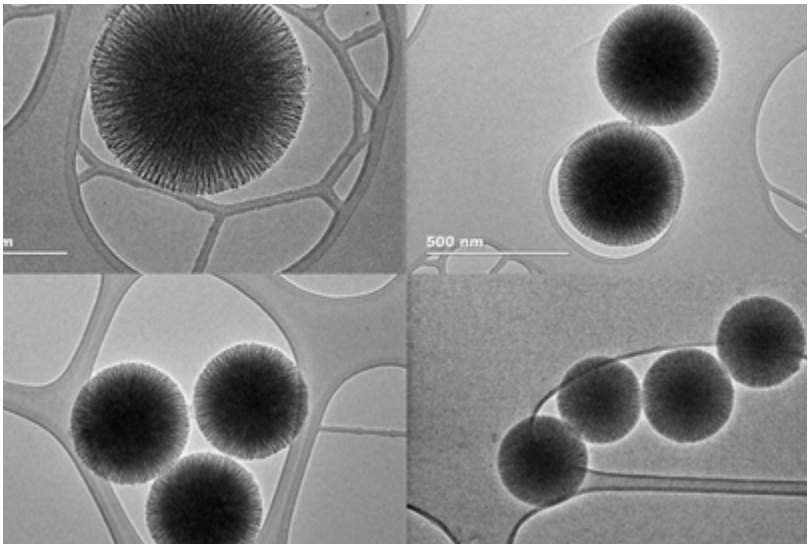


Figure 4: Transition Electron Microscopy images of KCC-1 (M1 grade)

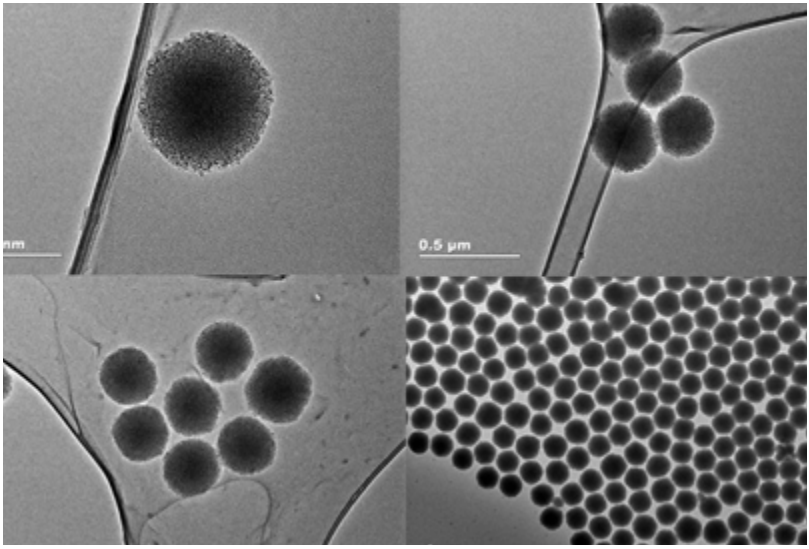


Figure 5: Transition Electron Microscopy images of KCC-1 (M2 grade)

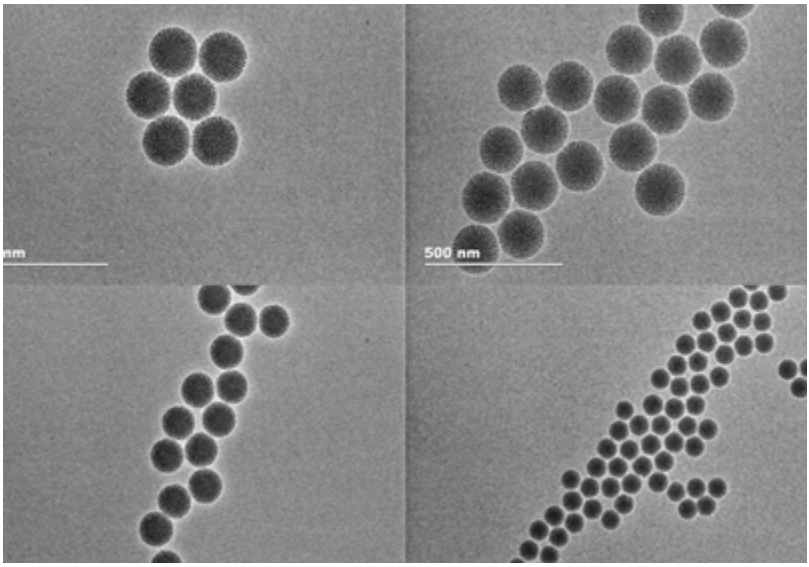


Figure 6: Transition Electron Microscopy images of KCC-1 (S1 grade)

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SILICON (Compounds)

14-6100 NEW

High Surface area Silica nanoparticles, large, particle size ~900-1000 nm, surface area ~700 m²/g, (KCC-1 L1) *(112945-52-5)*
SiO_2; FW: 60.09; white pwdr.; SA: ~700 m^2/g; P.Vol. ~1.4 cm^3/g
Note: Diameter: ~900-1000nm; This product is under license of patented Technology from King Abdullah University of Science and Technology – KAUST. Patent PCT/IB2010/002421.

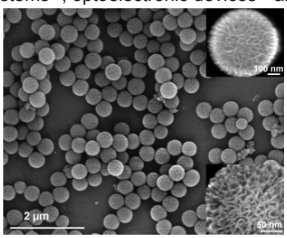
1g
5g

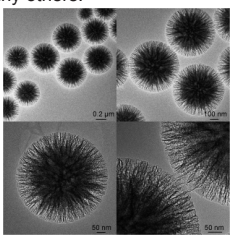
Technical Note:

1. Novel fibrous shaped silica nanospheres, denoted as KCC-1 (KAUST Catalysis Center)[1], have unique physical properties which have never before been reported in silica materials. These nanomaterials have been developed by Prof. J. M. Basset of King Abdullah University of Science and Technology (KAUST). A fibrous surface morphology arranged in three-dimensional structure forms the spheres (Fig. 1). Unlike traditional pore-based silica, these nanospheres possess a fibrous structure that increases accessibility to the available surface area; this in turn, significantly increases the catalytic activity.

   These materials exhibit excellent physical properties, including a high surface area, a fibrous surface morphology, good thermal and hydrothermal stabilities and high mechanical stability (Table 1). The fibrous morphology of KCC-1 remains unaffected even after mechanical compression up to 216 MPa pressure. This is superior to the conventional MCM-41 type of silica, which is affected at pressure 86 MPa.[1]

   A range of heterogeneous catalysts, prepared using KCC-1 as a supporting material, have been showing excellent catalytic activity for various transformations of research and industrial importance. As a catalyst support, sorbent or carrier, KCC-1 is able to demonstrate superior activity as compared to regular mesoporous silica materials in energy related processes[2-3], a variety of organic reactions[4-7], biomedical applications and drug delivery systems[8], optoelectronic devices[9] and many others.





Product #	Category	Grade	Particle Size (nm)	Surface Area (m^2/g)	Pore Volume (cm^3/g)
14-6100	Large	(KCC-1 L1)	~900-1000	~700	~1.4
14-6110	Large	(KCC-1 L2)	~900-1000	~600	~1.2
14-6120	Large	(KCC-1 L3)	~900-1000	~550	~0.9
14-6200	Medium	(KCC-1 M1)	~400-450	~400	~0.7
14-6210	Medium	(KCC-1 M2)	~300-350	~600	~0.6
14-6300	Small	(KCC-1 S1)	~130-190	~380	~0.8

References:

1. *Angew. Chem. Int. Ed*. **2010**, *49*, 9652
2. *Chem. Mater*. **2015**, *27*, 8237
3. *ACS Catalysis*. **2016**, *6*, 2770
4. *ChemSusChem* **2012**, *5*, 85
5. *Green Chem*., **2016**, *18*, 5890
6. *Angew. Chem. Int. Ed*. **2011**, *50*, 2747
7. *RSC Adv*., **2017**, *7,* 24885
8. *Langmuir* **2014**, *30*, 10886
9. *J. Mater. Chem. B*, **2015**, *3*, 3201

SILICON (Compounds)

14-6110 NEW
High Surface area Silica nanoparticles, large, particle size ~900-1000 nm, surface area ~600 m²/g, (KCC-1 L2) *(112945-52-5)*
SiO_2; FW: 60.09; white pwdr.; SA: ~600 m^2/g; P.Vol. ~1.20 cm^3/g
Note: Diameter: ~900-1000nm; This product is under license of patented Technology from King Abdullah University of Science and Technology – KAUST. Patent PCT/IB2010/002421.
1g 5g

Technical Note:
1. See 14-6100 (page 24)

14-6120 NEW
High Surface area Silica nanoparticles, large, particle size ~900-1000 nm, surface area ~550 m²/g (KCC-1 L3) *(112945-52-5)*
SiO_2; FW: 60.09; white pwdr.; SA: ~550 m^2/g; P.Vol. ~0.97 cm^3/g
Note: Diameter: ~900-1000nm; This product is under license of patented Technology from King Abdullah University of Science and Technology – KAUST. Patent PCT/IB2010/002421.
1g 5g

Technical Note:
1. See 14-6100 (page 24)

14-6200 NEW
High Surface area Silica nanoparticles, medium, particle size ~400-450 nm, surface area ~400 m²/g, (KCC-1 M1) *(112945-52-5)*
SiO_2; FW: 60.09; white pwdr.; SA: ~400 m^2/g; P.Vol. ~0.7 cm^3/g
Note: Diameter: ~400-450nm; This product is under license of patented Technology from King Abdullah University of Science and Technology – KAUST. Patent PCT/IB2010/002421.
1g 5g

Technical Note:
1. See 14-6100 (page 24)

14-6210 NEW
High Surface area Silica nanoparticles, medium, particle size ~300-350 nm, surface area ~600 m²/g, (KCC-1 M2) *(112945-52-5)*
SiO_2; FW: 60.09; white pwdr.; SA: ~600 m^2/g; P.Vol. ~0.6 cm^3/g
Note: Diameter: ~300-350nm; This product is under license of patented Technology from King Abdullah University of Science and Technology – KAUST. Patent PCT/IB2010/002421.
1g 5g

Technical Note:
1. See 14-6100 (page 24)

14-6300 NEW
High Surface area Silica nanoparticles, small, particle size ~130-190 nm, surface area ~380 m²/g, (KCC-1 S1) *(112945-52-5)*
SiO_2; FW: 60.09; white to beige pwdr.; SA: ~380 m^2/g; P.Vol. ~0.8 cm^3/g
Note: Diameter: ~130-190nm; This product is under license of patented Technology from King Abdullah University of Science and Technology – KAUST. Patent PCT/IB2010/002421.
1g 5g

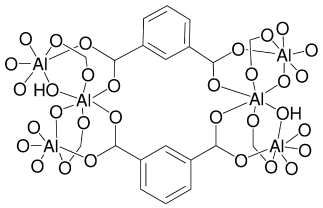
Technical Note:
1. See 14-6100 (page 24)

14-6310 NEW
High Surface area Silica nanoparticles, small, particle size ~40-50 nm, surface area ~520 m²/g, (KCC-1 S2) *(112945-52-5)*
SiO_2; FW: 60.09; white to beige pwdr.; SA: ~520 m^2/g; P.Vol. ~1.3 cm^3/g
Note: Diameter: ~40-50nm; This product is under license of patented Technology from King Abdullah University of Science and Technology – KAUST. Patent PCT/IB2010/002421.
1g 5g

ALUMINUM (Compounds)

13-0300 NEW

Aluminum hydroxide isophthalate MOF (CAU-10, Isophthalate:Al=0.9-1.0)
(1416330-84-1)
$Al(OH)(C_8H_4O_4)_x$, X = 0.9-1.0; white solid;
SA: 620-640 m^2/g ; P.Vol. 0.23-0.27 cm^3/g
Note: Particle size: 0.4-0.7 micron,
Thermal stability: 400ºC,
Activation temperature: 150ºC
Sold under license from Inven2 AS for research purposes only.
PCT/GB2009/001087.



500mg
2g

Technical Note:

1. MOF exhibits water adsorption characteristics which make it a promising adsorbent for application in heat-exchange processes[1]

References:

1. *Water adsorption behaviour of CAU-10-H: a thorough investigation of its structure–property relationships,* J. Mater. Chem. A, **2016**, *4*, 11859.
2. *Structures, Sorption Characteristics, and Nonlinear Optical Properties of a New Series of Highly Stable Aluminum MOFs*., Chem. Mater. **2013**, *25*, 17−26.

BIOCATALYSTS (Compounds)

07-3155 NEW

CalB immo 1090™ - Immobilized enzyme
white to slightly yellow spherical beads, dry
(store cold)
Note: Store in dry conditions (2-8°C). Do not freeze. Shelf Life: 1 year; Particle Size: 300-710 micron; CalB immo 1090 is an adsorbed preparation and is suitable for applications in solvent-free systems like oils, as well as organic solvents and it and can be used for (regio- and stereoselective) esterifications and transesterifications. CalB Immo 1090 has many advantages including high activity and the possibility to use in oils, organic solvent and bi-phasic systems. Sold in collaboration with Purolite for research purposes only.

10g
50g
250g

07-3152 NEW

CalB immo 5587™ - Immobilized enzyme
white to slightly yellow spherical beads, dry
(store cold)
Note: Store in dry conditions (2-8°C). Do not freeze. Shelf Life: 1 year; Particle Size: 300-710 micron; CalB immo 5587 is an adsorbed preparation and is particularly suitable for applications where cost is an essential parameter, like biodiesel or industrial oil manufacture. CalB Immo 5587 has many advantages including cost-effectiveness in processes like biodiesel manufacture. It is also a highly robust carrier, particularly suitable for column configurations. Sold in collaboration with Purolite for research purposes only.

10g
50g
250g

07-3159 NEW

CalB immo 5872™ - Immobilized enzyme
white to slightly yellow spherical beads, dry
(store cold)
Note: Store in dry conditions (2-8°C). Do not freeze. Shelf Life: 1 year; Particle Size: 300-1500 micron;CalB immo 5872 is an adsorbed preparation and is suitable for applications in solvent-free systems like oils, as well as organic solvents and it and can be used for (regio- and stereoselective) esterifications and transesterifications. CalB Immo 5872 has many advantages including cost-effectiveness and the possibility to use in oils, organic solvent and bi-phasic systems. Sold in collaboration with Purolite for research purposes only.

10g
50g
250g

BIOCATALYSTS (Compounds)

07-3142 NEW	**CalB immo 8285™ - Immobilized enzyme** white to slightly yellow spherical beads, dry *(store cold)* Note: Store in dry conditions (2-8°C). Do not freeze. Shelf Life: 1 year; Particle Size: 100-710 micron; CalB immo 8285 is covalently immobilized and is suitable for applications in water, organic solvents as well as solvent-free systems and can be used for (regio- and stereoselective) hydrolysis, esterifications and transesterifications. The lipase is immobilized by covalent immobilization onto Purolites highly hydrophobic carrier Purolite ECR8285 (an epoxy/butyl methacrylate co-polymer). Sold in collaboration with Purolite for research purposes only.	10g 50g 250g
07-3148 NEW	**CalB immo 8806™ - Immobilized enzyme** white to slightly yellow spherical beads, dry *(store cold)* Note: Store in dry conditions (2-8°C). Do not freeze. Shelf Life: 1 year; Particle Size: 300-710 micron; CalB immo 8806 is an adsorbed preparation and is suitable for applications in solvent-free systems like oils, as well as organic solvents and it and can be used for (regio- and stereoselective) esterifications and transesterifications. CalB Immo 8806 has many advantages including high activity and the possibility to use in oils, organic solvent and bi-phasic systems. Sold in collaboration with Purolite for research purposes only.	10g 50g 250g
96-4050	**CalB immo KIT™ - Immobilized enzyme** *See* page 107	
07-3130 NEW	**CalB immo Plus™ - Immobilized enzyme** white to off white spherical beads, dry *(store cold)* Note: Store in dry conditions (2-8°C). Do not freeze. Shelf Life: 1 year; Particle Size: 300-710 micron; CalB immo Plus is suitable for applications in organic solvents as well as solvent-free systems and can be used for (regio- and stereoselective) esterifications and transesterifications. CalB Immo Plus has many advantages including high activity and high mechanical stability. Sold in collaboration with Purolite for research purposes only.	10g 50g 250g
07-3133 NEW	**CalB immo Plus Food Grade™ - Immobilized enzyme** white to slightly yellow spherical beads, dry *(store cold)* Note: Store in dry conditions (2-8°C). Do not freeze. Shelf Life: 1 year; Particle Size: 300-710 micron; CalBimmo Plus Food Grade is supplied in food-grade quality and conforms to the General Specifications and Considerations for Enzyme Preparations Used in Food Processing of the Joint FAO/WHO Expert Committee on Food Additives (JECFA). CalB immo Plus is suitable for applications in organic solvents as well as a solvent-free systems and can be used for (regio- and stereoselective) esterifications and transesterifications. CalB Immo Plus has many advantages including high activity and high mechanical stability. Sold in collaboration with Purolite for research purposes only.	10g 50g 250g
06-0925 NEW	**Enzyme carrier Lifetech™ ECR1030M** White to off white spherical beads (wet); SA: 80 - 120 m^2/g *(store cold)* Note: Store in dry conditions (2-20°C). Do not freeze. Shelf Life: 5 years; Particle Size: 300-710 micron; Pore Diameter: 220-340 Å; Lifetech ECR1030M is a copolymer of divinylbenzene (DVB) and methacrylate with no functional groups. It is used for enzyme immobilization by adsorption (hydrophobic interaction) and it is particularly suitable for lipase immobilization such as CALB. Lifetech ECR1030M main features are high mechanical stability compared to other existing resins, low surface area that grants high enzyme activity at low protein loading. Sold in collaboration with Purolite for research purposes only.	50g 5x50g

BIOCATALYSTS (Compounds)

07-2215 NEW — **Enzyme carrier Lifetech™ ECR1504** — 50g, 5x50g
White to off white spherical beads (wet)
(store cold)
Note: Store in dry conditions (2-20°C). Do not freeze. Shelf Life: 5 years; Particle Size: 300-1200 micron; Lifetech ECR1504 is a copolymer of divinylbenzene (DVB) and styrene functionalized with tertiary amines. It is used for enzyme immobilization by ionic interaction of the ionizable surface aminoacids (Lys, Arg, His, Asp, Glu) with the tertiary amines on the polymer. It is particularly suitable for immobilization of enzymes with iP in the range 3 - 5 like many glycosidaseses. Lifetech ECR1504 main features are possibility to regenerate the resin, pH adjustment before immobilization and large particle size for column applications. Sold in collaboration with Purolite for research purposes only.

07-2220 NEW — **Enzyme carrier Lifetech™ ECR1508** — 50g, 5x50g
White to off white spherical beads (wet)
(store cold)
Note: Store in dry conditions (2-20°C). Do not freeze. Shelf Life: 5 years; Particle Size: 300-1200 micron; Lifetech ECR1508 is copolymer of divinylbenzene (DVB) and styrene functionalized with tertiary amines. It is used for enzyme immobilization by ionic interaction of the ionizable surface aminoacids (Lys, Arg, His, Asp, Glu) with the tertiary amines on the polymer. It is particularly suitable for immobilization of enzymes with iP in the range 3 - 5 like many glycosidaseses. Lifetech ECR1508 main features are possibility to regenerate the resin, pH adjustment before immobilization and large particle size for column applications. Sold in collaboration with Purolite for research purposes only.

07-2224 NEW — **Enzyme carrier Lifetech™ ECR1604** — 50g, 5x50g
White to off white spherical beads (wet)
(store cold)
Note: Store in dry conditions (2-20°C). Do not freeze. Shelf Life: 5 years; Particle Size: 300-1200 micron; Lifetech ECR1604 is a copolymer of divinylbenzene (DVB) and styrene functionalized with quaternary amines. It is used for enzyme immobilization by ionic interaction of the ionizable surface aminoacids (Lys, Arg, His, Asp, Glu) with the tertiary amines on the polymer. It is particularly suitable for immobilization of enzymes with iP in the range 3 - 5 like many glycosidaseses. Lifetech ECR1604 main features are possibility to regenerate the resin, pH adjustment before immobilization and large particle size for column applications. Sold in collaboration with Purolite for research purposes only.

07-2230 NEW — **Enzyme carrier Lifetech™ ECR1640** — 50g, 5x50g
White to off white spherical beads (wet)
(store cold)
Note: Store in dry conditions (2-20°C). Do not freeze. Shelf Life: 5 years; Particle Size: 300-1200 micron; Lifetech ECR1640 is a copolymer of divinylbenzene (DVB) and styrene functionalized with quaternary amines. It is used for enzyme immobilization by ionic interaction of the ionizable surface aminoacids (Lys, Arg, His, Asp, Glu) with the tertiary amines on the polymer. It is particularly suitable for immobilization of enzymes with iP in the range 3 - 5 like many glycosidaseses. Lifetech ECR1640 main features are possibility to regenerate the resin, pH adjustment before immobilization and large particle size for column applications. Sold in collaboration with Purolite for research purposes only.

06-0928 NEW — **Enzyme carrier Lifetech™ ECR1061M** — 50g, 5x50g
White to off white spherical beads (wet); SA: 400 - 510 m^2/g
(store cold)
Note: Store in dry conditions (2-20°C). Do not freeze. Shelf Life: 5 years; Particle Size: 300-710 micron; Pore Diameter: 600-750 Å; Lifetech ECR1061M is a copolymer of divinylbenzene (DVB) with methacrylate with no functional groups. It is used for enzyme immobilization by adsorption (hydrophobic interaction) and it is particularly suitable for lipase immobilization as CALB. Lifetech ECR1061M main features are higher porosity compared to Lifetech ECR1030M to allow better diffusion for bulky substrates or better application in viscous systems. Sold in collaboration with Purolite for research purposes only.

BIOCATALYSTS (Compounds)

06-0905 NEW	**Enzyme carrier Lifetech™ ECR1090F** White to off white spherical beads (wet); SA: 750 - 850 m^2/g *(store cold)* Note: Store in dry conditions (2-20°C). Do not freeze. Shelf Life: 5 years; Particle Size: 150-300 micron; Pore Diameter: 900-1100 Å; Lifetech ECR1090F is a copolymer of divinylbenzene (DVB) and styrene with high porosity and no functional groups. It is used for enzyme immobilization by adsorption (hydrophobic interaction) and it is particularly suitable for lipase immobilization. Lifetech ECR1090F main features are high porosity, high mechanical stability and high surface area. Sold in collaboration with Purolite for research purposes only.	50g 5x50g
06-0913 NEW	**Enzyme carrier Lifetech™ ECR1090M** White to off white spherical beads (wet); SA: 750 - 850 m^2/g *(store cold)* Note: Store in dry conditions (2-20°C). Do not freeze. Shelf Life: 5 years; Particle Size: 300-710 micron; Pore Diameter: 900-1100 Å; Lifetech ECR1090M is a copolymer of divinylbenzene (DVB) and styrene with high porosity and no functional groups. It is used for enzyme immobilization by adsorption (hydrophobic interaction) and it is particularly suitable for lipase immobilization. Lifetech ECR1090M main features are high porosity, high mechanical stability and high surface area. Sold in collaboration with Purolite for research purposes only.	50g 5x50g
06-0922 NEW	**Enzyme carrier Lifetech™ ECR1091M** White to off white spherical beads (wet); SA: > 450 m^2/g *(store cold)* Note: Store in dry conditions (2-20°C). Do not freeze. Shelf Life: 5 years; Particle Size: 300-710 micron; Pore Diameter: 950-1200 Å; Lifetech ECR1091M is a copolymer of divinylbenzene (DVB) and styrene with very high porosity and no functional groups. It is used for enzyme immobilization by adsorption (hydrophobic interaction) and it is particularly suitable for lipase immobilization. Lifetech ECR1091M main features are high porosity, high mechanical stability and high surface area. Sold in collaboration with Purolite for research purposes only.	50g 5x50g
06-0810 NEW	**Enzyme carrier Lifetech™ ECR8204F** White to off white spherical beads (wet) *(store cold)* Note: Store in dry conditions (2-8°C). Do not freeze. Shelf life: 6 months; Particle Size: 150-300 micron; Pore Diameter: 300-600 Å; Lifetech ECR8204F is a methacrylate polymer functionalized with epoxy groups, used for covalent enzyme immobilization. Epoxides form very stable covalent linkages with different protein surface groups as ε-NH2 in Lys or nucleophiles (amino, thiol, phenolic). Immobilization is performed under very mild experimental conditions of pH and temperature, at high ionic buffer strength. Lifetech ECR8204F main features are the low porosity, the hydrophilicity, high mechanical strengh and it is optimal for use in batch reactors. Sold in collaboration with Purolite for research purposes only.	50g 5x50g
06-0813 NEW	**Enzyme carrier Lifetech™ ECR8204M** White to off white spherical beads (wet) *(store cold)* Note: Store in dry conditions (2-8°C). Do not freeze. Shelf Life: 6 months; Particle size: 300-710 micron; Pore Diameter: 300-600 Å; Lifetech ECR8204M is a methacrylate polymer functionalized with epoxy groups, used for covalent enzyme immobilization. Epoxides form very stable covalent linkages with different protein surface groups as ε-NH_2 in Lys or nucleophiles (amino, thiol, phenolic). Immobilization is performed under very mild experimental conditions of pH and temperature, at high ionic buffer strength. Lifetech ECR8204M main features are the low porosity, the hydrophilicity, high mechanical strengh and it is optimal for use in batch reactors and columns.	50g 5x50g

BIOCATALYSTS (Compounds)

06-0817 NEW	**Enzyme carrier Lifetech™ ECR8209F** white to off white spherical beads (wet) *(store cold)* Note: Store in dry conditions (2-8°C). Do not freeze. Shelf Life: 6 months; Particle Size: 150-300 micron; Pore Diameter: 300-600 Å; Lifetech ECR8209F is a methacrylate polymer functionalized with epoxy groups, used for covalent enzyme immobilization. Epoxy groups form very stable covalent linkages with different protein surface groups as ε-NH_2 in Lys or nucleophiles (amino, thiol, phenolic). Immobilization is performed under very mild experimental conditions of pH and temperature, at high ionic buffer strength. Lifetech ECR8209F main features are the high porosity, the hydrophilicity and it is optimal for use in batch reactors.	50g 5x50g
07-1512 NEW	**Enzyme carrier Lifetech™ ECR8309F** white to off white spherical beads (wet); SA: 70 min. m^2/g *(store cold)* Note: Store in dry conditions (2-20°C). Do not freeze. Shelf Life: 5 years; Particle Size: 150-300 micron; Pore Diameter: 600-1200 Å; Lifetech ECR8309F is a methacrylate polymer functionalized with amino groups on a short spacer (C2). It is used for covalent enzyme immobilization by pre-activation of the resin with glutaraldehyde and to subsequently form very stable covalent linkages with different protein groups (amino, thiol, phenolic) under very mild experimental conditions of pH and temperature, at low ionic buffer strength. It can also be used for enzyme immobilization by ionic interaction of the ionizable surface aminoacids (Lys, Arg, His, Asp, Glu) with the charged amines on the polymer. Lifetech ECR8309F main features are the medium porosity, the hydrophilicity and its optimal use in batch reactors. Sold in collaboration with Purolite for research purposes only.	50g 5x50g
07-1515 NEW	**Enzyme carrier Lifetech™ ECR8309M** White to off white spherical beads (wet); SA: 70 min. m^2/g *(store cold)* Note: Store in dry conditions (2-20°C). Do not freeze. Shelf Life: 5 years; Particle Size: 300-710 micron; Pore Diameter: 600-1200 Å; Lifetech ECR8309M is a methacrylate polymer functionalized with amino groups on a short spacer (C2). It is used for covalent enzyme immobilization by pre-activation of the resin with glutaraldehyde and to subsequently form very stable covalent linkages with different protein groups (amino, thiol, phenolic) under very mild experimental conditions of pH and temperature, at low ionic buffer strength. It can also be used for enzyme immobilization by ionic interaction of the ionizable surface aminoacids (Lys, Arg, His, Asp, Glu) with the charged amines on the polymer. Lifetech ECR8309M main features are the medium porosity, the hydrophilicity and its optimal use in batch reactors and columns. Sold in collaboration with Purolite for research purposes only.	50g 5x50g
07-1518 NEW	**Enzyme carrier Lifetech™ ECR8315F** white to off white spherical beads (wet); SA: 60 min. m^2/g *(store cold)* Note: Store in dry conditions (2-20°C). Do not freeze. Shelf Life: 5 years; Particle Size: 150-300 micron; Pore Diameter: 1200-1800 Å; Lifetech ECR8315F is a methacrylate polymer functionalized with amino groups on a short spacer (C2). It is used for covalent enzyme immobilization by pre-activation of the resin with glutaraldehyde and to subsequently form very stable covalent linkages with different protein groups (amino, thiol, phenolic) under very mild experimental conditions of pH and temperature, at low ionic buffer strength. Lifetech ECR8315F main features are the high porosity, the hydrophilicity and its optimal use in batch reactors. Sold in collaboration with Purolite for research purposes only.	50g 250g

BIOCATALYSTS (Compounds)

07-1520 NEW
Enzyme carrier Lifetech™ ECR8315M 50g 250g
white to off white spherical beads (wet); SA: 60 min. m^2/g
(store cold)
Note: Store in dry conditions (2-20°C). Do not freeze. Shelf Life: 5 years; Particle Size: 300-710 micron; Pore Diameter: 1200-1800 Å; Lifetech ECR8315M is a methacrylate polymer functionalized with amino groups on a short spacer (C2). It is used for covalent enzyme immobilization by pre-activation of the resin with glutaraldehyde and to subsequently form very stable covalent linkages with different protein groups (amino, thiol, phenolic) under very mild experimental conditions of pH and temperature, at low ionic buffer strength. It can also be used for enzyme immobilization by ionic interaction of the ionizable surface aminoacids (Lys, Arg, His, Asp, Glu) with the charged amines on the polymer. Lifetech ECR8315M main features are the medium porosity, the hydrophilicity and its optimal use in batch reactors and columns. Sold in collaboration with Purolite for research purposes only.

07-1523 NEW
Enzyme carrier Lifetech™ ECR8409F 50g 250g
white to off white spherical beads (wet); SA: 70 min. m^2/g
(store cold)
Note: Store in dry conditions (2-20°C). Do not freeze. Shelf Life: 5 years; Particle Size: 150-300 micron; Pore Diameter: 600-1200 Å; Lifetech ECR8409F is a methacrylate polymer functionalized with amino groups on a long spacer (C6). It is used for covalent enzyme immobilization by pre-activation of the resin with glutaraldehyde and to subsequently form very stable covalent linkages with different protein groups (amino, thiol, phenolic) under very mild experimental conditions of pH and temperature, at low ionic buffer strength. It can also be used for enzyme immobilization by ionic interaction of the ionizable surface aminoacids (Lys, Arg, His, Asp, Glu) with the charged amines on the polymer. Lifetech ECR8409F main features are the medium porosity, the hydrophilicity and its optimal use in batch reactors. Sold in collaboration with Purolite for research purposes only.

07-1525 NEW
Enzyme carrier Lifetech™ ECR8409M 50g 250g
white to off white spherical beads (wet); SA: 70 min. m^2/g
(store cold)
Note: Store in dry conditions (2-20°C). Do not freeze. Shelf Life: 5 years; Particle Size: 300-710 micron; Pore Diameter: 600-1200 Å; Lifetech ECR8409M is a methacrylate polymer functionalized with amino groups on a long spacer (C6). It is used for covalent enzyme immobilization by pre-activation of the resin with glutaraldehyde and to subsequently form very stable covalent linkages with different protein groups (amino, thiol, phenolic) under very mild experimental conditions of pH and temperature, at low ionic buffer strength. It can also be used for enzyme immobilization by ionic interaction of the ionizable surface aminoacids (Lys, Arg, His, Asp, Glu) with the charged amines on the polymer. Lifetech ECR8409M main features are the medium porosity, the hydrophilicity and its optimal use in batch reactors and columns. Sold in collaboration with Purolite for research purposes only.

07-1528 NEW
Enzyme carrier Lifetech™ ECR8415F 50g 250g
white to off white spherical beads (wet); SA: 60 min. m^2/g
(store cold)
Note: Store in dry conditions (2-20°C). Do not freeze. Shelf Life: 5 years; Particle Size: 150-300 micron; Pore Diameter: 1200-1800 Å; Lifetech ECR8415F is a methacrylate polymer functionalized with amino groups on a long spacer (C6). It is used for covalent enzyme immobilization by pre-activation of the resin with glutaraldehyde and to subsequently form very stable covalent linkages with different protein groups (amino, thiol, phenolic) under very mild experimental conditions of pH and temperature, at low ionic buffer strength. It can also be used for enzyme immobilization by ionic interaction of the ionizable surface aminoacids (Lys, Arg, His, Asp, Glu) with the charged amines on the polymer. Lifetech ECR8415F main features are the high porosity, the hydrophilicity and its optimal use in batch reactors. Sold in collaboration with Purolite for research purposes only.

BIOCATALYSTS (Compounds)

07-1530 NEW	**Enzyme carrier Lifetech™ ECR8415M** White to off white spherical beads (wet); SA: 60 min. m^2/g *(store cold)* Note: Store in dry conditions (2-20°C). Do not freeze. Shelf Life: 5 years; Particle Size: 300-710 micron; Pore Diameter: 1200-1800 Å; Lifetech ECR8415M is a methacrylate polymer functionalized with amino groups on a long spacer (C6). It is used for covalent enzyme immobilization by pre-activation of the resin with glutaraldehyde and to subsequently form very stable covalent linkages with different protein groups (amino, thiol, phenolic) under very mild experimental conditions of pH and temperature, at low ionic buffer strength. It can also be used for enzyme immobilization by ionic interaction of the ionizable surface aminoacids (Lys, Arg, His, Asp, Glu) with the charged amines on the polymer. Lifetech ECR8415M main features are the high porosity, the hydrophilicity and its optimal use in batch reactors. Sold in collaboration with Purolite for research purposes only.	50g 5x50g
07-1532 NEW	**Enzyme carrier Lifetech™ ECR8806F** White to off white spherical beads (wet); SA: 70 min. m^2/g *(store cold)* Note: Store in dry conditions (2-20°C). Do not freeze. Shelf Life: 5 years; Particle Size: 150-300 micron; Pore Diameter: 350-600 Å; Lifetech ECR8806F is a methacrylic polymer functionalized with octadecyl groups. It is used for enzyme immobilization by adsorption (hydrophobic interaction) and it is particularly suitable for lipase and transaminases immobilization. Lifetech ECR8806F main features are very enzyme activity achieved upon immobilization compared to other existing resins. Sold in collaboration with Purolite for research purposes only.	50g 5x50g
07-1535 NEW	**Enzyme carrier Lifetech™ ECR8806M** White to off white spherical beads (wet); SA: 70 min. m^2/g *(store cold)* Note: Store in dry conditions (2-20°C). Do not freeze. Shelf Life: 5 years; Particle Size: 300-710 micron; Pore Diameter: 350-600 Å; Lifetech ECR8806M is a methacrylic polymer functionalized with octadecyl groups. It is used for enzyme immobilization by adsorption (hydrophobic interaction) and it is particularly suitable for lipase and transaminases immobilization. Lifetech ECR8806M main features are very high enzyme activity achieved upon immobilization compared to other existing resins. Optimal for column packed reactors. Sold in collaboration with Purolite for research purposes only.	50g 5x50g
06-0820 NEW	**Enzyme carrier Lifetech™ ECR8209M** white to off white spherical beads (wet); SA: 70 min. m^2/g *(store cold)* Note: Store in dry conditions (2-8°C). Do not freeze. Shelf Life: 6 months; Particle Size: 300-710 micron; Pore Diameter: 600-1200 Å; Lifetech ECR8209M is a methacrylate polymer functionalized with epoxy groups, used for covalent enzyme immobilization. Epoxy groups form very stable covalent linkages with different protein surface groups as ε-NH2 in Lys or nucleophiles (amino, thiol, phenolic). Immobilization is performed under very mild experimental conditions of pH and temperature, at high ionic buffer strength. Lifetech ECR8209M main features are the high porosity, the hydrophilicity and it is optimal use in batch reactors and columns.	50g 5x50g
06-0823 NEW	**Enzyme carrier Lifetech™ ECR8215F** white to off white spherical beads (wet); SA: 60 min. m^2/g *(store cold)* Note: Store in dry conditions (2-8°C). Do not freeze. Shelf Life: 6 months; Particle Size: 150-300 micron; Pore Diameter: 1200-1800 Å; Lifetech ECR8215F is a methacrylate polymer functionalized with epoxy groups, used for covalent enzyme immobilization. Epoxy groups form very stable covalent linkages with different protein surface groups as ε-NH_2 in Lys or nucleophiles (amino, thiol, phenolic). Immobilization is performed under very mild experimental conditions of pH and temperature, at high ionic buffer strength. Lifetech ECR8215F main features are the very high porosity, the hydrophilicity and it is optimal for use in batch reactors.	50g 5x50g

BIOCATALYSTS (Compounds)

06-0826 NEW — **Enzyme carrier Lifetech™ ECR8215M** — 50g, 5x50g
white to off white spherical beads (wet); SA: 60 min. m^2/g
(store cold)
Note: Store in dry conditions (2-8°C). Do not freeze. Shelf Life: 6 months; Particle Size: 300-710 micron; Pore Diameter: 1200-1800 Å; Lifetech ECR8215M is a methacrylate polymer functionalized with epoxy groups, used for covalent enzyme immobilization. Epoxy groups form very stable covalent linkages with different protein surface groups as ε-NH2 in Lys or nucleophiles (amino, thiol, phenolic). Immobilization is performed under very mild experimental conditions of pH and temperature, at high ionic buffer strength. Lifetech ECR8215M main features are the very high porosity, the hydrophilicity and its optimal use in batch reactors and columns.

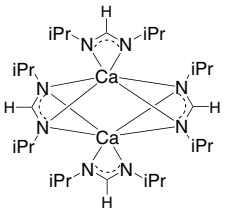
06-0828 NEW — **Enzyme carrier Lifetech™ ECR8285** — 50g, 5x50g
white to off white spherical beads (wet); SA: 100-200 m^2/g
(store cold)
Note: Store in dry conditions (2-8°C). Do not freeze. Shelf Life: 6 months; Particle Size: 250-1000 micron; Pore Diameter: 400-600 Å; Lifetech ECR8285 is a methacrylate polymer functionalized with both butyl and epoxy groups. This combination creates a good balance of hydrophobicity that makes the polymer optimal for immobilization of hydrophobic enzymes like lipases and transaminases. Epoxides form very stable covalent linkages with different protein groups (amino, thiol, phenolic) under very mild experimental conditions of pH and temperature. Lifetech ECR8285 main features are the process advtantages deriving from hydrophobic property combined with epoxy groups allowing the use in bi-phasic systems. Sold in collaboration with Purolite for research purposes only.

96-0255 — **Enzyme carrier Lifetech™ ECRKIT1**
See page 107

96-4065 — **Lipase immo Kit - Immobilized enzymes**
See page 109

CALCIUM (Compounds)

20-8200 NEW — **Bis(N,N'-diisopropylformamidinato)calcium(II) dimer, (99.99 %-Ca) PURATREM** *(1959584-78-1)* — 1g, 5g
$C_{28}H_{60}Ca_2N_8$; FW: 588.99; tan to light-brown pwdr.
air sensitive, moisture sensitive
Note: Product sold under, use subject to, terms and conditions of label license at www.strem.com/harvard2.



Technical Note:
1. Calcium amidinate precursor for the atomic layer deposition (ALD) of calcium containing thin films.

References:
1. Sang Bok Kim, Chuanxi Yang, Tamara Powers, Luke M. Davis, Xiabing Lou, and Roy G. Gordon, *Angew. Chem. Int. Ed.*, **2016**, *55*, 10228 –10233.

CARBON (Elemental Forms)

06-2530 NEW — **Graphene oxide (4mg/ml water dispersion) - low Mn.** *(1034343-98-0)* — 100ml, 500ml
C; brown liq.
Note: Diameter: 5-30 micron flakes;

06-0330 — **Graphene Quantum Dots (GQDs), Aqua-Green Luminescent** *(1034343-98-0)*
See page 48

06-0332 — **Graphene Quantum Dots (GQDs) in water, Aqua-Green Luminescent** *(1034343-98-0)*
See page 48

06-0334 — **Graphene Quantum Dots (GQDs), Blue Luminescent** *(1034343-98-0)*
See page 49

06-0336 — **Graphene Quantum Dots (GQDs) in water, Blue Luminescent** *(1034343-98-0)*
See page 49

06-0340 — **Graphene Quantum Dots (GQDs) in water, Cyan Luminescent** *(1034343-98-0)*
See page 49

CARBON (Elemental Forms)

06-0365 NEW
High Strength Metallurgical Graphene on GLASS HSMG® (10x10mm) 1pc
(1034343-98-0)
C; FW: 12.011
Note: HSMG® Sold under license for research purposes only.
U.S. Patent no. 9,284,640 B2.

06-0345 NEW
High Strength Metallurgical Graphene on PMMA HSMG® (10x10mm) 1pc
(1034343-98-0)
C; FW: 12.011
Note: HSMG® Sold under license for research purposes only.
U.S. Patent no. 9,284,640 B2.

06-0355 NEW
High Strength Metallurgical Graphene on PMMA HSMG® (25x25mm) 1pc
(1034343-98-0)
C; FW: 12.011
Note: HSMG® Sold under license for research purposes only.
U.S. Patent no. 9,284,640 B2.

06-0360 NEW
High Strength Metallurgical Graphene on PMMA HSMG® (50x50mm) 1pc
(1034343-98-0)
C; FW: 12.011
Note: HSMG® Sold under license for research purposes only.
U.S. Patent no. 9,284,640 B2.

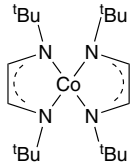
CHROMIUM (Compounds)

24-0000 NEW
Chromium(III) acetate, 97% *(1066-30-4)* 100g 500g
$Cr(CH_3CO_2)_3$; FW: 229.13; green pwdr.

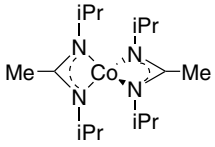
24-2427 NEW HAZ
Chromium (III) naphthenate, 30-40% in heavy naphtha (2-2.5% Cr) 100g 500g
(61788-69-0)
green liq.

COBALT (Compounds)

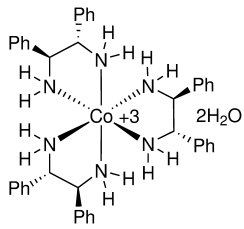
27-1025 NEW
Bis(1,4-di-t-butyl-1,3-diazabutadienyl)cobalt(II) $Co(DAD)_2$, min. 98% (99.999%-Co) PURATREM 250mg 1g 5g
(177099-51-3)
$C_{20}H_{40}CoN_4$; FW: 395.49; dark green-blue xtl.
air sensitive
Note: U.S. Patent Application No. 13/818,154. Product sold under, use subject to, terms and conditions of label license at www.strem.com/waynestate1



27-0486 NEW amp HAZ
Bis(N,N'-di-i-propylacetamidinato)cobalt(II), min. 98% (99.99%-Co) PURATREM (Co(iPr-MeAMD)$_2$ *(635680-58-9)* 250mg 1g 5g
$C_{16}H_{34}CoN_4$; FW: 341.40; green xtl.
air sensitive, moisture sensitive
Note: Product sold under, use subject to, terms and conditions of label license at www.strem.com/harvard2.



27-4010 NEW
lambda-Tris[(1S,2S)-1,2-diphenyl-1,2-ethanediamine]cobalt(III) chloride tetrakis[3,5-bis(trifluoromethyl)phenyl]borate dihydrate SKJ-1 50mg 250mg
(1542135-29-4)
$C_{74}H_{60}BCl_2CoF_{24}N_6$; FW: 1629.92(1665.92); orange pwdr.
Note: U.S. Patent 14/417655

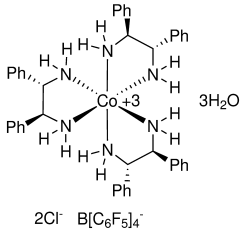


$2Cl^-$ $B[C_6H_3(CF_3)_2]_4^-$

COBALT (Compounds)

27-4011 NEW

delta-Tris[(1S,2S)-1,2-diphenyl-1,2-ethanediamine]cobalt(III) chloride tetrakis(2,3,4,5,6-pentafluorophenyl)borate trihydrate SKJ-3 *(1867120-15-7)*
$C_{66}H_{48}BCl_2CoF_{20}N_6$; FW: 1445.74 (1501.80); orange solid
Note: U.S. Patent 14/417655



50mg
250mg

COPPER (Compounds)

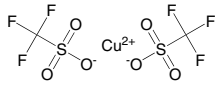
29-0225 NEW

Copper(I) bromide, dimethyl sulfide complex, 99% *(54678-23-8)*
BrC_2CuH_6S; FW: 205.59; off-white to light-green pwdr.
moisture sensitive

5g
25g

29-5001 NEW HAZ

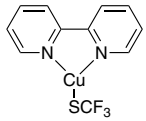
Copper(II) trifluoromethanesulfonate, 99% (99.9%-Cu) (Copper triflate) *(34946-82-2)*
$Cu(CF_3SO_3)_2$; FW: 361.68; light green solid
air sensitive



5g
25g
100g

29-5515

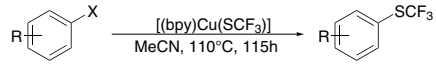
Trifluoromethylthiolato(2,2-bipyridine)copper(I), 97% *(1413732-47-4)*
$C_{11}H_8CuF_3N_2S$; FW: 320.80; red xtl.
air sensitive, moisture sensitive



250mg
1g

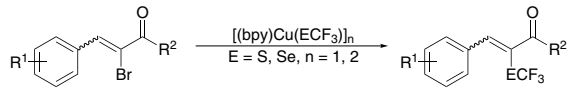
Technical Notes:

1. Catalyst for nucleophilic trifluoromethylthiolation of aryl halides.
2. Catalyst for synthesis of α-trifluoromethylthio- and seleno-α,β-unsaturated carbonyl compounds.
3. Catalyst for trifluoromethylthiolation of vinyl bromides.
4. Catalyst for trifluoromethylthiolation of bromopyridines.

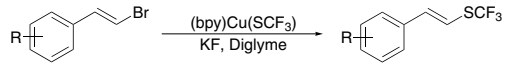


X = Br, I
R = H, Me, Ph, Cl, CO_2Me, CN, NO_2, OMe

Tech. Note (1)
Ref. (1,2)

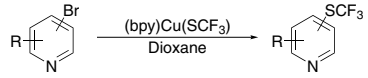


Tech. Note (2)
Ref. (3)



R = OMe, NMe, NO_2, CF_3, F, Cl, *et al.*

Tech. Note (3)
Ref. (4)



Tech. Note (4)
Ref. (4)

References:

1. *Angew. Chem. Int. Ed.* **2013**, *52*, 1548.
2. *Tetrahedron*, **2013**, *69*, 6046.
3. *Tetrahedron*, **2014**, *70*, 672.
4. *J. Org. Chem.* **2015**, *80*, 2912.
5. *Adv. Synth. Catal.* **2016**, *358*, 386.

ELECTROPOLISHED STAINLESS STEEL BUBBLERS (Vertical)

95-4002 NEW	**Stainless steel bubbler, 1200ml, vertical, electropolished with fill-port, high temp valves (315°C), DOT 4B, UN stamped** Note: See the Technical Note tab at strem.com for drawings.	1cyl
95-3000 NEW	**Stainless steel bubbler, 150ml, vertical, electropolished with fill-port, replaceable-seat valves with rotated handles, DOT 4B, UN stamped** Note: See the Technical Note tab at strem.com for drawings.	1cyl

GERMANIUM (Compounds)

32-3215 NEW	**Germanium(II) chloride dioxane adduct** *(28595-67-7)* $C_4H_8Cl_2GeO_2$; FW: 231.65 *air sensitive, moisture sensitive*	2g 10g

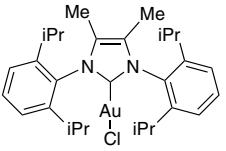
GOLD (Elemental Forms)

79-0921 NEW	**Gold nanoparticles, 1% on carbon black (surfactant and reactant-free)** *(7440-57-5)* Au; FW: 196.70; black solid *(store cold)* Note: Manufactured by laser ablation. Sold in collaboration with Particular® for research purposes only.	5g 25g
79-0916 NEW	**Gold nanoparticles, 1% on Titania (anatase) (surfactant and reactant-free)** *(7440-57-5)* Au; FW: 196.70; dark purple pwdr. *(store cold)* Note: Manufactured by laser ablation. Sold in collaboration with Particular® for research purposes only.	5g 25g
79-0905 NEW	**Gold nanoparticles, 1% on Titania (rutile) (surfactant and reactant-free)** *(7440-57-5)* Au; FW: 196.70; purple solid *(store cold)* Note: Manufactured by laser ablation. Sold in collaboration with Particular® for research purposes only.	5g 25g
79-0926 NEW	**Gold nanoparticles, 5% on carbon black (surfactant and reactant-free)** *(7440-57-5)* Au; FW: 196.70; black solid *(store cold)* Note: Manufactured by laser ablation. Sold in collaboration with Particular® for research purposes only.	5g 25g
79-0935 NEW	**Gold nanoparticles, 10% on Titania (anatase) (surfactant and reactant-free)** *(7440-57-5)* Au; FW: 196.70; purple solid *(store cold)* Note: Manufactured by laser ablation. Sold in collaboration with Particular® for research purposes only.	1g 5g
79-0930 NEW	**Gold nanoparticles, 10% on Titania (rutile) (surfactant and reactant-free)** *(7440-57-5)* Au; FW: 196.70; dark purple solid *(store cold)* Note: Manufactured by laser ablation. Sold in collaboration with Particular® for research purposes only.	1g 5g

GOLD (Compounds)

79-1230 NEW

Chloro{1,3-bis[2,6-bis(1-methylethyl) phenyl]-1,3-dihydro-4,5-dimethyl-2H-imidazol-2-ylidene}gold(I), 98% IPrMeAuCl *(1192141-66-4)*
$C_{29}H_{40}AuClN_2$; FW: 649.0; white pwdr.
air sensitive

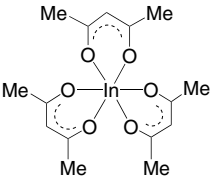


100mg
500mg

INDIUM (Compounds)

49-4901 NEW

Indium(III) acetylacetonate (99.99+%-In) PURATREM *(14405-45-9)*
$In(CH_3COCHCOCH_3)_3$; FW: 412.15; off-white pwdr.; m.p. 180-185; b.p. 260-280 subl.; d. 1.41

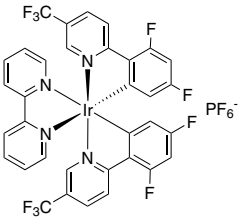


5g
25g

IRIDIUM (Compounds)

77-0220 NEW

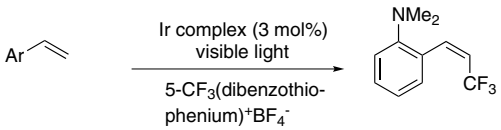
(2,2'-Bipyridine)bis[3,5-difluoro-2-[5-(trifluoromethyl)-2-pyridinyl-kN][phenyl-kC]iridium(III) hexafluorophosphate, 95% *(1092775-62-6)*
$C_{34}H_{18}F_{16}IrN_4P$; FW: 1009.70; yellow pwdr.
air sensitive
Note: Photocatalyst



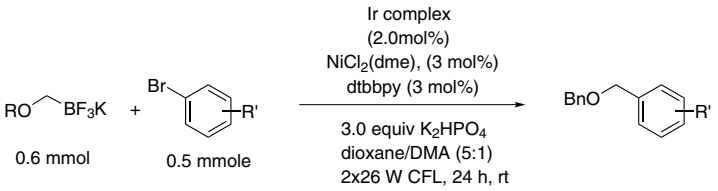
50mg
250mg

Technical Notes:

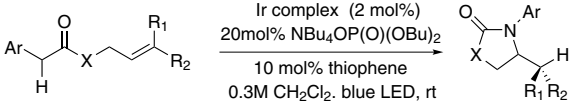
1. Photocatalyst used for the chemo-, regio, and stereoselective trifluoromethylation of styrene.
2. Photoredox catalyst used in cross-coupling: Ir/Ni dual catalysts for the synthesis of benzylic ethers.
3. Iridium complex used for catalytic olefin hydroamidation enabled by proton-coupled electron transfer.
4. Catalyst used for visible light photoredox cross-coupling of acyl chlorides with potassium alkoxymethyltrifluoroborates.
5. Iridium catalyst used in the photoredox/nickel dual catalytic cross-coupling of secondary alkyl β-trifluoroboratoketones and –esters with aryl bromides.
6. Photocatalyst used in the cross-coupling of trifluoroalkylboranes.



Tech. Note (1)
Ref. (1)



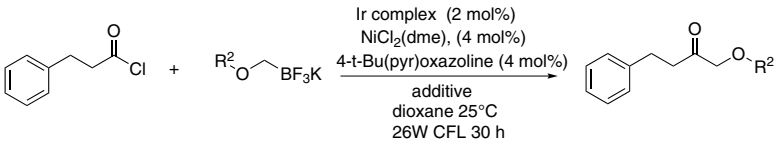
Tech. Note (2)
Ref. (2)



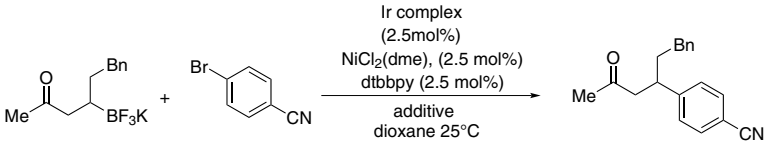
Tech. Note (3)
Ref. (3)

IRIDIUM (Compounds)

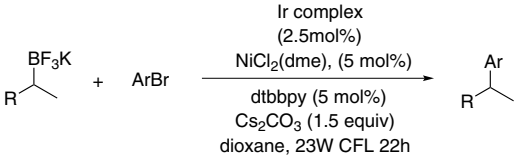
77-0220 (cont.) **(2,2'-Bipyridine)bis[3,5-difluoro-2-[5-(trifluoromethyl)-2-pyridinyl-kN][phenyl-kC]iridium(III) hexafluorophosphate, 95%** *(1092775-62-6)*



Tech. Note (4)
Ref. (4)



Tech. Note (5)
Ref. (5)



Tech. Note (6)
Ref. (6)

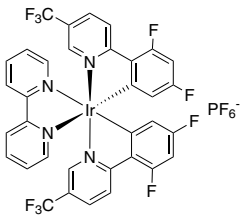
References:

1. *J. Org. Chem.*, **2014**, *79*, 10446.
2. *Org. Lett.*, **2015**, *17*, 3294.
3. *J. Am. Chem. Soc.*, **2015**, *137*, 13495.
4. *Org. Lett.*, **2016**, *18*, 732.
5. *Org. Lett.*, **2016**, *18*, 2994.
6. *Org. Lett.*, **2016**, *18*, 5760.

77-0453

NEW

(2,2'-Bipyridine)bis[3,5-difluoro-2-[5-trifluoromethyl-2-pyridinyl-kN)phenyl-kC]iridium(III) hexafluorophosphate, 99% *(1092775-62-6)*
$[Ir(C_{10}H_8N_2)(C_{12}H_5F_5N)_2]$ PF_6; FW: 1009.70; yellow pwdr.
Note: Photocatalyst



50mg
250mg

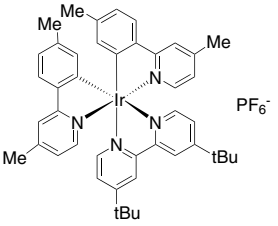
Technical Notes:

1. See 77-0220 (page 37)

IRIDIUM (Compounds)

77-0218 NEW

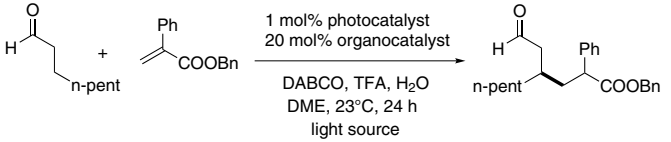
4,4'-Bis(t-butyl-2,2'-bipyridine]bis[5-methyl-2-(4-methyl-2-pyridinyl-kN)phenyl-kC]iridium hexafluorophosphate, 95% *(1607469-49-7)*
$C_{44}H_{48}F_6IrN_4P$; FW: 970.06; yellow pwdr.
air sensitive
Note: Photocatalyst



50mg
250mg

Technical Note:

1. Catalyst used for the direct β-alkylation of aldehydes via photoredox organocatalysis.



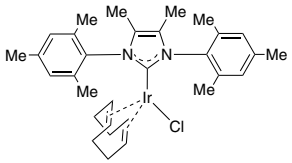
Tech. Note (1)
Ref. (1)

References:

1. *J. Am. Chem. Soc.*, **2014**, *136*, 6858.

77-1845 NEW

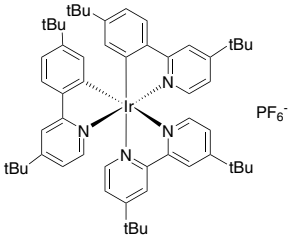
Chloro(1,5-cyclooctadiene)[4,5-dimethyl-1,3-bis(2,4,6-trimethylphenyl) imidazol-2-ylidene] iridium(I), min. 98% *(1118917-09-1)*
$C_{31}H_{40}ClIrN_2$; FW: 668.33; yellow pwdr.; m.p. >200C (dec)



100mg
500mg

77-0285 NEW

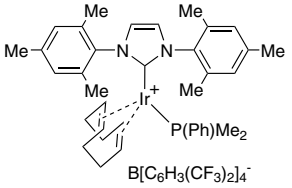
[4,4'-Di-t-butyl-2,2'-bipyridine][bis[5-(t-butyl)-2-[4-(t-butyl)-2-pyridinyl-kN]phenyl-kC] iridium(III) hexafluorophosphate, 95% *(808142-80-5)*
$C_{56}H_{72}F_6IrN_4P$; FW: 1138.38; yellow pwdr.
air sensitive
Note: Photocatalyst



50mg
250mg

77-1850 NEW

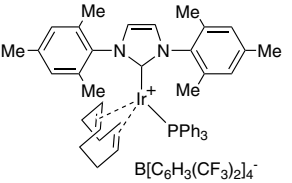
Dimethylphenylphosphine(1,5-cyclooctadiene)[1,3-bis(2,4,6-trimethylphenyl)imidazol-2-ylidene] iridium(I) tetrakis(3,5-bis(trifluoromethyl)phenylborate, min. 98% *(1884137-92-1)*
$C_{37}H_{47}IrN_2P(C_{32}H_{12}BF_{24})$; FW: 1606.18; red solid; m.p. 146-149



100mg
500mg

77-1840 NEW

Triphenylphosphine(1,5-cyclooctadiene) [1,3-bis(2,4,6-trimethylphenyl)imidazol-2-ylidene] iridium(I) tetrakis(3,5-bis(trifluoromethyl)phenylborate, min. 98% *(1628471-64-6)*
$C_{47}H_{51}IrN_2P(C_{32}H_{12}BF_{24})$; FW: 1730.32; red solid; m.p. > 156C (dec)

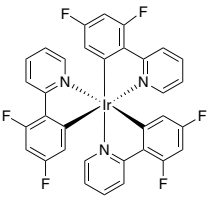


100mg
500mg

IRIDIUM (Compounds)

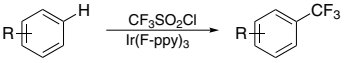
77-7030 NEW

Tris[2-(2,4-difluorophenyl)pyridine] iridium(III), 95% *(387859-70-3)*
$C_{33}H_{18}F_6IrN_3$; FW: 762.72; yellow pwdr.
air sensitive
Note: Photocatalyst

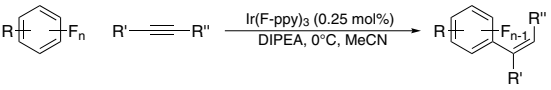


50mg
250mg

Technical Notes:
1. Photoredox catalysis for trifluoromethylation of arenes and heteroarenes.
2. Photocatalyst for C–F alkenylation coupling reactions between perfluoroarenes and alkynes.



Tech. Note (1)
Ref. (1)



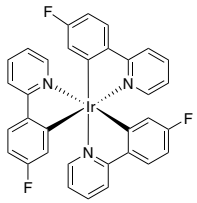
Tech. Note (2)
Ref. (2)

References:

1. *Nature*, **2011**, *480*, 224.
2. *Chem. Sci.,* **2016**, *7*, 6796.

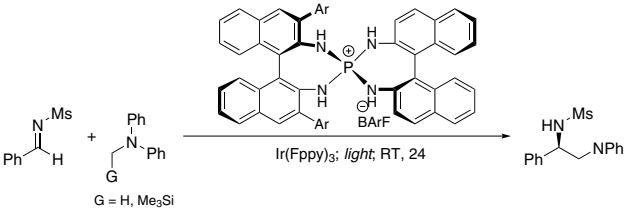
77-6100 NEW

Tris[5-fluoro-2-(2-pyridinyl-kN)phenyl-kC] iridium(III), 95% *(370878-69-6)*
$C_{33}H_{21}F_3IrN_3$; FW: 708.75; yellow pwdr.
air sensitive
Note: Photocatalyst

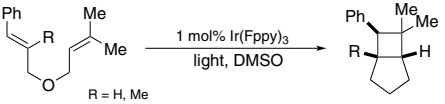


50mg
250mg

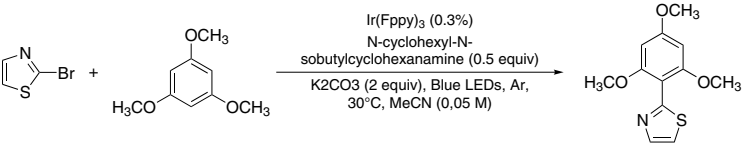
Technical Notes:
1. Photosensitizer for the enantioselective coupling reaction between (N-arylamino)methanes and (N-methanesulfonyl)-aldimines catalyzed by P-Spiro chiral (arylamino)phosphonium catalyst.
2. Photocatalyst for [2+2] styrene cycloadditions.
3. Photocatalyst for azoylation of trimethoxybenzene by via C−H functionalization.



Tech. Note (1)
Ref. (1)



Tech. Note (2)
Ref. (2)



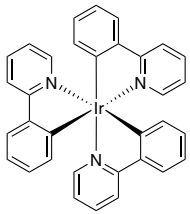
Tech. Note (3)
Ref. (3)

References:

1. *J. Org. Chem.,* **2016**, *81*, 6953.
2. *Chem. Sci.,* **2016**, *7*, 6796.
3. *Org. Lett.,* **2016**, *18*, 3996.

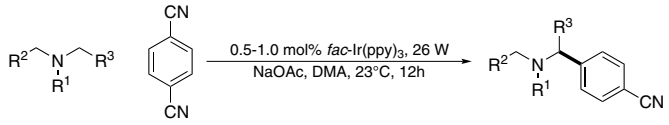
IRIDIUM (Compounds)

77-7015 **Tris(2-phenylpyridinato-C2,N)iridium(III), 95%** 50mg
NEW *(94928-86-8)* 250mg
$C_{33}H_{24}IrN_3$; yellow pwdr.
air sensitive
Note: Photocatalyst

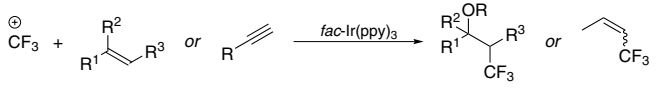


Technical Notes:

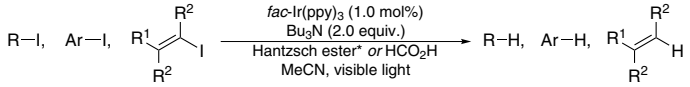
1. Photocatalyst for α-amino C–H arylation of cyano(hetero)arenes by tertiary amines
2. Photocatalyst for trifluoromethylation of alkenes and alkynes
3. Photocatalyst for reduction of alkyl, alkenyl, aryl iodides (a) and intramolecular reductive cyclizations (d)
4. Photocatalyst for organocatalyst assisted direct arylation of allylic sp^3 C–H bonds
5. Photocatalyst for the generation multifluorinated biaryls via functionalization of the C−F bond of a perfluoroarene and C−H bond of the other arene in the presence of amines
6. Photocatalyst for visible-light photoredox arylation of thiols with various aryl halides



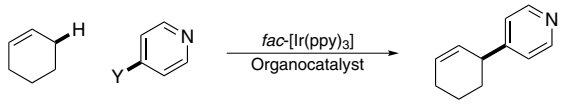
Tech. Note (1)
Ref. (1)



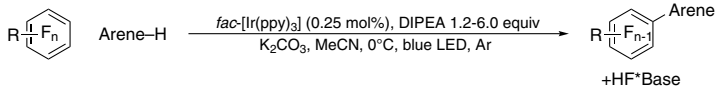
Tech. Note (2)
Ref. (2,3)



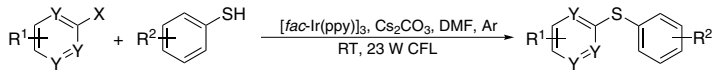
Tech. Note (3)
Ref. (4)



Tech. Note (4)
Ref. (5)



Tech. Note (5)
Ref. (6)



X=I, Br, Cl, F
Y=CH, N

Tech. Note (6)
Ref. (7)

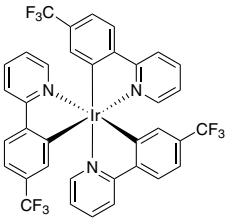
References:

1. *Science* **2011**, *334*, 1114
2. *Angew. Chem. Int. Ed.* **2012**, *51*, 9567
3. *Angew. Chem. Int. Ed.* **2014**, *53*, 539
4. *Nat. Chem.* **2012**, *4*, 854
5. *Nature* **2015** *519*, 74
6. *J. Am. Chem. Soc.* **2016**, *138*, 2520
7. *Angew. Chem. Int. Ed.* **2017**, *56*, 874

IRIDIUM (Compounds)

77-6580 NEW

Tris[(2-(2-pyridinyl-kN)-5-(trifluoromethyl) phenyl-kC]iridium(III), 95% *(500295-52-3)*
$C_{36}H_{21}F_9IrN_3$; FW: 858.78; yellow solid
air sensitive
Note: Photocatalyst

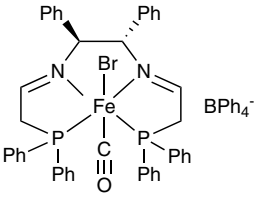


50mg
250mg

IRON (Compounds)

26-0873 NEW

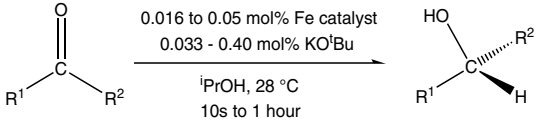
Bromocarbonyl[(1S,2S)-2,3-diphenylethylenediamine-N,N'-bis(2-diphenylphosphinoethyllidene)]iron(II) tetraphenylborate, FeATHer-II Catalyst
(1257252-03-1)
$C_{67}H_{65}BBrFeN_2OP_2$; FW: 1122.75; yellow pwdr.
air sensitive, moisture sensitive
Note: Sold in collaboration with GreenCentre for research purposes only. Patents: PCT/CA2013/050405, PCT 2013/010275.



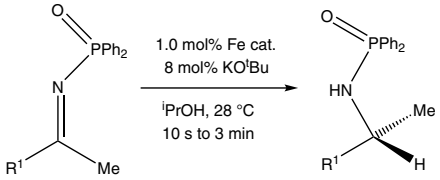
100mg
500mg

Technical Note:

1. Catalyst used in the transfer hydrogenation of ketones and imines.



Tech. Note (1)
Ref. (1)



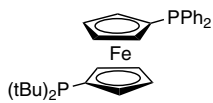
Tech. Note (1)
Ref. (1)

References:

1. *Science*, **2013**, *342*, 1080.

26-1240 NEW

1-Diphenylphosphino-1'-(di-t-butylphosphino) ferrocene, 97% *(95408-38-1)*
$C_{30}H_{36}FeP_2$; FW: 514.40; yellow to orange pwdr.; m.p. 75-79°
air sensitive

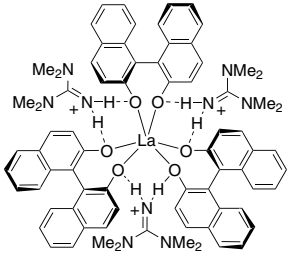


250mg
1g

LANTHANUM (Compounds)

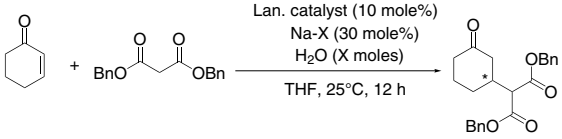
57-0505 NEW
Lanthanum(III) bromide, anhydrous (99.99%-La) (REO) PURATREM 2g 10g
(13536-79-3)
$LaBr_3$; FW: 378.62; white xtl.
air sensitive, moisture sensitive

57-1250 NEW
Tris[N,N,N,N-tetramethylguanidinium] [tris(1S)-(1,1'-binaphalene)-2,2'-diolato] lanthanate La-HTMG-B *(1611526-71-6)* 250mg 1g
$C_{75}H_{78}N_9O_6La$; FW: 1340.38; tan pwdr.
Note: U.S. Patent 14/898,925.

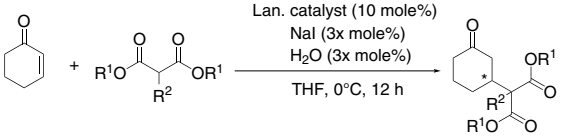


Technical Notes:

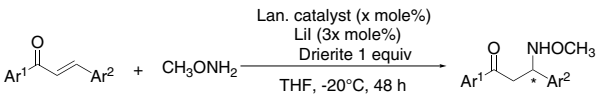
1. Catalyst used for an asymmetric Michael addition.
2. Catalyst used for an asymmetric Michael addition of 1,3-dicarbonyls to enones.
3. Catalyst used for the asymmetric aza-Michael addition of methylhydroxylamine to chalcone derivatives.
4. Catalyst used for the asymmetric direct aldol reaction of acetophenone and pivaldehyde.



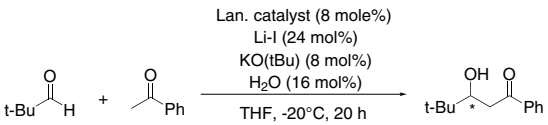
Tech. Note (1)
Ref. (1)



Tech. Note (2)
Ref. (1)



Tech. Note (3)
Ref. (1)



Tech. Note (4)
Ref. (1)

References:

1. *J. Am. Chem. Soc.*, **2014**, *136*, 8034.

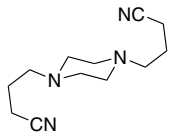
MANGANESE (Compounds)

25-1345 NEW
Manganese(II) chloride anhydrous (99.995%-Mn) PURATREM 5g 25g 100g
(7773-01-5)
$MnCl_2$; FW: 125.84; pink solid; m.p. 650°; b.p. 1190°; d. 2.98
hygroscopic

METALS SCAVENGING AGENTS (Compounds)

07-2203 NEW

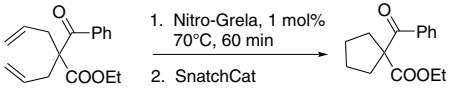
1,4-Bis(2-isocyanopropyl)piperazine (SnatchCat Metal Scavenger) *(51641-96-4)*
$C_{12}H_{20}N_4$; FW: 220.31; white xtl.
(store cold)
Note: Sold in collaboration with Apeiron Synthesis, Inc. U.S. Patent 14/443,048; PCT/IB2014/062564.



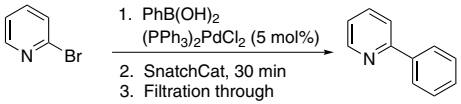
1g
5g

Technical Note:

1. SnatchCat represents a universal tool for metal removal with a proven efficiency for Ru and Pd metals. The product is an immediate metathesis reaction quencher, allowing reduced metal content to 10ppm after 20 min scavenging time and a simple workup by silica gel filtration. Compatible with a broad range of functional groups and solvents, the product is stable, non-toxic, non-volatile and odor-free.



Tech. Note (1)
Ref. (1)



References:

1. *ChemSus Chem.*, **2015**, *8*, 4139.

06-1522 NEW

Chelating/scavenger resin with aminophosphonic - S940
spherical beads (wet)
(store cold)
Note: Store in dry conditions (2-20°C). Do not freeze. Shelf Life: 5 years; Particle Size: 425-850 micron; Purolite S940 is a chelating resin of macroporous structure, with a polystyrene matrix crosslinked with divinylbenzene (DVB) substituted with weakly acidic aminophosphonic active groups. This chemical structure facilitates the formation of complexes with metallic ions. The aminophosphonic chelating resins have a greater affinity for certain cations, and form more stable complexes with cations of low atomic mass metals than their iminodiacetic resin counterparts. Hence Purolite S940 is capable of fixing one or more specific cations from a larger range even from solutions which are highly concentrated. Sold in collaboration with Purolite for research purposes only.

50g
5x50g

06-1525 NEW

Chelating/scavenger resin with aminophosphonic - S950
spherical beads (wet)
(store cold)
Note: Store in dry conditions (2-20°C). Do not freeze. Shelf Life: 5 years; Particle Size: 300-1000 micron; Purolite S950 is a macroporous aminophosphonic acid chelating resin, designed for the removal of cations of toxic metals such as lead, copper and zinc from industrial effluents at low pH. At somewhat higher pH values, calcium, magnesium and barium, as well as the toxic metals cadmium, nickel, and cobalt are strongly complexed and may be separated from quite high concentrations of univalent cations. Purolite S950 is highly selective (under the appropriate conditions) for a range of both heavy metal and common divalent ions. Hence its use may be recommended where it is necessary to remove calcium or magnesium in order to avoid possible precipitation, or where its selectivity for a particular range of metals offers advantages. Sold in collaboration with Purolite for research purposes only.

50g
5x50g

METALS SCAVENGING AGENTS (Compounds)

06-1508 NEW — **Chelating/scavenger resin with aminoxime - S910** — 50g, 5x50g
spherical beads (wet)
(store cold)
Note: Store in dry conditions (2-20°C). Do not freeze. Shelf Life: 5 years; Particle Size: 300-1200 micron; Purolite® S910 is an amidoxime chelating resin, designed for the removal of cations of metals such as copper and iron from water or other solvent even at relatively low pH. It can also be used for the recovery of traces of precious metals from dilute solutions. It cannot be used for removal of alkaline earth metals. Sold in collaboration with Purolite for research purposes only.

06-1530 NEW — **Chelating/scavenger resin with bispicolylamine - S960** — 50g, 5x50g
spherical beads (wet)
(store cold)
Note: Store in dry conditions (2-20°C). Do not freeze. Shelf Life: 5 years; Particle Size: 425-1000 micron; Purolite® S960 is a macroporous poly-styrene divinylbenzene copolymer within which weakly basic bis-picolylamine chelating functional groups are covalently bonded. This resin has high selectivity for metals such as nickel, copper, and cobalt as compared to iron, aluminum, calcium, and magnesium. Purolite® S960 is active within the pH range of 0 8 and may function outside that range depending on the metals involved. Sold in collaboration with Purolite for research purposes only.

06-1520 NEW — **Chelating/scavenger resin with iminodiacetic - S930Plus** — 50g, 5x50g
spherical beads (wet)
(store cold)
Note: Store in dry conditions (2-20°C). Do not freeze. Shelf Life: 5 years; Particle Size: 425-1000 micron; Purolite S930Plus is a macroporous polystyrene; based chelating resin, with iminodiacetic groups designed for the removal of heavy metals from industrial effluents. Purolite S930Plus finds use in processes for extraction and recovery of metals from ores, galvanic plating solutions, pickling baths and effluents. Further uses include the decalcification of brine for chloralkali processes, where Purolite S930Plus shows advantages under certain operating conditions over the typically used aminophosphonic type resins such as Purolite S940. Purolite S930Plus has high selectivity and capacity for hardness and strontium and has excellent osmotic stability. Purolite S930Plus is susceptible to oxidation. Hence direct treatment of brine solutions containing free chlorine should be avoided, for instance by preliminary reaction with sulphur dioxide, sulphide or, by use of a treatment with activated carbon. Brine solutions can often contain significant concentrations of chlorates. In this case it is necessary to ensure that the displacement rinse prior to the acid regeneration is efficient, so as to avoid the formation of free chlorine from contact of chlorates in the brine solution with the regeneration acid. Sold in collaboration with Purolite for research purposes only.

06-1514 NEW — **Chelating/scavenger resin with isothiouronium - S920Plus** — 50g, 5x50g
spherical beads (wet)
(store cold)
Note: Store in dry conditions (2-20°C). Do not freeze. Shelf Life: 5 years; Particle Size: 300-1200 micron; Purolite® S920Plus is a macroporous polystyrenic based chelating resin, with thiouronium groups designed for the selective removal of mercury and for the recovery of precious metals from industrial effluents. Mercury is strongly bound to the functional groups to form highly stable complexes, with high selective affinity compared with those of other heavy metals. These properties are largely unaffected by high chloride (or sulfate) content of the effluent. Effluent solutions which may typically contain 2 - 20 ppm of mercury can be treated to reduce the concentration in solution to less than 0.005 ppm. Purolite S920Plus can load up to 200g of mercury, or gold, or approximately 60g of platinum or palladium for each liter of resin, equivalent to 12.5, and 3.75 lb/ft3 respectively. Purolite S920Plus is designed for the removal of low concentrations of soluble mercury salts from waste streams and for the recovery of precious metals from rinse waters in the galvanic and electronic industries. It is also used in hydrometallurgy for the separation of precious metals from acid liquors. Mercury and precious metals are so strongly held, and run lengths are so long (thousands of hours) that it is not normally considered economic to regenerate the resin for reuse. Purolite S920Plus is more resistant to oxidation than many thiol based resins and contact with the atmosphere is not detrimental, however free chlorine and other strong oxidizing agents may damage the resin and their removal from solution by filtering through activated carbon is recommended. Sold in collaboration with Purolite for research purposes only.

METALS SCAVENGING AGENTS (Compounds)

06-1501 NEW
Chelating/scavenger resin with N-methylglucamine - S108 50g
spherical beads (wet) 5x50g
(store cold)
Note: Store in dry conditions (2-20°C). Do not freeze. Shelf Life: 5 years;
Particle Size: 425-630 micron; Purolite® S108 is a macroporous polystyrenic based resin with excellent kinetics and functional groups specially designed for the selective removal of salts of boron from aqueous solutions. It is effective for such solutions over a wide range of pH values, and over a wide range of boron concentrations. The presence of boron ions in water for potable and agriculture/horticulture use, even in relatively small (ppm) concentrations can give rise to major problems. Even where concentrations of other ions are reasonably high, Purolite® S108 will reduce boron concentrations by an order of magnitude. Sold in collaboration with Purolite for research purposes only.

06-1528 NEW
Chelating/scavenger resin with phosphonic and sulfonic acid - S957 50g
spherical beads (wet) 5x50g
(store cold)
Note: Store in dry conditions (2-20°C). Do not freeze. Shelf Life: 5 years;
Particle Size: 425-1000 micron; Purolite S957 is a specially developed Monophos chelating resin, which incorporates phosphonic, and sulfonic functional groups on a mechanically and osmotically resistant matrix. These combined properties give it high selectivity for iron and other transitional metals, even in acidic solutions. Purolite S957 has been especially designed for the selective removal of ferric iron from acidic solutions, such as copper electrolyte or from nickel, cobalt and zinc processing solutions. Purolite S957 can also be used in potable water applications for the selective removal of trace levels of selected metals from neutral pH waters. Its selectivity for uranium and other lanthanide elements should give good opportunities for its successful employment in other areas. Sold in collaboration with Purolite for research purposes only.

06-1532 NEW
Chelating/scavenger resin with polyamine - S985 50g
spherical beads (wet) 5x50g
(store cold)
Note: Store in dry conditions (2-20°C). Do not freeze. Shelf Life: 5 years; Particle Size: 300-1200 micron; Purolite® S985 is a high capacity, macroporous, weak base anion exchange resin with a polyacrylic matrix supporting functional groups of the polyamine type. The carefully formulated, macroporous acrylic matrix ensures excellent exchange kinetics for the removal of trace heavy metals from waste water streams and the special polyamine functionality produces very interesting operating capacities and makes the uptake of metallic cations possible even when they are present in the waste stream as organic anionic complexes. Its tough and resilient macroporous structure also affords excellent mechanical, strength and resistance to osmotic shock. Sold in collaboration with Purolite for research purposes only.

06-1518 NEW
Chelating/scavenger resin with thiol - S924 50g
spherical beads (wet) 5x50g
(store cold)
Note: Store in dry conditions (2-20°C). Do not freeze. Shelf Life: 5 years; Particle Size: 300-1000 micron; Purolite S924 is a chelating resin, polystyrene based and designed for the selective removal of mercury. The mercury is strongly bound to the functional groups to form highly stable complexes with high selective affinity compared with those of other heavy metals. Even so the high selectivity for metals such as silver, copper, lead, cadmium, nickel and cobalt, makes this resin useful in waste treatment and hydrometallurgical processes. The high selectivity for mercury is largely unaffected by high chloride or sulphate content of the effluent. Effluent solutions that may typically contain 0.01-25ppm of mercury can be treated to reduce the concentration to significantly less than 5ppb residual mercury. Purolite S924 can load up to 150 g (16 lb/cu.ft) of mercury per litre of resin. Purolite S924 is designed for the removal of moderately low concentrations of soluble mercury salts from brine streams used to produce caustic soda and chlorine where mercury cells are used, and may be regenerated with concentrated hydrochloric acid solutions. In the process for the manufacture of caustic soda and chlorine from brine, where all or part of the production uses mercury cells, the mercury rich regenerant acid may be neutralized with the sodium hydroxide to produce a recovered brine solution that may be recycled to the mercury cell process. Mercury may be present at very low concentrations and consequently run lengths are often long (thousands of hours). It is sometimes not economic to regenerate the resin for re-use. In such cases Purolite S920 may be preferred because of its higher capacity. Purolite S924 is prone to oxidation and long-term contact with the atmosphere is detrimental. It is recommended that this resin is shipped and stored under water. Also, free chlorine and other strong oxidizing agents may damage the resin. Their removal from solution by filtering through activated carbon is recommended. Sold in collaboration with Purolite for research purposes only.

METALS SCAVENGING AGENTS (Compounds)

06-1512 NEW
Chelating/scavenger resin with thiourea - S914 50g
spherical beads (wet) 5x50g
(store cold)
Note: Store in dry conditions (2-20°C). Do not freeze. Shelf Life: 5 years; Particle Size: 300-1200 micron; Purolite S914 is a macroporous type chelating resin with thiourea functionality. It has very high selectivity for mercury and platinum group metals such as platinum, gold and silver. Purolite S914 is stable over the whole pH range. The applications include mercury removal from brine and effluent in chloralkali process, mercury removal from flue gas scrubber effluent, recovery of platinum group metals from effluents amongst others. Sold in collaboration with Purolite for research purposes only.

MOFS AND LIGANDS FOR MOF SYNTHESIS (Compounds)

22-1070 **Hexakis[μ-(2-amino-1,4-benzenedicarboxylato)][tetra-μ-hydroxyoc-ta-μ-oxooctatitanium], NH2-MIL-125(Ti), CONEKTIC™ T125** *(1309760-94-8)*
See page 96

40-1109 **Zirconium aminobenzenedicarboxylate MOF (UiO-66-BDC-NH2, BDC-NH2:Zr=0.9-1.0)** *(1260119-00-3)*
See page 97

40-1108 **Zirconium benzenedicarboylate MOF (UiO-66-BDC, BDC:Zr=0.66-0.98)**
See page 98

40-1112 **Zirconium biphenyldicarboxylate MOF (UiO-66-BPDC/UiO-67, BPDC:Zr=0.9-1.0)**
See page 98

40-1114 **Zirconium Fumarate MOF (UiO-66-FA, FA:Zr=0.66-0.98)**
See page 99

40-1106 **Zirconium trans-1, 2-ethylenedicarboxylic acid MOF (UiO-66-FA, FA:Zr=1)**
See page 99

40-1111 **Zirconium trimellitate MOF (UiO-66-BDC-COOH, BDC-COOH:Zr=0.9-1.0)**
See page 100

NANOMATERIALS (Elemental Forms)

79-0921 **Gold nanoparticles, 1% on carbon black (surfactant and reactant-free)** *(7440-57-5)*
See page 36

79-0916 **Gold nanoparticles, 1% on Titania (anatase) (surfactant and reac-tant-free)** *(7440-57-5)*
See page 36

79-0905 **Gold nanoparticles, 1% on Titania (rutile) (surfactant and reactant-free)** *(7440-57-5)*
See page 36

79-0926 **Gold nanoparticles, 5% on carbon black (surfactant and reactant-free)** *(7440-57-5)*
See page 36

79-0935 **Gold nanoparticles, 10% on Titania (anatase) (surfactant and reac-tant-free)** *(7440-57-5)*
See page 36

79-0930 **Gold nanoparticles, 10% on Titania (rutile) (surfactant and reactant-free)** *(7440-57-5)*
See page 36

06-2530 **Graphene oxide (4mg/ml water dispersion) - low Mn.** *(1034343-98-0)*
See page 33

NANOMATERIALS (Elemental Forms)

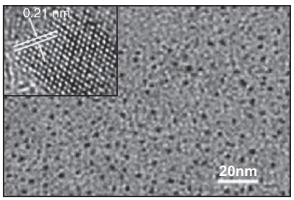
06-0330 **Graphene Quantum Dots (GQDs), Aqua-Green Luminescent** 100mg
NEW
(1034343-98-0)
C; dark red-brown pwdr.
light sensitive, (store cold)
Note: Particle diameter: <5 nm. Sold in collaboration with Dotz Nano Ltd. for research purposes only. Suggested use within 6 months of purchase. Do not freeze. Store in DARK.

Suggested Applications:
Graphene quantum dots (GQDs), sheets of few-layered graphene and lateral dimensions smaller than 100nm possess strong quantum confinement and edge effects. Thus, they possess unique physical properties such as strong photoluminescence, which can be tailored for specific applications by controlling their size, shape, defects and functionality.

In contrast to classic QDs, such as metal or silicon quantum dots, GQDs are biocompatible, photostable and inherit superior thermal, electrical and mechanical properties from the graphene. These features can greatly contribute to various state-of-the-art applications: optical brighteners, taggants for security applications[1], bioimaging markers[2], fluorescent polymers[3], antibacterial[4], antibiofouling[5], and disinfection systems[6], heavy metals[7], humidity and pressure[8] sensors, batteries[9], flash memory devices[10], photovoltaic devices[11] and light-emitting diodes[12].

Item #	Photoluminescence			
	QY+ *	λ_{max} *	Max emission	FWHM *
06-0330 / 06-0332	>17%	485 nm	525 nm	70 nm
06-0334 / 06-0336	>65%	350 nm	445 nm	65 nm
06-0340	>25%	420 nm	490 nm	80 nm

Abbreviations	
QY+	Quantum Yield
λ_{max}	Maximum excitation wavelength
FWHM	Full width at half maximum



References:

1. http://onlinelibrary.wiley.com/doi/10.1002/anie.201206791/abstract
2. http://onlinelibrary.wiley.com/doi/10.1002/ppsc.201400219/abstract
3. http://pubs.acs.org/doi/abs/10.1021/acsami.5b06057
4. http://pubs.acs.org/doi/abs/10.1021/acsami.6b01765
5. http://www.nature.com/articles/srep20142
6. http://pubs.acs.org/doi/abs/10.1021/nn501640q
7. http://www.sciencedirect.com/science/article/pii/S0013468615000468
8. http://pubs.acs.org/doi/abs/10.1021/nl4003443
9. http://pubs.acs.org/doi/abs/10.1021/nl504038s
10. http://iopscience.iop.org/article/10.1088/0957-4484/25/25/255203/meta
11. http://onlinelibrary.wiley.com/doi/10.1002/anie.200906291/abstract
12. http://link.springer.com/article/10.1007/s10853-012-7016-8

06-0332 **Graphene Quantum Dots (GQDs) in water, Aqua-Green Luminescent** 100ml
NEW
(1034343-98-0)
C; cloudy orange liq.
light sensitive, (store cold)
Note: Particle diameter: <5 nm. Concentration: 1 mg/ml. Sold in collaboration with Dotz Nano Ltd. for research purposes only. Suggested use within 6 months of purchase. Do not freeze. Store in DARK.

Technical Note:
1. See 06-0330 (page 48)

NANOMATERIALS (Elemental Forms)

06-0334 NEW — **Graphene Quantum Dots (GQDs), Blue Luminescent** *(1034343-98-0)* — 100mg
C; dark brown pwdr.
light sensitive, (store cold)
Note: Particle diameter: <5 nm. Sold in collaboration with Dotz Nano Ltd. for research purposes only. Suggested use within 6 months of purchase. Do not freeze. Store in DARK.
Technical Note:
1. See 06-0330 (page 48)

06-0336 NEW — **Graphene Quantum Dots (GQDs) in water, Blue Luminescent** *(1034343-98-0)* — 100ml
C; cloudy colorless liq.
light sensitive, (store cold)
Note: Particle diameter: <5 nm. Concentration: 1 mg/ml. Sold in collaboration with Dotz Nano Ltd. for research purposes only. Suggested use within 6 months of purchase. Do not freeze. Store in DARK.
Technical Note:
1. See 06-0330 (page 48)

06-0340 NEW — **Graphene Quantum Dots (GQDs) in water, Cyan Luminescent** *(1034343-98-0)* — 100ml
C; cloudy brown liq.
light sensitive, (store cold)
Note: Particle diameter: <5 nm. Concentration: 1 mg/ml. Sold in collaboration with Dotz Nano Ltd. for research purposes only. Suggested use within 6 months of purchase. Do not freeze. Store in DARK.
Technical Note:
1. See 06-0330 (page 48)

96-7410 — **Graphene Quantum Dots (GQDs) Master Kit** *(1034343-98-0)*
See page 108

96-7425 — **Graphene Quantum Dots (GQDs) Mini Kit (Powders)** *(1034343-98-0)*
See page 108

96-7420 — **Graphene Quantum Dots in water (GQDs) Mini Kit (Liquids)** *(1034343-98-0)*
See page 109

06-0365 — **High Strength Metallurgical Graphene on GLASS HSMG® (10x10mm)** *(1034343-98-0)*
See page 34

06-0345 — **High Strength Metallurgical Graphene on PMMA HSMG® (10x10 mm)** *(1034343-98-0)*
See page 34

06-0355 — **High Strength Metallurgical Graphene on PMMA HSMG® (25x25mm)** *(1034343-98-0)*
See page 34

06-0360 — **High Strength Metallurgical Graphene on PMMA HSMG® (50x50mm)** *(1034343-98-0)*
See page 34

28-0015 — **Nickel/palladium alloy nanoparticle on graphene (G-$Ni_{33}Pd_{67}$)**
See page 62

78-3015 — **Platinum nanoparticles, 1% on carbon black (surfactant and reactant-free)** *(7440-06-4)*
See page 80

78-3020 — **Platinum nanoparticles, 5% on carbon black (surfactant and reactant-free)** *(7440-06-4)*
See page 80

78-3030 — **Platinum nanoparticles, 10% on carbon black (surfactant and reactant-free)** *(7440-06-4)*
See page 80

78-3032 — **Platinum nanoparticles, 20% on carbon black (surfactant and reactant-free)** *(7440-06-4)*
See page 80

78-3035 — **Platinum nanoparticles, 30% on carbon black (surfactant and reactant-free)** *(7440-06-4)*
See page 80

78-3012 — **Platinum nanoparticles, 1% on Titania (anatase) (surfactant and reactant-free)** *(7440-06-4)*
See page 81

78-3005 — **Platinum nanoparticles, 1% on Titania (rutile) (surfactant and reactant-free)** *(7440-06-4)*
See page 81

78-3026 — **Platinum nanoparticles, 10% on Titania (anatase) (surfactant and reactant-free)** *(7440-06-4)*
See page 81

78-3023 — **Platinum nanoparticles, 10% on Titania (rutile) (surfactant and reactant-free)** *(7440-06-4)*
See page 81

NANOMATERIALS (Compounds)

14-6100 **High Surface area Silica nanoparticles, large, particle size ~900-1000 nm, surface area ~700 m²/g, (KCC-1 L1)** *(112945-52-5)*
See page 92

14-6110 **High Surface area Silica nanoparticles, large, particle size ~900-1000 nm, surface area ~600 m²/g, (KCC-1 L2)** *(112945-52-5)*
See page 93

14-6120 **High Surface area Silica nanoparticles, large, particle size ~900-1000 nm, surface area ~550 m²/g (KCC-1 L3)** *(112945-52-5)*
See page 93

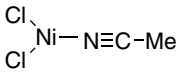
14-6200 **High Surface area Silica nanoparticles, medium, particle size ~400-450 nm, surface area ~400 m²/g, (KCC-1 M1)** *(112945-52-5)*
See page 93

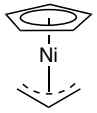
14-6210 **High Surface area Silica nanoparticles, medium, particle size ~300-350 nm, surface area ~600 m²/g, (KCC-1 M2)** *(112945-52-5)*
See page 94

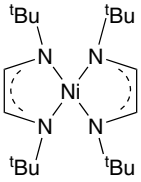
14-6300 **High Surface area Silica nanoparticles, small, particle size ~130-190 nm, surface area ~380 m²/g, (KCC-1 S1)** *(112945-52-5)*
See page 94

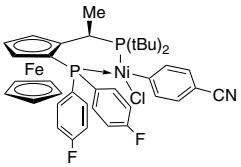
14-6310 **High Surface area Silica nanoparticles, small, particle size ~40-50 nm, surface area ~520 m²/g, (KCC-1 S2)** *(112945-52-5)*
See page 94

NICKEL (Compounds)

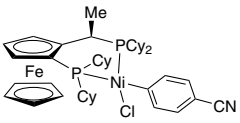
28-1210 NEW
(Acetonitrile)dichloronickel(II), 99% *(18897-44-4)*
$C_2H_3Cl_2NNi$; FW: 170.65; yellow pwdr.
air sensitive, hygroscopic

1g 5g

28-0009 NEW HAZ
Allyl(cyclopentadienyl)nickel(II), min. 97%
(12107-46-9)
$C_8H_{10}Ni$; FW: 164.86; dark purple liq.; d. 1.31
air sensitive, moisture sensitive, pyrophoric

1g 5g

28-0225 NEW
Bis(1,4-di-t-butyl-1,3-diazabutadienyl)nickel(II) Ni(DAD)2, min. 98% (99.999%-Ni) PURATREM
$C_{20}H_{40}N_4Ni$; FW: 395.25;
Bis(1,4-di-t-butyl-1,3-diazabutadienyl)nickel(II)
Ni(DAD)2, min. 98% (99.999%-Ni) PURATREM
air sensitive
Note: U.S. Patent Application No. 13/818,154. Product sold under, use subject to, terms and conditions of label license at www.strem.com/waynestate1

250mg 1g 5g

28-0178 NEW
Chloro(4-cyanophenyl){(R)-1-[(S)-2-(bis(4-fluorophenyl)phosphinoferrocenyl]ethyl(di-t-butylphosphine)}nickel(II) *(2049086-37-3)*
$C_{39}H_{42}ClF_2FeNNiP_2$; FW: 774.69; red-violet solid
Note: Sold in collaboration with Solvias for research purposes only.

100mg 500mg

Technical Note:
1. See 28-0170 (page 51)

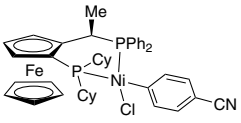
28-0172 NEW
Chloro(4-cyanophenyl){(R)-1-[(S)-2-(dicyclohexylphosphino)ferrocenyl]ethyl (dicyclohexylphosphine)}nickel(II) *(2049086-35-1)*
$C_{43}H_{60}ClFeNNiP_2$; FW: 802.88; orange solid
Note: Sold in collaboration with Solvias for research purposes only.

100mg 500mg

Technical Note:
1. See 28-0170 (page 51)

NICKEL (Compounds)

28-0175 NEW

Chloro(4-cyanophenyl){(R)-1-[(S)-2-(dicyclohexylphosphino)ferrocenyl]ethyl (diphenylphosphine)}nickel(II) *(2049086-36-2)*
$C_{43}H_{48}ClFeNNiP_2$; FW: 790.79; orange solid
Note: Sold in collaboration with Solvias for research purposes only.

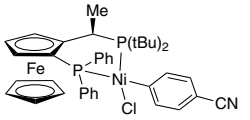


100mg
500mg

Technical Note:
1. See 28-0170 (page 51)

28-0170 NEW

Chloro(4-cyanophenyl){(R)-1-[(S)-2-(diphenylphosphino)ferrocenyl]ethyl(di-t-butyl) phosphine} nickel(II) *(2049086-34-0)*
$C_{39}H_{44}ClFeNNiP_2$; FW: 738.71; red-violet solid
Note: Sold in collaboration with Solvias for research purposes only.



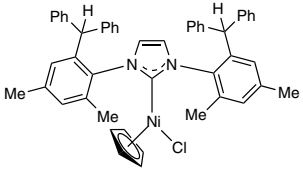
100mg
500mg

Technical Notes:
1. Versatile, air-stable, low cost nickel catalyst alternative to palladium for carbon-carbon and carbonheteroatom cross-coupling reactions.
2. Used to react substituted aryl and heteroaryl halides and tosylates with ammonia to produce diverse aryl and heteroaryl amines[1].
3. Used in monoarylation experiments using commercially available ammonia gas, ammonium salts or ammonia stock solutions[2,3].
4. Catalyzes the coupling of aryl chlorides with gaseous amines in the form of their hydrochloride salts[3].

References:
1. *Org.Process Res. Dev.*, **2015**, *19*, 1936.
2. *Angew. Chem, Int. Ed.*, **2015**, *54*, 3773.
3. *Angew. Chem, Int. Ed.*, **2015**, *54*, 3768.

28-1095 NEW

Chloro(cyclopentadienyl){1,3-bis[2-(diphenylmethyl)-4,6-dimethylphenyl]1H-imidazolium}nickel(II) *(1955555-28-8)*
$C_{50}H_{46}ClN_2Ni$; FW: 769.06; pink purple pwdr.



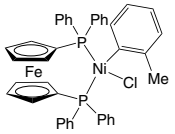
100mg
500mg

Technical Note:
1. Complexes of this type are pre-catalysts for Suzuki-Miyaura[2] and Buchwald-Hartwig[3,4] cross-couplings, and for hydrosilylation[4] and hydrothiolation[5] of alkenes.

References:
1. *Dalton Trans*. **2016**, *45*, 11772
2. *Dalton Trans.* **2010**, *39*, 8153
3. *Organometallics* **2013**, *32*, 6265
4. *Organometallics* **2005**, *24*, 3442-3447.
5. *Organometallics* **2006**, *25*, 4462

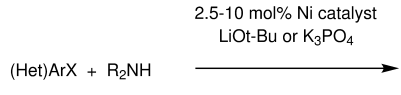
28-0518 NEW

Chloro(2-methylphenyl)[1,1'-bis(diphenylphosphino)ferrocene]nickel (II), 98% *(1501945-23-8)*
$C_{41}H_{35}ClFeNiP_2$; FW: 739.66; yellow pwdr.
air sensitive



100mg
500mg

Technical Note:
1. Air-stable nickel precatalyst for the amination of aryl chlorides, sulfamates, mesylates and triflates.



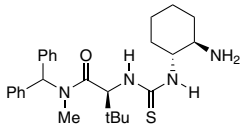
Tech. Note (1)
Ref. (1)

References:
1. *Org. Lett.,* **2014**, *16*, 220.

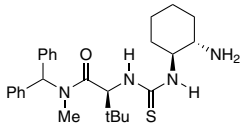
96-3660 **Solvias Josiphos Nickel Catalyst Kit**
See page 110

NITROGEN (Compounds)

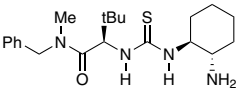
07-2061 NEW
(2S)-2-[[[[(1R,2R)-2-Aminocyclohexyl] amino]thioxomethyl]amino]-N-(diphenyl-methyl)-N,3,3-trimethylbutanamide, 98%, (99% ee) *(1421052-39-2)*
$C_{27}H_{38}N_4OS$; FW: 466.70; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.
50mg



07-2060 NEW
(2S)-2-[[[[(1S,2S)-2-Aminocyclohexyl] amino]thioxomethyl]amino]-N-(diphenyl-methyl)-N,3,3-trimethylbutanamide, 98%, (99% ee) *(1421697-46-2)*
$C_{27}H_{38}N_4OS$; FW: 466.70; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.
50mg

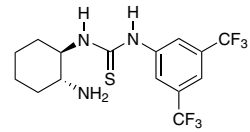


07-0955 NEW
(2R)-2-[[[[(1S,2S)-2-Aminocyclohexyl] amino]thioxomethyl]amino]-N,3,3-trimethyl-N-(phenylmethyl)butanamide, 98%, (99% ee)
$C_{21}H_{34}N_4OS$; FW: 390.60; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.
50mg



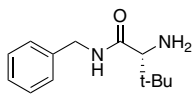
07-0956 NEW
(2S)-2-[[[[(1R,2R)-2-Aminocyclohexyl]amino]thioxomethyl]amino]-N,3,3-trimethyl-N-(phenylmethyl)butanamide, 98%, (99% ee) *(479423-21-7)*
$C_{21}H_{34}N_4OS$; FW: 390.60; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.
50mg

07-0988 NEW
N-[(1R,2R)-2-Aminocyclohex-yl]-N'-[3,5-bis(trifluoromethyl)phenyl] thiourea, 98%, (99% ee) *(860994-58-7)*
$C_{15}H_{17}F_6N_3S$; FW: 385.40; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.
100mg



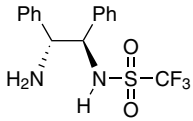
07-7018 NEW
(2S)-2-Amino-3,3-dimethyl-N-(phenylmethyl)butanamide, 98%, (99% ee) *(207121-91-3)*
$C_{13}H_{20}N_2O$; FW: 220.30; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.
100mg

07-7019 NEW
(2R)-2-Amino-3,3-dimethyl-N-(phenylmethyl) butanamide, 98%, (99% ee) *(268556-62-3)*
$C_{13}H_{20}N_2O$; FW: 220.30; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.
500mg

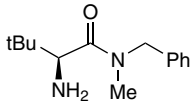


07-2081 NEW
N-[(1S,2S)-2-Amino-1,2-diphenylethyl]-1,1,1-trifluoromethanesulfonamide, 95%, (99% ee) *(167316-28-1)*
$C_{15}H_{15}F_3N_2O_2S$; FW: 344.40; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.
100mg

07-2080 NEW
N-[(1R,2R)-2-Amino-1,2-diphenylethyl]-1,1,1-tri-fluoromethanesulfonamide, 98%, (99% ee) *(852212-89-6)*
$C_{15}H_{15}F_3N_2O_2S$; FW: 344.40; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.
100mg



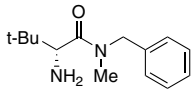
07-8033 NEW
(2S)-2-Amino-N,3,3-trimethyl-N-(phenylmethyl) butanamide, 98%, (99% ee) *(947383-62-2)*
$C_{14}H_{22}N_2O$; FW: 234.30; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.
100mg



NITROGEN (Compounds)

07-8034 NEW

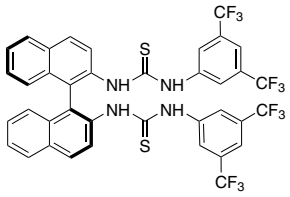
(2R)-2-Amino-N,3,3-trimethyl-N-(phenylmethyl) butanamide, 98%, (99% ee)
$C_{14}H_{22}N_2O$; FW: 234.30; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.



100mg

07-8410 NEW

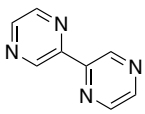
N,N'-(S)-[1,1'-Binaphthalene]-2,2'-diylbis[N'-[3,5-bis(trifluoromethyl)phenyl]thiourea], 95%, (99% ee) *(914497-25-9)*
$C_{38}H_{22}F_{12}N_4S_2$; FW: 826.70; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.



100mg

07-0750 NEW

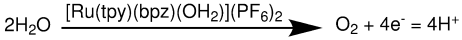
2,2'-Bipyrazine, 95% *(10199-00-5)*
$C_8H_6N_4$; FW: 158.16; light-brown solid
air sensitive
Note: Ligand for photocatalyst synthesis.



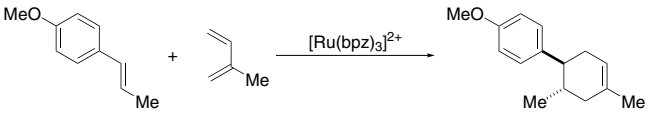
250mg
1g

Technical Notes:

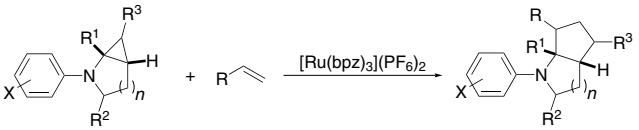
1. Ligand for the ruthenium- promoted catalytic water oxidation reaction.
2. Ligand for the ruthenium promoted photocatalytic Diels-Alder cycloaddition.
3. Ligand for the ruthenium photocatalyzed intermolecular [3+2] cycloaddition of cyclopropylamines with olefins.
4. Ligand for the ruthenium mediated photocatalytic reaction for the preparation of N-arylindoles.
5. Endoperoxide synthesis by photocatalytic aerobic [2+2+2] cycloadditions.
6. $[Ru(bpz)_3](PF_6)_2$ catalyzed anti-Markovnikov hydrothiolation of olefins with a variety of thiols.
7. $[Ru(bpz)_3](PF_6)_2$ catalyzed [3+2] photooxygenation of aryl cyclopropanes.
8. $[Ru(bpz)_3](PF_6)_2$ catalyzed intermolecular [3 + 2] annulation of cyclopropylanilines with alkynes.



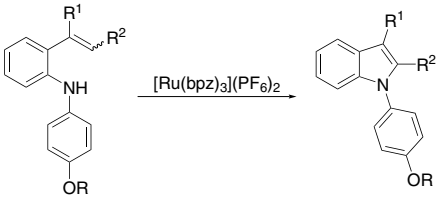
Tech. Note (1)
Ref. (1)



Tech. Note (2)
Ref. (2)



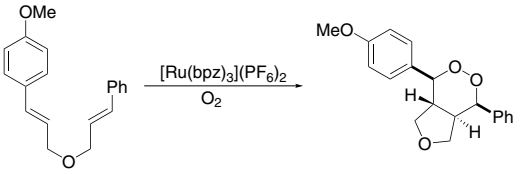
Tech. Note (3)
Ref. (3)



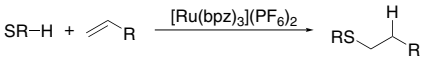
Tech. Note (4)
Ref. (4)

NITROGEN (Compounds)

07-0750 **2,2'-Bipyrazine, 95%** *(10199-00-5)*
(cont.)



Tech. Note (5)
Ref. (5)



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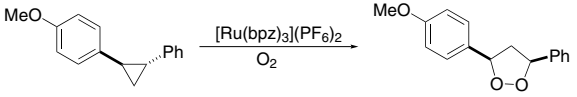
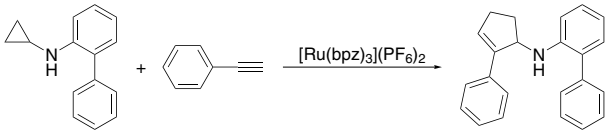
Ref. (6)



Tech. Note (7)
Ref. (7)

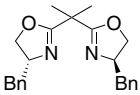


Tech. Note (8)
Ref. (8)

References:

1. *J. Am. Chem. Soc.*, **2008**, *130,* 16462.
2. *J. Am. Chem. Soc.*, **2011**, *133,* 19350.
3. *Angew. Chem. Int. Ed.,*., **2012**, *51,* 222.
4. *Angew. Chem. Int. Ed.,*., **2012**, *51,* 9562.
5. *Org. Lett.,*., **2012**, *14,* 1640.
6. *J. Org. Chem.,*., **2013**, *78,* 2046.
7. *Tetrahedron*, **2014**, *70*, 4270.
8. *Beilstein J. Org. Chem.,* , **2014**, *10*, 975.

07-7043 NEW
2,2-Bis[(4R)-4-benzyl-2-oxazolin-2-yl]propane, 98%, (99% ee) *(141362-77-8)*
$C_{23}H_{26}N_2O_2$; FW: 362.50; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

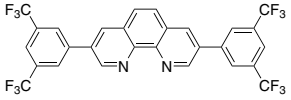


100mg

07-7044 NEW
2,2-Bis[(4S)-4-benzyl-2-oxazolin-2-yl]propane, 98%, (99% ee) *(176706-98-2)*
$C_{23}H_{26}N_2O_2$; FW: 362.50; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

100mg

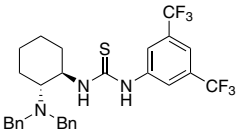
07-0481 NEW
3,8-Bis[3,5-bis(trifluoromethyl)phenyl]-1,10-phenanthroline *(1228032-35-6)*
$C_{28}H_{12}F_{12}N_2$; FW: 604.39; off-white pwdr.



100mg
500mg

07-2203 **1,4-Bis(2-isocyanopropyl)piperazine (SnatchCat Metal Scavenger)** *(51641-96-4)*
See page 44

07-6320 NEW
N-[(1R,2R)-2-[Bis(phenylmethyl)amino]cyclohexyl]-N'-[3,5-bis(trifluoromethyl)phenyl] thiourea, 98%, (99% ee) *(1240466-16-3)*
$C_{29}H_{29}F_6N_3S$; FW: 565.60; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.



50mg

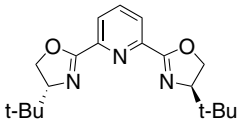
NITROGEN (Compounds)

07-6321 NEW — 50mg

N-[(1S,2S)-2-[Bis(phenylmethyl)amino]cyclohexyl]-N'-[3,5-bis(trifluoromethyl)phenyl]thiourea, 98%, (99% ee) *(1233369-39-5)*
$C_{29}H_{29}F_6N_3S$; FW: 565.60; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

07-7051 NEW — 100mg

2,6-Bis[(4R)-4-tert-butyloxazolin-2-yl]pyridine, 98%, (99% ee) *(185346-17-2)*
$C_{19}H_{27}N_3O_2$; FW: 329.40; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

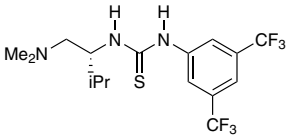


07-7050 NEW — 100mg

2,6-Bis[(4S)-4-tert-butyloxazolin-2-yl]pyridine, 98%, (99% ee) *(118949-63-6)*
$C_{19}H_{27}N_3O_2$; FW: 329.40; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

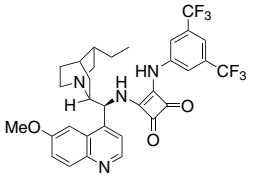
07-7130 NEW — 50mg

(R)-1-[3,5-Bis(trifluoromethyl)phenyl]-3-[1-(dimethylamino)-3-methylbutan-2-yl]thiourea, 98%, (99% ee) *(1048692-61-0)*
$C_{16}H_{21}F_6N_3S$; FW: 401.40; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.



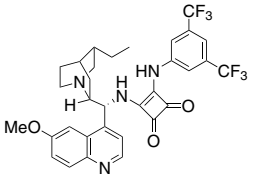
07-7029 NEW — 50mg

3-[[3,5-Bis(trifluoromethyl)phenyl]amino]-4-[[(8α,9S)-10,11-dihydro-6'-methoxycinchonan-9-yl]amino]-3-cyclobutene-1,2-dione, 98%, (99% ee) *(1352957-59-5)*
$C_{32}H_{30}F_6N_4O_3$; FW: 632.60; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.



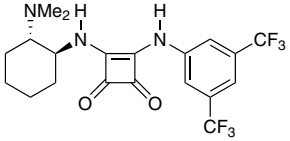
07-7028 NEW — 50mg

3-[[3,5-Bis(trifluoromethyl)phenyl]amino]-4-[[(9R)-10,11-dihydro-6'-methoxycinchonan-9-yl]amino]-3-cyclobutene-1,2-dione, 98%, (99% ee) *(1407166-63-5)*
$C_{32}H_{30}F_6N_4O_3$; FW: 632.60; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.



07-7128 NEW — 100mg

3-[[3,5-Bis(trifluoromethyl)phenyl]amino]-4-[[(1S,2S)-2-(dimethylamino)cyclohexyl]amino]-3-cyclobutene-1,2-dione, 95%, (99% ee) *(1263205-96-4)*
$C_{20}H_{21}F_6N_3O_2$; FW: 449.40; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

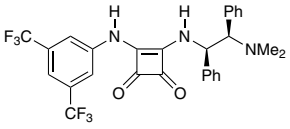


07-7129 NEW — 100mg

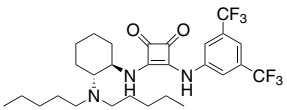
3-[[3,5-Bis(trifluoromethyl)phenyl]amino]-4-[[(1R,2R)-2-(dimethylamino)cyclohexyl]amino]-3-cyclobutene-1,2-dione, 98%, (99% ee) *(1211565-07-9)*
$C_{20}H_{21}F_6N_3O_2$; FW: 449.40; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

07-1025 NEW — 50mg

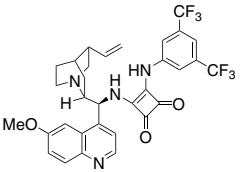
3-[[3,5-Bis(trifluoromethyl)phenyl]amino]-4-[[(1R,2R)-2-(dimethylamino)-1,2-diphenylethyl]amino]-3-cyclobutene-1,2-dione, 98%, (99% ee) *(1223105-89-2)*
$C_{28}H_{23}F_6N_3O_2$; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

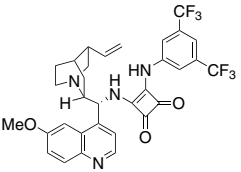


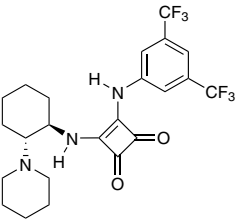
NITROGEN (Compounds)

07-8510 NEW
3-[[3,5-Bis(trifluoromethyl)phenyl]amino]-4-[[(1R,2R)-2-(dipentylamino)cyclohexyl]amino]-3-cyclobutene-1,2-dione, 98%, (99% ee) *(1411983-40-8)*
$C_{28}H_{37}F_6N_3O_2$; FW: 561.60; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

50mg

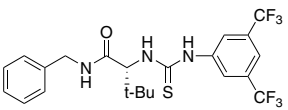
07-8511 NEW
3-[[3,5-Bis(trifluoromethyl)phenyl]amino]-4-[[(1S,2S)-2-(dipentylamino) cyclohexyl]amino]-3-cyclobutene-1,2-dione, 98%, (99% ee) *(1411983-41-9)*
$C_{28}H_{37}F_6N_3O_2$; FW: 561.60; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.
50mg

07-8436 NEW
3-[[3,5-Bis(trifluoromethyl)phenyl]amino]-4-[[(8α,9S)-6'-methoxycinchonan-9-yl]amino]-3-cyclobutene-1,2-dione, 95%, (99% ee) *(1256245-84-7)*
$C_{32}H_{28}F_6N_4O_3$; FW: 630.60; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

50mg

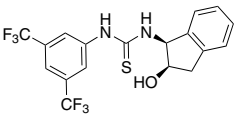
07-8435 NEW
3-[[3,5-Bis(trifluoromethyl)phenyl]amino]-4-[[(9R)-6'-methoxycinchonan-9-yl]amino]-3-cyclobutene-1,2-dione, 98%, (99% ee) *(1256245-79-0)*
$C_{32}H_{28}F_6N_4O_3$; FW: 630.60; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

50mg

07-5610 NEW
3-[[3,5-Bis(trifluoromethyl)phenyl]amino]-4-[[(1R,2R)-2-(1-piperidinyl)cyclohexyl]amino]-3-cyclobutene-1,2-dione, 98% *(1211565-11-5)*
$C_{23}H_{25}F_6N_3O_2$; FW: 489.50; orange pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

50mg

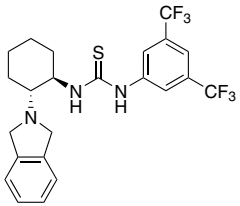
07-5611 NEW
3-[[3,5-Bis(trifluoromethyl)phenyl]amino]-4-[[(1S,2S)-2-(1-pyrrolidinyl) cyclohexyl]amino]-3-cyclobutene-1,2-dione, 98%, (99% ee) *(1346683-42-8)*
$C_{22}H_{23}F_6N_3O_2$; FW: 475.40; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.
50mg

07-0630 NEW
(2R)-2-[[[[3,5-Bis(trifluoromethyl)phenyl] amino]thioxomethyl]amino]-3,3-dimethyl-N-(phenylmethyl)butanamide, 98%, (99% ee)
$C_{22}H_{23}F_6N_3OS$; FW: 491.50; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

50mg

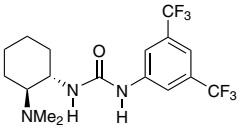
07-0631 NEW
(2S)-2-[[[[3,5-Bis(trifluoromethyl)phenyl]amino]thioxomethyl] amino]-3,3-dimethyl-N-(phenylmethyl)butanamide, 98%, (99% ee) *(1490388-03-8)*
$C_{22}H_{23}F_6N_3OS$; FW: 491.50; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.
50mg

07-6300 NEW
N-[3,5-Bis(trifluoromethyl)phenyl]-N'-[(1S,2R)-2,3-dihydro-2-hydroxy-1H-inden-1-yl]thiourea, 95%, (99% ee) *(949480-57-3)*
$C_{18}H_{14}F_6N_2OS$; FW: 420.4; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

100mg

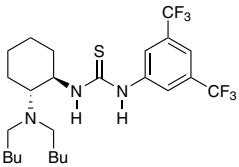
NITROGEN (Compounds)

07-8418 NEW
N-[3,5-Bis(trifluoromethyl)phenyl]-N'-[(1R,2R)-2-(1,3-dihydro-2H-isoindol-2-yl)cyclohexyl]thiourea, 95%, (99% ee) *(620960-27-2)*
$C_{23}H_{23}F_6N_3S$; FW: 487.50; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

50mg

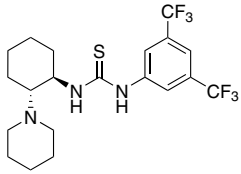
07-8419 NEW
N-[3,5-Bis(trifluoromethyl)phenyl]-N'-[(1S,2S)-2-(1,3-dihydro-2H-isoindol-2-yl)cyclohexyl]thiourea, 98%, (99% ee)
$C_{23}H_{23}F_6N_3S$; FW: 487.50; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.
50mg

07-1336 NEW
N-[3,5-Bis(trifluoromethyl)phenyl]-N'-[(1S,2S)-2-(dimethylamino)cyclohexyl]urea, 95%, (99% ee) *(1221442-12-1)*
$C_{17}H_{21}F_6N_3O$; FW: 397.4; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

100mg

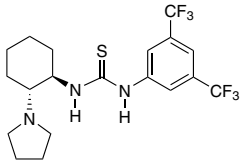
07-1337 NEW
N-[3,5-Bis(trifluoromethyl)phenyl]-N'-[(1R,2R)-2-(dimethylamino)cyclohexyl]urea, 98%, (99% ee) *(820242-14-6)*
$C_{17}H_{21}F_6N_3O$; FW: 397.4; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.
100mg

07-1345 NEW
N-[3,5-Bis(trifluoromethyl)phenyl]-N'-[(1R,2R)-2-(dipentylamino)cyclohexyl]thiourea, 98%, (99% ee)
$C_{25}H_{37}F_6N_3S$; FW: 525.60; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

50mg

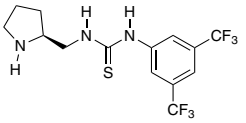
07-1346 NEW
N-[3,5-Bis(trifluoromethyl)phenyl]-N'-[(1S,2S)-2-(dipentylamino)cyclohexyl]thiourea, 98%, (99% ee) *(1429516-79-9)*
$C_{25}H_{37}F_6N_3S$; FW: 525.60; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.
50mg

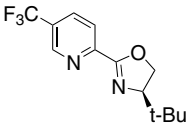
07-6318 NEW
N-[3,5-Bis(trifluoromethyl)phenyl]-N'-[(1R,2R)-2-(1-piperidinyl)cyclohexyl]thiourea, 98%, (99% ee) *(1289514-24-4)*
$C_{20}H_{25}F_6N_3S$; FW: 453.50; light red xtl.
Note: Sold in collaboration with Daicel for research purposes only.

50mg

07-6319
N-[3,5-Bis(trifluoromethyl)phenyl]-N'-[(1S,2S)-2-(1-piperidinyl)cyclohexyl]thiourea, 98%, (99% ee) *(1244061-69-5)*
$C_{20}H_{25}F_6N_3S$; FW: 453.50; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.
50mg

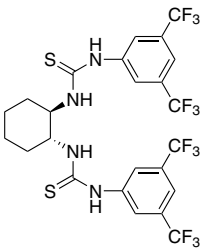
07-1350 NEW
1-[3,5-Bis(trifluoromethyl)phenyl]-3-[(1R,2R)-2-(pyrrolidin-1-yl)cyclohexyl]thiourea, 98%, (99% ee) *(1314743-49-1)*
$C_{19}H_{23}F_6N_3S$; FW: 439.50; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

50mg

NITROGEN (Compounds)

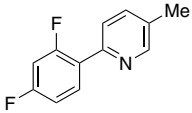
07-0912 NEW
N-[3,5-Bis(trifluoromethyl) phenyl]-N'-[(2S)-2-pyrrolidinylmethyl] thiourea, 98% *(904928-30-9)*
$C_{14}H_{15}F_6N_3S$; FW: 371.30; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

100mg

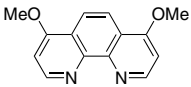
07-7173 NEW
2-[(4R)-4-tert-Butyl-4,5-dihydro-2-oxazolyl]-5-(trifluoromethyl)pyridine, 98%, (99% ee) *(1428537-19-2)*
$C_{13}H_{15}F_3N_2O$; FW: 272.30; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

50mg

07-7124 NEW
2-[(4S)-4-tert-Butyl-4,5-dihydro-2-oxazolyl]-5-(trifluoromethyl)pyridine, 98%, (99% ee) *(1416819-91-4)*
$C_{13}H_{15}F_3N_2O$; FW: 272.30; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.
100mg

07-6312 NEW
N,N'-(1R,2R)-1,2-Cyclohexanediyl-bis[N'-[3,5-bis(trifluoromethyl)phenyl] thiourea], 98%, (99% ee) *(743458-79-9)*
$C_{24}H_{20}F_{12}N_4S_2$; FW: 656.6; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

100mg

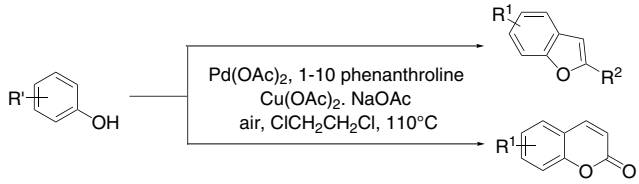
07-1813 NEW
2,6-Dichloro-1-fluoropyridinium triflate, 95% *(130433-68-0)*
$C_6H_3Cl_2F_4NO_3S$; FW: 316.06; white to light-yellow pwdr.
air sensitive, moisture sensitive, (store cold)
500mg
2g

07-1280 NEW
2-(2,4-Difluorophenyl)-5-methylpyridine, 95% *(583052-21-5)*
$C_{12}H_9F_2N$; FW: 205.20; white solid
air sensitive
Note: Ligand for photocatalyst synthesis.

500mg
2g

07-1923 NEW HAZ
4,7-Dimethoxy-1,10-phenanthroline, 98% *(92149-07-0)*
$C_{14}H_{10}N_2O_2$; FW: 238.24; white to off-white pwdr.; m.p. 210-212°; d. 1.25
air sensitive
Note: Ligand for photocatalyst synthesis.

250mg
1g

Technical Notes:

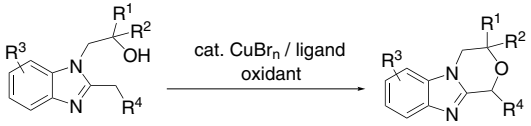
1. Palladium-catalyzed synthesis of benzofurans and coumarins from phenols and olefins.
2. Copper-catalyzed benzylic C(sp3)-H alkoxylation of heterocyclic compounds.
3. Synthesis of amides via copper-catalyzed amidation of aryl halides using isocyanides.
4. Iridium-catalyzed silylation of aryl C-H bonds.
5. Palladium-catalyzed intramolecular cyclization of nitroalkenes: synthesis of thienopyrroles.
6. A Copper-catalyzed N-alkynylation route to 2-substitued N-alkynyl pyrroles and their cyclization into pyrrolo[2,1-c]oxazin-1-ones



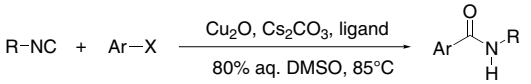
Tech. Note (1)
Ref. (1)

NITROGEN (Compounds)

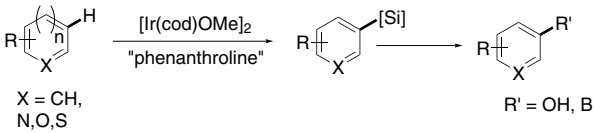
07-1923 **4,7-Dimethoxy-1,10-phenanthroline, 98%** *(92149-07-0)*
(cont.)



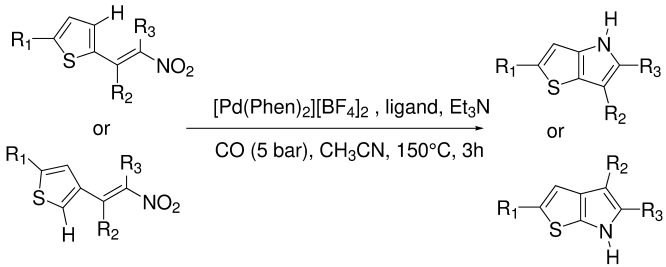
Tech. Note (2)
Ref. (2)



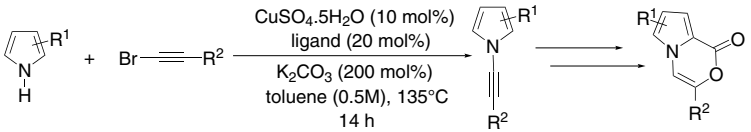
Tech. Note (3)
Ref. (3)



Tech. Note (4)
Ref. (4)



Tech. Note (5)
Ref. (5)



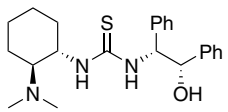
Tech. Note (6)
Ref. (6)

References:

1. *Angew. Chem. Int. Ed.*, **2013**, *52*, 12669.
2. *Organic & Biomolecular Chemistry,* **2014**, *12*, 2528.
3. *Tetrahedron Letts.*, **2014**, *55*, 4981.
4. *J. Am. Chem. Soc.*, **2015**, *137*, 592.
5. *European Journal of Organic Chemistry*, **2017**, *2017(14)*, 1902
6. *Synthesis,* **2017**, *49*, 2544.

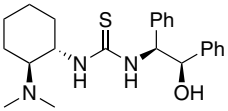
07-6326 **N-[(1S,2S)-2-(Dimethylamino)cyclohexyl]-N'-[(1R,2S)-2-hydroxy-1,2-diphenylethyl] thiourea, 98%, (99% ee)** 50mg

$C_{23}H_{31}N_3OS$; FW: 397.60; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

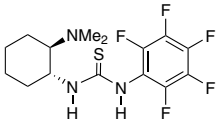


07-6325 NEW **N-[(1S,2S)-2-(Dimethylamino)cyclohexyl]-N'-[(1S,2R)-2-hydroxy-1,2-diphenylethyl] thiourea, 98%, (99% ee)** 50mg

$C_{23}H_{31}N_3OS$; FW: 397.60; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

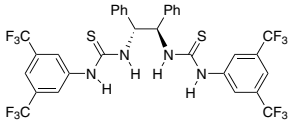


NITROGEN (Compounds)

07-2063 NEW
1-[(1R,2R)-2-(Dimethylamino)cyclohexyl]-3-(perfluorophenyl)thiourea, 98%, (99% ee)
$C_{15}H_{18}F_5N_3S$; FW: 367.40; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

100mg

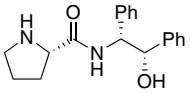
07-2064 NEW
1-[(1S,2S)-2-(Dimethylamino)cyclohexyl]-3-(perfluorophenyl) thiourea, 98%, (99% ee)
$C_{15}H_{18}F_5N_3S$; FW: 367.40; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.
100mg

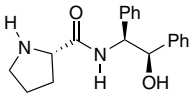
07-8020 NEW
N,N'-[(1S,2S)-1,2-Diphenyl-1,2-ethanediyl]bis[N'-[3,5-bis(trifluoromethyl)phenyl]thiourea], 95%, (99% ee) *(1416334-72-9)*
$C_{32}H_{22}F_{12}N_4S_2$; FW: 754.70; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.
100mg

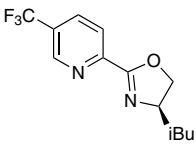
07-0821 NEW
N,N'-[(1R,2R)-1,2-Diphenyl-1,2-ethanediyl] bis[N'-[3,5-bis(trifluoromethyl)phenyl] thiourea], 98%, (99% ee) *(1012051-90-9)*
$C_{32}H_{22}F_{12}N_4S_2$; FW: 754.70; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

100mg

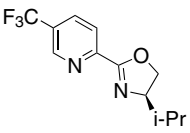
07-1828 NEW
1-Fluoropyridinium triflate, 95% *(107263-95-6)*
$C_6H_5F_4NO_3S$; FW: 247.17; white to pale-yellow pwdr.
air sensitive, moisture sensitive, (store cold)
500mg
2g

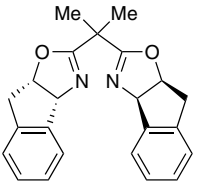
07-1835 NEW
1-Fluoro-2,4,6-trimethylpyridinium triflate *(107264-00-6)*
$C_9H_{11}F_4NO_3S$; FW: 289.25; white to pale-yellow pwdr.
air sensitive, moisture sensitive, (store cold)
500mg
2g

07-0984 NEW
(2S)-N-[(1R,2S)-2-Hydroxy-1,2-diphenyleth-yl]-2-pyrrolidinecarboxamide, 98%, (99% ee) *(529486-23-5)*
$C_{19}H_{22}N_2O_2$; FW: 310.40; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

100mg

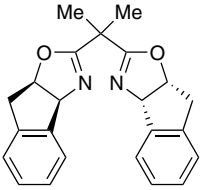
07-0983 NEW
(2S)-N-[(1S,2R)-2-Hydroxy-1,2-diphenyleth-yl]-2-pyrrolidinecarboxamide, 98%, (99% ee) *(529486-25-7)*
$C_{19}H_{22}N_2O_2$; FW: 310.40; whie to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

100mg

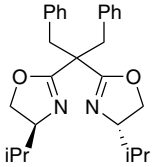
07-1040 NEW
2-[(4R)-4-Isobutyl-4,5-dihydro-2-oxaz-olyl]-5-(trifluoromethyl)pyridine, 98%, (99% ee)
$C_{13}H_{15}F_3N_2O$; FW: 272.30; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

50mg

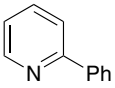
07-7058 NEW
2-[(4R)-4-Isopropyl-4,5-dihydro-2-oxazolyl]-5-(tri-fluoromethyl)pyridine, 98%, (99% ee)
$C_{12}H_{13}F_3N_2O$; FW: 258.20; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

100mg

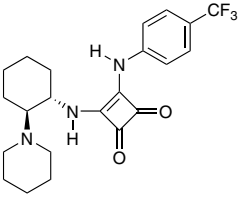
07-1035 NEW
(3aR,3'aR,8aS,8'aS)-2,2'-(1-Methylethylidene) bis[3a,8a-dihydro-8H-indeno[1,2-d]oxazole], 95%, (99% ee) *(189623-45-8)*
$C_{23}H_{22}N_2O_2$; FW: 358.40; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

100mg

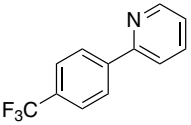
NITROGEN (Compounds)

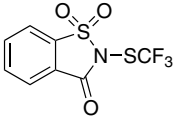
07-1034 NEW
(3aS,3'aS,8aR,8'aR)-2,2'-(1-Methylethylidene) bis[3a,8a-dihydro-8H-indeno[1,2-d]oxazole], 98%, (99% ee) *(175166-51-5)*
$C_{23}H_{22}N_2O_2$; FW: 358.40; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

100mg

07-7105 NEW
(4S,4'S)-2,2'-[2-Phenyl-1-(phenylmethyl) ethylidene]bis[4-(1-methylethyl)-4,5-dihydrooxazole], 95%, (99% ee) *(444575-98-8)*
$C_{27}H_{34}N_2O_2$; FW: 418.60; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

50mg

07-1780 NEW
2-Phenylpyridine, 95% *(1008-89-5)*
$C_{11}H_9N$; FW: 155.20; amber liquid; b.p. 268-270º; f.p. 230º; d. 1.086
air sensitive
Note: Ligand for photocatalyst synthesis.

1g

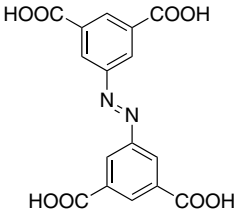
07-0905 NEW
3-[[(1S,2S)-2-(1-Piperidinyl)cyclohexyl] amino]-4-[[4-(trifluoromethyl)phenyl]amino]-3-cyclobutene-1,2-dione, 95%, (99% ee) *(1312991-08-4)*
$C_{22}H_{26}F_3N_3O_2$; FW: 421.50; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

50mg

07-2625 NEW
2-[4-(Trifluoromethyl)phenyl]pyridine, 95% *(203065-88-7)*
$C_{12}H_8F_3N$; FW: 223.19; white to yellow solid
air sensitive
Note: Ligand for photocatalyst synthesis.

1g

07-1840 NEW
2-[(Trifluoromethyl)thio]-1,1-dioxide-1,2-benzisothiazol-3(2H)-one, 97% *(1647073-46-8)*
$C_8H_4F_3NO_3S_2$; FW: 283.25; white solid
air sensitive, moisture sensitive

250mg
1g

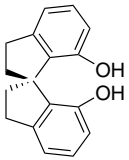
OXYGEN (Compounds)

08-0125 NEW
3,3',5,5'-Azobenzene tetracarboxylic acid, $TazbH_4$, 97% *(365549-33-33)*
$C_{16}H_{10}N_2O_8$; FW: 358.26; yellow-orange pwdr.
Note: Ligand for MOF Synthesis



1g
5g

08-2065 NEW
(R)-2,2',3,3'-Tetrahydro-1,1'-spirobi[indene]-7,7'-diol, 99% *(223259-62-9)*
$C_{17}H_{16}O_2$; FW: 252.31; white solid
Note: Sold in collaboration with Daicel for research purposes only.



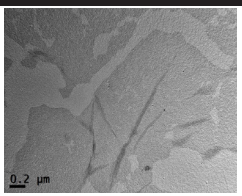
250mg
1g

98-8000 NEW
Water, 99.999% (PURATREM), 98-0295, contained in 50 ml Swagelok® cylinder (96-1070) for CVD/ALD *(7732-18-5)*
H_2O; FW: 18.015; colorless liq.; m.p. 0; b.p. 100; d. 1.0

25g

PALLADIUM (Elemental Forms)

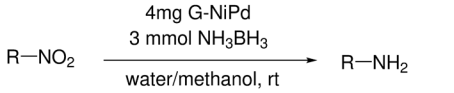
28-0015 NEW
Nickel/palladium alloy nanoparticle on graphene (G-$Ni_{33}Pd_{67}$)
black pwdr.
Note: U.S. Patent Application 14/667,859.

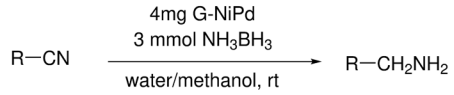


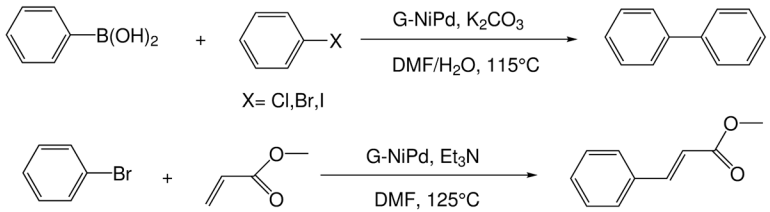
25mg
100mg

Technical Note:

1. NiPd NPs are useful catalysts for the tandem dehydrogenation of ammoniaborane and hydrogenation of R-NO_2 or R-CN to R-NH_2. NiPd nanoparticles also catalyze Suzuki-Miyaura and Heck cross-coupling reactions. The product is synthesized via the borane reduction of nickel and palladium salts in oleylamine, followed by dispersing the resulting mixture of Ni/Pd nanoparticles on graphene. The catalyst is 100% recyclable and shows no drop in catalytic activity after one month, when stored in air or argon at ambient temperatures.





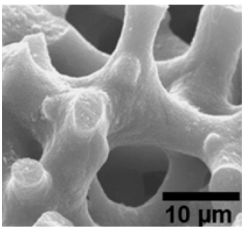


References:

1. *Nano Research,* **2013,** *6*, 10.
2. *ACS Catal*., **2014**, *4*, 1777.

PALLADIUM (Elemental Forms)

46-1660 NEW
Palladium on carbon - 1 wt % loading, activated synthetic carbon pellet *(7440-05-3)*
Pd; FW: 106.42; black pellet; SA: Pd 130 m^2/g; P.Vol. 1.2 cm^3/g
10g 50g



Technical Notes:
1. The enhanced dispersion of these Pd particles on the high purity carbon support (in both powder and pellet forms) enables the catalysts' operation under mild conditions (from RT to 60 °C) with higher selectivity and minimum unwanted side reactions.

One of the key differences of the Pd/C catalyst in pellet form (46-1660) is its more accessible surface area. This product has macroporosity (10 micron) and mesoporosity (6 nm) which makes carbon considerably lower in density (0.27 g/mL versus 0.5 -0.8 g/mL) and lighter than other carbon supports. This macroporosity allows palladium to be distributed throughout the carbon support instead of just on the outside. As a result, the metal surface area is much greater (130 m^2/g vs 20 m^2/g) and has a much smaller particle size (3.5 nm vs 40 nm).

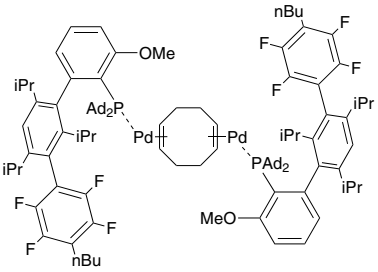
46-1610 NEW
Palladium on carbon - 1 wt % loading, activated synthetic carbon powder *(7440-05-3)*
Pd; FW: 106.42; black pwdr.; SA: Pd 150 m^2/g; P.Vol. 0.35 cm^3/g
10g 50g

46-1630 NEW
Palladium on carbon - 5 wt % loading, activated synthetic carbon powder *(7440-05-3)*
Pd; black pwdr.; SA: Pd 70 m^2/g; P.Vol. 0.35 cm^3/g
5g 25g

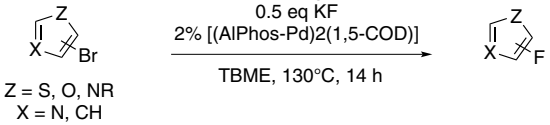
PALLADIUM (Compounds)

46-0700 NEW
Bis(acetonitrile)palladium(II) p-toluenesulfonate, 98% *(114757-66-3)*
$C_{18}H_{20}N_2O_6S_2Pd$; FW: 530.91; yellow pwdr.
air sensitive, (store cold)
50mg 250mg

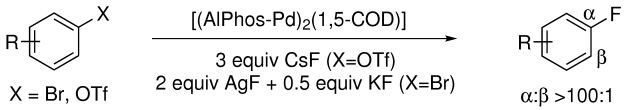
46-0241 NEW
Bis{[2-(Diadamantylphosphino)-3-methoxy-2',4',6'-tri-i-propyl-3'-(2,3,5,6-tetrafluoro-4-butylphenyl)-1,1'-biphenyl] palladium(0)}1,5-cyclooctadiene, [AlPhos Palladium complex] *(1805783-51-0)*
$C_{112}H_{146}F_8O_2P_2Pd_2$; FW: 1951.13; yellow-green solid
Note: Patents: US 6,395,916, US 6,307,087
50mg 250mg



Technical Notes:
1. Ligand for the Palladium-Catalyzed Fluorination of Five-Membered Heteroaryl Bromides.
2. Ligand for the Palladium-Catalyzed Fluorination of Aryl Triflates and Bromides.



Tech. Note (1)
Ref. (1)



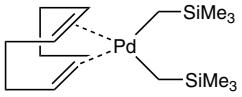
Tech. Note (2)
Ref. (2)

References:
1. *Organometallics*, **2015**, *34*, 4775
2. *J. Am. Chem. Soc.,*, **2015**, *137*, 13433

PALLADIUM (Compounds)

46-0308 NEW

Bis[(trimethylsilyl)methyl](1,5-cyclooctadiene)palladium(II), 98%
(225931-80-6)
$C_{16}H_{34}PdSi_2$; FW: 389.03; gray pwdr.
air sensitive, (store cold)

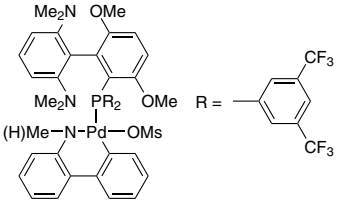


250mg
1g

96-5506 **Buchwald Palladacycle Precatalyst Kit 2b (Methanesulfonato-2'-amino-1,1'-biphenyl-2-yl- Palladacycles Gen. 3)**
See page 105

46-0347 NEW

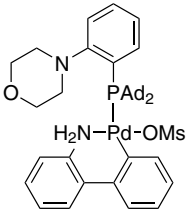
Methanesulfonato(2-bis(3,5-di(trifluoromethyl)phenylphosphino)-3,6-dimethoxy-2',6'-bis(dimethylamino)-1,1'-biphenyl) (2'-methylamino-1,1'-biphenyl-2-yl) palladium(II) [Palladacycle Gen. 4]
(1810068-35-9)
$C_{48}H_{44}F_{12}N_3O_5PPdS$; FW: 1140.32;
yellow to orange solid
Note: Patents: PCT/US2013/030779, US Serial No. 13/799620



100mg
500mg

46-0935 NEW

Methanesulfonato{N-[2-(di-1-adamantylphosphino)phenyl]morpholine} (2'-amino-1,1'-biphenyl-2-yl)palladium(II) dichloromethane adduct, min. 98% [Mor-Dalphos Palladacycle Gen. 3]
$C_{43}H_{55}N_2O_4PPdS$; FW: 833.37; Beige to brown solid
Note: Patents: PCT/US2013/030779, US Serial No. 13/799620



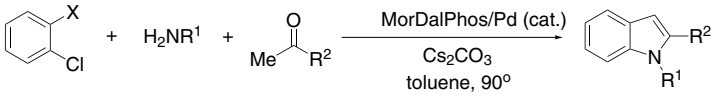
250mg
1g

Technical Note:

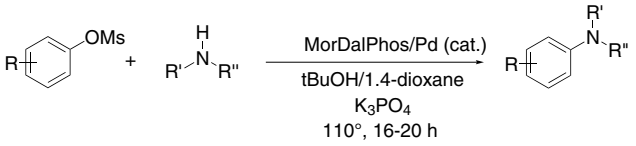
1. Palladium catalyst for ammonia arylation
2. Palladium catalyst for multicomponent one-pot synthesis of indoles.
3. Palladium catalyst for primary aliphatic amination of aryl mesylates.
4. Palladium catalyst for ketone mono-α-arylation of aryl mesylates.

X = Cl or OTs
R= electron-donating or withdrawing group

Tech. Note (1)
Ref. (1)



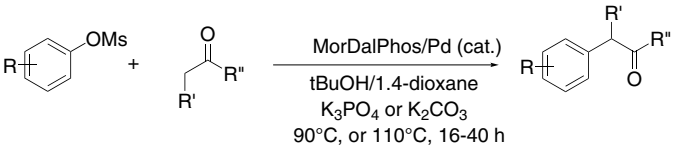
Tech. Note (2)
Ref. (2)



Tech. Note (3)
Ref. (3)

PALLADIUM (Compounds)

46-0935 ***(cont.)*** **Methanesulfonato{N-[2-(di-1-adamantylphosphino)phenyl]morpholine}(2'-amino-1,1'-biphenyl-2-yl)palladium(II) dichloromethane adduct, min. 98% [Mor-Dalphos Palladacycle Gen. 3]**



Tech. Note (4)
Ref. (3)

References:

1. *Angew. Int. Ed.,* **2010**, *49,* 4071.
2. *Angew. Int. Ed.,* **2013**, *52,* 7242.
3. *Adv. Synth. Catal.,* **2015**, *357,* 100.

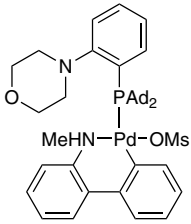
46-0940

NEW

Methanesulfonato{N-[2-(di-1-adamantylphosphino)phenyl]morpholine}(2'-methylamino-1,1'-biphenyl-2-yl)palladium(II) dichloromethane adduct, min. 98% MorDalphos Palladacycle Gen. 4

$C_{44}H_{57}N_2O_4PPdS$; FW: 847.39; off-white to gray solid

Note: Patents: PCT/US2013/030779, US Serial No. 13/799620.



250mg
1g

Technical Note:

1. See 46-0935 (page 64)

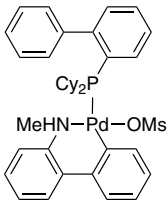
46-0980

NEW

Methanesulfonato(2-dicyclohexylphosphino-1,1'-biphenyl)(2'-methylamino-1,1-biphenyl-2-yl)]palladium(II) dichloromethane adduct, min. 98% CyJohnphos Palladacycle Gen. 4

$C_{38}H_{46}NO_3PPdS$; FW: 734.24; light brown solid

Note: Patents: PCT/US2013/030779,
US Serial No. 13/799620



250mg
1g

PHOSPHORUS (Compounds)

15-1960

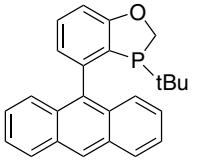
NEW

4-(Anthracen-9-yl)-3-(t-butyl-2,3-dihydrobenzo[d][1,3]oxaphosphole, 98+% rac-AntPhos *(1268693-24-8)*

$C_{25}H_{23}O_3P$; FW: 370.42; pale yellow pwdr.

air sensitive, (store cold)

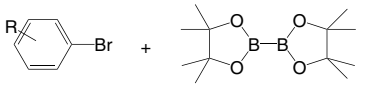
Note: Sold in collaboration with Zejun for research purposes only. Patents ZL201310020371.1, CN 201610056390.



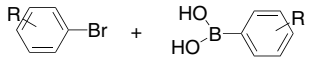
25mg
100mg
500mg

Technical Notes:

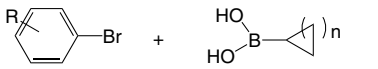
1. Ligand/palladium catalyst for general Miyaura borylation reactions.
2. Ligand/palladium catalyst for general and sterically demanding Suzuki-Miyaura cross-coupling reactions.
3. Ligand/palladium catalyst for aryl-alkyl Suzuki-Miyaura cross-coupling reactions.
4. Ligand/nickel catalyst for intramolecular reductive cyclization.
5. Ligand/palladium catalyst for Dearomative cyclization.



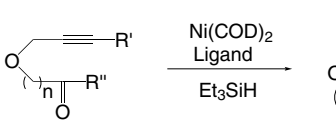
Tech. Note (1)
Ref. (1)



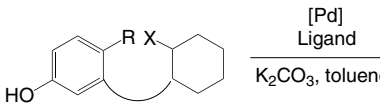
Tech. Note (2)
Ref. (2)



Tech. Note (3)
Ref. (3)



Tech. Note (4)
Ref. (4)



Tech. Note (5)
Ref. (5,6)

References:

1. *Org. Lett.,* **2011,***13*,1366.
2. *Chem. Eur. J.,* **2013,***19*,2261.
3. *Org.Chem. Front.,* **2014**,*1*, 225.
4. *Angew. Chem. Int. Ed.,* **2015**, *54,* 2520.
5. *Angew. Chem. Int. Ed.,* **2015**, *54,* 3033.
6. *Tetrahedron,* **2016,** *72,* 1782.

15-1963

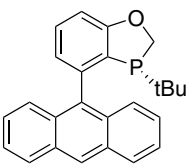
NEW

(R)-4-(Anthracen-9-yl)-3-(t-butyl-2,3-dihydrobenzo[d][1,3]oxaphosphole,98+% (>99% ee) [(R)-AntPhos] *(1456816-37-7)*

$C_{25}H_{23}O_3P$; FW: 370.42; light-yello xtl.

air sensitive, (store cold)

Note: Sold in collaboration with Zejun for research purposes only. Patents ZL201310020371.1, CN 201610056390.



25mg
100mg
500mg

Technical Note:

1. See 15-1960 (page 66)

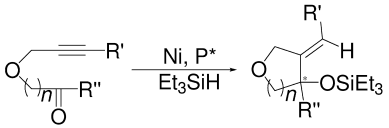
PHOSPHORUS (Compounds)

15-1967 NEW — 25mg / 100mg / 500mg

(S)-4-(Anthracen-9-yl)-3-(t-butyl-2,3-dihydrobenzo[d][1,3] oxaphosphole,99+% (>99% ee) [(S)-AntPhos] *(1807740-34-6)*
$C_{25}H_{23}O_3P$; FW: 370.42; light yellow xtl.
air sensitive, (store cold)
Note: Sold in collaboration with Zejun for research purposes only.
Patents ZL201310020371.1, CN 201610056390.

Technical Note:

1. Ligand for the enantioselective nickel-catalyzed intramolecular reductive cyclization of alkynones.



Tech. Note (1)
Ref. (1)

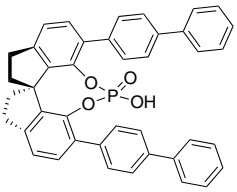
References:

1. *Angew. Chem. Int. Ed.,* **2015**, *54*, 2520.

96-0650 — **BI-DIME Ligand Kit**
See page 102

15-0293 NEW — 25mg

(11aR)-3,7-Bis([1,1'-biphenyl]-4-yl)-10,11,12,13-tetrahydro-5-hydroxy-diindeno[7,1-de:1',7'-fg][1,3,2]dioxaphosphocin, 98%, (99% ee)
(1297613-77-4)
$C_{41}H_{31}O_4P$; FW: 618.70; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

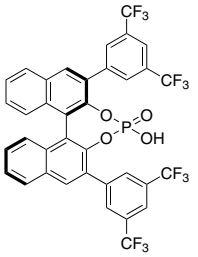


15-0294 NEW — 25mg

(11aS)-3,7-Bis([1,1'-biphenyl]-4-yl)-10,11,12,13-tetrahydro-5-hydroxy-diindeno[7,1-de:1',7'-fg][1,3,2]dioxaphosphocin, 98%, (99% ee)
(1297613-77-4)
$C_{41}H_{31}O_4P$; FW: 618.67; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

15-1366 NEW — 100mg

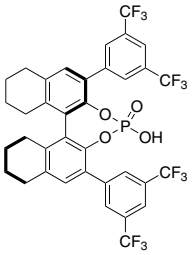
(11bR)-2,6-Bis[3,5-bis(trifluoromethyl)phenyl]-4-hydroxy-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2] dioxaphosphepin, 98%, (99% ee) *(791616-62-1)*
$C_{36}H_{17}F_{12}O_4P$; FW: 772.5; white to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.



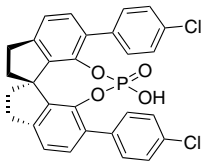
15-1367 NEW — 100mg

(11bS)-2,6-Bis[3,5-bis(trifluoromethyl)phenyl]-4-hydroxy-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2]dioxaphosphepin, 98%, (99% ee)
(878111-17-2)
$C_{36}H_{17}F_{12}O_4P$; FW: 772.5; White to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

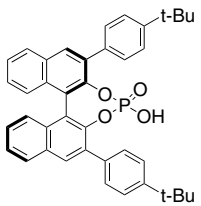
PHOSPHORUS (Compounds)

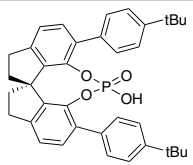
15-1376 NEW
(11bR)-2,6-Bis[3,5-bis(trifluoromethyl)phenyl]-8,9,10,11,12,13,14,15-octahydro-4-hydroxy-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2]dioxaphosphepin, 98%, (99% ee) *(1011465-24-9)*
$C_{36}H_{25}F_{12}O_4P$; FW: 780.5; White to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

25mg
100mg

15-1377 NEW
(11bS)-2,6-Bis[3,5-bis(trifluoromethyl)phenyl]-8,9,10,11,12,13,14,15-octahydro-4-hydroxy-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2]dioxaphosphepin, 98%, (99% ee)
$C_{36}H_{25}F_{12}O_4P$; FW: 780.5; White to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.
25mg
100mg

15-0276 NEW
(11aR)-3,7-Bis(4-chlorophenyl)-10,11,12,13-tetrahydro-5-hydroxy-diindeno[7,1-de:1',7'-fg][1,3,2]dioxaphosphocin, 98%, (99% ee)
$C_{29}H_{21}Cl_2O_4P$; FW: 535.36; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

50mg

15-0275 NEW
(11aS)-3,7-Bis(4-chlorophenyl)-10,11,12,13-tetrahydro-5-hydroxy-diindeno[7,1-de:1',7'-fg][1,3,2]dioxaphosphocin, 98%, (99% ee) *(1258327-05-7)*
$C_{29}H_{21}Cl_2O_4P$; FW: 535.36; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.
50mg

15-3280 NEW
(11bR)-2,6-Bis[4-(1,1-dimethylethyl)phenyl]-4-hydroxy-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2]dioxaphosphepin, 98%, (99% ee) *(861909-30-0)*
$C_{40}H_{37}O_4P$; FW: 612.71; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

50mg

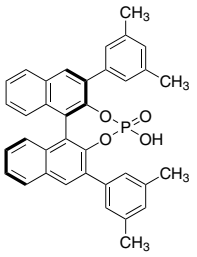
15-0339 NEW
(11aR)-3,7-Bis((4-(1,1-dimethylethyl)phenyl)-10,11,12,13-tetrahydro-5-hydroxy-diindeno[7,1-de:1',7'-fg][1,3,2]dioxaphosphocin, 98%, (99% ee)
$C_{37}H_{39}O_4P$; FW: 578.7; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

25mg

15-0338 NEW
(11aS)-3,7-Bis((4-(1,1-dimethylethyl)phenyl)-10,11,12,13-tetrahydro-5-hydroxy-diindeno[7,1-de:1',7'-fg][1,3,2]dioxaphosphocin, 98%, (99% ee)
$C_{37}H_{39}O_4P$; FW: 578.70; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.
25mg

PHOSPHORUS (Compounds)

15-1368 NEW

(11bR)-2,6-Bis(3,5-dimethylphenyl)-4-hydroxy-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2]dioxaphosphepin, 98%, (99% ee) *(861909-53-7)*
$C_{36}H_{29}O_4P$; FW: 556.6; White to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.



100mg

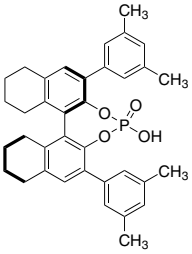
15-1369 NEW

(11bS)-2,6-Bis(3,5-dimethylphenyl)-4-hydroxy-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2]dioxaphosphepin, 98%, (99% ee) *(1170736-59-0)*
$C_{36}H_{29}O_4P$; FW: 556.6; White to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

100mg

15-1373 NEW

(11bR)-2,6-Bis(3,5-dimethylphenyl)-8,9,10,11,12,13,14,15-octahydro-4-hydroxy-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2]dioxaphosphepin, 98%, (99% ee) *(1065214-95-0)*
$C_{36}H_{37}O_4P$; FW: 564.7; White to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.



25mg
100mg

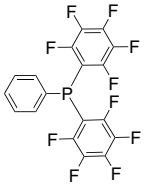
15-1374 NEW

(11bS)-2,6-Bis(3,5-dimethylphenyl)-8,9,10,11,12,13,14,15-octahydro-4-hydroxy-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2]dioxaphosphepin, 98%, (99% ee)
$C_{36}H_{37}O_4P$; FW: 564.7; White to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

25mg
100mg

15-0374 NEW

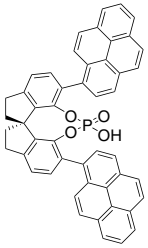
Bis(pentafluorophenyl)phenylphosphine, 97% *(5074-71-5)*
$C_{18}H_5F_{10}P$; FW: 442.20; white pwdr.; m.p. 59-61°; b.p. 105°C/0.3mm; f.p. >110°C
air sensitive



250mg
1g

15-0277 NEW

(11aR)-3,7-Bis(1-pyrenyl)-10,11,12,13-tetrahydro-5-hydroxy-diindeno[7,1-de:1',7'-fg][1,3,2]dioxaphosphocin, 98%, (99% ee)
$C_{49}H_{31}O_4P$; FW: 714.7; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.



25mg

15-0278 NEW

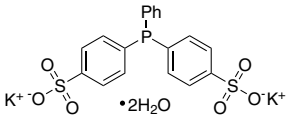
(11aS)-3,7-Bis(1-pyrenyl)-10,11,12,13-tetrahydro-5-hydroxy-diindeno[7,1-de:1',7'-fg][1,3,2]dioxaphosphocin, 98%, (99% ee)
$C_{49}H_{31}O_4P$; FW: 714.7; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

25mg

PHOSPHORUS (Compounds)

15-0638 NEW

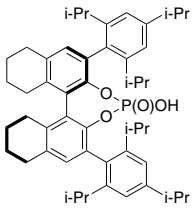
Bis(p-sulfonatophenyl)phenylphosphine dihydrate dipotassium salt, 97% *(308103-66-4)*
$C_{18}H_{13}K_2O_6PS_2$; FW: 498.60(534.63); white pwdr.; m.p. 98-102°
air sensitive



100mg
500mg

15-1395 NEW

(R)-3,3'-Bis2,4,6-triisopropylphenyl)-5,5',6,6',7,7',8,8'-octahydro-1,1'-binaphthyl-2,2'-diyl Hydrogenphosphate, 98%, (99% ee) *(929294-27-9)*
$C_{50}H_{65}O_4P$; FW: 761; White to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.



25mg
100mg

15-1394 NEW

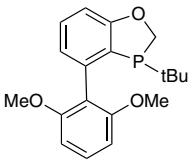
(S)-3,3'-Bis2,4,6-triisopropylphenyl)-5,5',6,6',7,7',8,8'-octahydro-1,1'-binaphthyl-2,2'-diyl Hydrogenphosphate, 98%, (99% ee) *(878111-20-7)*
$C_{50}H_{65}O_4P$; FW: 761; White to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

25mg
100mg

96-5495 **Buchwald Biaryl Phosphine Ligand Mini Kit 3 for Aromatic Carbon-Heteroatom Bond Formation, Suzuki Coupling and Negishi Cross-coupling**
See page 103

15-6205 NEW

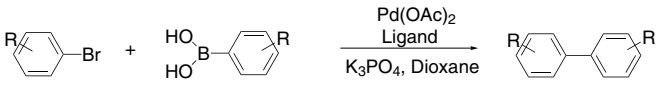
3-(t-Butyl)-4-(2,6-dimethoxyphenyl)-2,3-dihydrobenzo[d][1,3]oxaphosphole, min. 97%
rac-BI-DIME *(1246888-90-3)*
$C_{19}H_{23}O_3P$; FW: 330.36; light-yellow xtl.
Note: Sold in collaboration with Zejun for research purposes only. Patents: ZL2013105048267, CN104558038



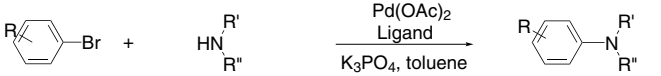
25mg
100mg
500mg

Technical Notes:

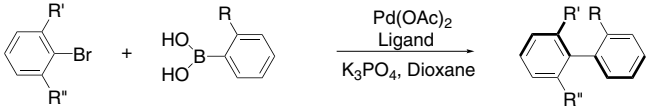
1. Ligand/palladium catalyst for general and sterically demanding Suzuki-Miyaura cross-coupling reactions
2. Ligand/palladium catalyst for sterically demanding Buchwald-Hartwig amination
3. Ligand/palladium catalyst for asymmetric Suzuki-Miyaura cross-coupling reactions.
4. Ligand/nickel catalyst for asymmetric intramolecular reductive cyclization
5. Ligand/rhodium catalyst for asymmetric hydroboration



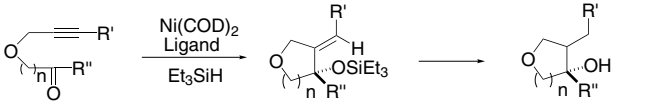
Tech. Note (1)
Ref. (1,2)



Tech. Note (2)
Ref. (3)



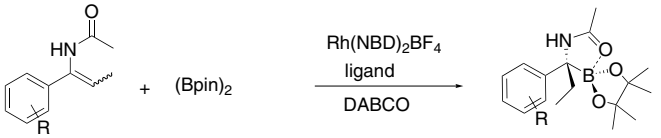
Tech. Note (3)
Ref. (4,5,6)



Tech. Note (4)
Ref. (7,8)

PHOSPHORUS (Compounds)

15-6205 ***(cont.)*** **3-(t-Butyl)-4-(2,6-dimethoxyphenyl)-2,3-dihydrobenzo[d][1,3]oxaphosphole, min. 97% rac-BI-DIME** *(1246888-90-3)*



Tech. Note (5)
Ref. (9)

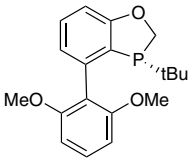
References:

1. *Angew. Chem., Int. Ed.* **2010**, *49*, 5879-5883
2. *Chem. Eur. J.* **2013**, *19*, 2261-2265
3. *Adv. Syn. Cat.* **2011**, *353*, 533-537
4. *Org. Lett.* **2012**, *14* , 2258–2261
5. *J. Am. Chem. Soc.*, **2014**, *136*, 570–573
6. *Angew. Chem., Int. Ed.* **2015**, *54*, 7144-7148
7. *Angew. Chem., Int. Ed.* **2015**, *54*, 2520 -2524
8. *Org. Chem. Front.* **2015**, *2*, 1322-1325
9. *J. Am. Chem. Soc.* **2015**, *137*, 6746-6749

15-6211

NEW

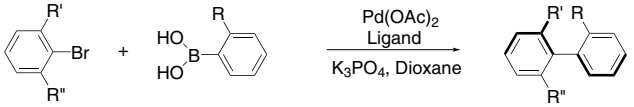
(R)-3-(t-Butyl)-4-(2,6-dimethoxyphenyl)-2,3-dihydrobenzo[d][1,3]oxaphosphole, min. 97% (R)-BI-DIME *(1373432-03-7)*
$C_{19}H_{23}O_3P$; FW: 330.36; light-yellow xtl.
Note: Sold in collaboration with Zejun for research purposes only. Patents: ZL2013105048267, CN104558038.



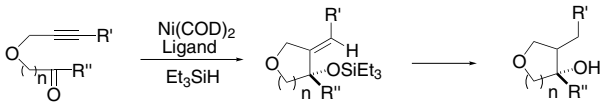
25mg
100mg
500mg

Technical Notes:

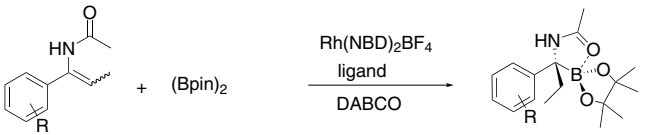
1. Ligand/palladium catalyst for asymmetric Suzuki-Miyaura cross-coupling reactions.
2. Ligand/nickel catalyst for asymmetric intramolecular reductive cyclization
3. Ligand/rhodium catalyst for asymmetric hydroboration



Tech. Note (1)
Ref. (1,2,3)



Tech. Note (2)
Ref. (4,5)



Tech. Note (3)
Ref. (6)

References:

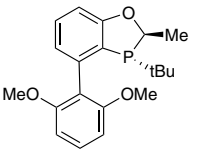
1. *Org. Lett.* **2012**, *14* , 2258–2261
2. *J. Am. Chem. Soc.*, **2014**, *136*, 570–573
3. *Angew. Chem., Int. Ed.* **2015**, *54*, 7144-7148
4. *Angew. Chem., Int. Ed.* **2015**, *54*, 2520 -2524
5. *Org. Chem. Front.* **2015**, *2*, 1322-1325
6. *J. Am. Chem. Soc.* **2015**, *137*, 6746-6749

PHOSPHORUS (Compounds)

15-6210 **(S)-3-(t-Butyl)-4-(2,6-dimethoxyphenyl)-2,3-dihydrobenzo[d][1,3]oxaphosphole, min. 97% (S)-BI-DIME** *(1373432-09-7)*
$C_{19}H_{23}O_3P$; FW: 330.36; light-yellow xtl.
Note: Sold in collaboration with Zejun for research purposes only.
Patents: ZL2013105048267, CN104558038.
25mg 100mg 500mg

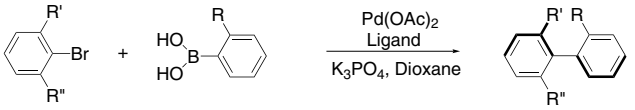
Technical Note:
1. See 15-6211 (page 71)

15-6225 NEW **(2R,3R)-3-(t-Butyl)-4-(2,6-dimethoxyphenyl)-2-methyl-2,3-dihydrobenzo[d][1,3]oxaphosphole, min. 97% (R,R)-Me-BI-DIME** *(1477517-18-2)*
$C_{20}H_{25}O_3P$; FW: 344.38; light-yellow xtl.
Note: Sold in collaboration with Zejun for research purposes only. Patents: ZL2013105048267, CN104558038.



25mg 100mg 500mg

Technical Note:
1. Ligand/palladium catalyst for asymmetric Suzuki-Miyaura cross-coupling reactions



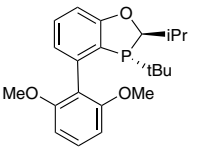
Tech. Note (1)
Ref. (1,2,3)

References:
1. *Org. Lett.* **2012**, *14* , 2258–2261
2. *J. Am. Chem. Soc.* **2014,** *136*, 570-573
3. *Angew. Chem., Int. Ed.* **2015**, *54*, 7144-7148

15-6220 NEW **(2S,3S)-3-(t-Butyl)-4-(2,6-dimethoxyphenyl)-2-methyl-2,3-dihydrobenzo[d][1,3]oxaphosphole, min. 97% (S,S)-Me-BI-DIME** *(1373432-11-1)*
$C_{20}H_{25}O_3P$; FW: 344.38; light-yellow xtl.
Note: Sold in collaboration with Zejun for research purposes only.
Patents: ZL2013105048267, CN104558038.
25mg 100mg 500mg

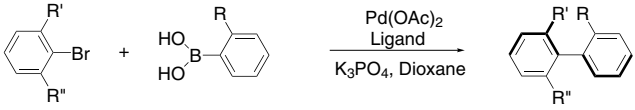
Technical Note:
1. See 15-6225 (page 72)

15-6235 NEW **(2R,3R)-3-(t-Butyl)-4-(2,6-dimethoxyphenyl)-2-i-propyl-2,3-dihydrobenzo[d][1,3]oxaphosphole, min. 97% (R,R)-iPr-BI-DIME** *(1477517-19-3)*
$C_{22}H_{29}O_3P$; FW: 372.44; light-yellow xtl.
Note: Sold in collaboration with Zejun for research purposes only. Patents: ZL2013105048267, CN104558038.



25mg 100mg 500mg

Technical Note:
1. Ligand/palladium catalyst for asymmetric Suzuki-Miyaura cross-coupling reactions



Tech. Note (1)
Ref. (1,2,3)

References:
1. *Org. Lett.* **2012**, *14* , 2258–2261
2. *J. Am. Chem. Soc.* **2014,** *136*, 570-573
3. *Angew. Chem., Int. Ed.* **2015**, *54*, 7144-7148

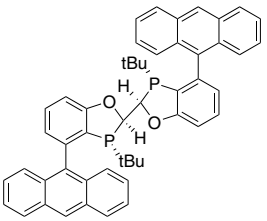
15-6230 NEW **(2S,3S)-3-(t-Butyl)-4-(2,6-dimethoxyphenyl)-2-i-propyl-2,3-dihydrobenzo[d][1,3]oxaphosphole, min. 97% (S,S)-iPr-BI-DIME** *(1477517-21-7)*
$C_{22}H_{29}O_3P$; FW: 372.44; light-yellow xtl.
Note: Sold in collaboration with Zejun for research purposes only.
Patents: ZL2013105048267, CN104558038.
25mg 100mg 500mg

Technical Note:
1. See 15-6235 (page 72)

PHOSPHORUS (Compounds)

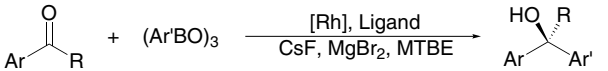
15-1011 NEW
Cyclohexyldi-t-butylphosphine, 98% (10wt% in hexanes) *(436865-11-1)*
$C_{14}H_{29}P$; FW: 228.36; colorless liq.
air sensitive
5g
25g

15-1970 NEW
(2R,2'R,3R,3'R)-4,4'-Di(anthracen-9-yl)-3,3'-di-t-butyl-2,2',3,3'-tetrahydro-2,2'-bibenzo[d][1,3]oxaphosphole, min 98% (>90% ee), [(2R,2'R,3R,3'R)-WingPhos]
(1884680-45-8)
$C_{50}H_{44}O_2P_2$; FW: 738.83; light yello pwdr.
air sensitive, (store cold)
Note: Sold in collaboration with Zejun for research purposes only. Patents ZL201310020371.1, CN 201610056390.



25mg
100mg
500mg

Technical Note:
1. Ligand for rhodium-catalyzed enantioselective addition of arylboroxines to simple aryl ketones.



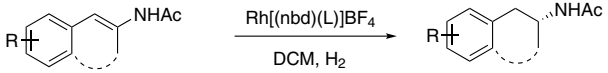
Tech. Note (1)
Ref. (1)

References:
1. *Angew. Chem.Int Ed.*, **2016,** *55,* 4527.

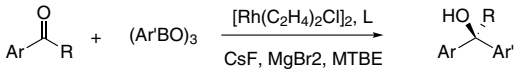
15-1975 NEW
(2S,2'S,3S,3'S)-4,4'-Di(anthracen-9-yl)-3,3'-di-t-butyl-2,2',3,3'-tetrahydro-2,2'-bibenzo[d][1,3]oxaphosphole, min 98%, (>99% ee), [(2S,2'S,3S,3'S)-WingPhos] *(1435940-19-4)*
$C_{50}H_{44}O_2P_2$; FW: 738.83; light yellow pwdr.
air sensitive, (store cold)
Note: Sold in collaboration with Zejun for research purposes only.
Patents ZL201310020371.1, CN 201610056390.

25mg
100mg
500mg

Technical Notes:
1. Ligand/Rhodium catalyst for asymmetric hydrogenation.
2. Ligand/Rhodium catalyst for asymmetric arylboronic reagents addition to aryl ketones.



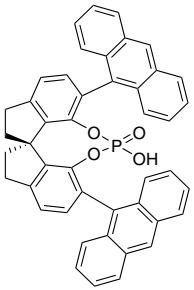
Tech. Note (1)
Ref. (1)



Tech. Note (2)
Ref. (2)

References:
1. *Angew. Chem.Int.Ed.,* **2013**, *52*, 4235.
2. *Angew. Chem.Int Ed.,* **2016,** *55,* 4527.

15-0334 NEW
(11aR)-3,7-Di-9-anthracenyl-10,11,12,13-tetrahydro-5-hydroxy-5-oxide-diindeno[7,1-de:1',7'-fg][1,3,2]dioxaphosphocin, 98%, (99% ee)
(1345628-08-1)
$C_{45}H_{31}O_4P$; FW: 666.71; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.



25mg

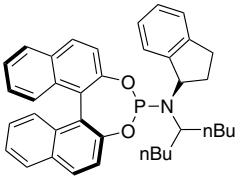
15-0335 NEW
(11aS)-3,7-Di-9-anthracenyl-10,11,12,13-tetrahydro-5-hydroxy-5-oxide-diindeno[7,1-de:1',7'-fg][1,3,2]dioxaphosphocin, 98%, (99% ee)
(1393527-23-5)
$C_{45}H_{31}O_4P$; FW: 666.71; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

25mg

PHOSPHORUS (Compounds)

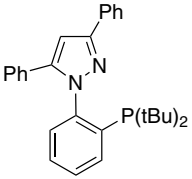
15-0870 NEW

(11bS)-N-((R)-2,3-dihydro-1H-inden-1-yl)-N-(Di-n-butyl methyl)dinaphtho[2,1-d:1',2'-f][1,3,2]dioxaphosphepin-4-amine
(2019254-27-2)
$C_{38}H_{40}NO_2P$; FW: 573.7
Note: Patent: UK1710941.4



15-1720 NEW

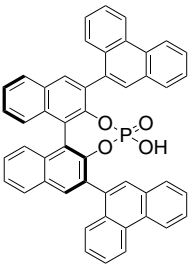
1-(2-Di-t-butylphosphinophenyl)-3,5-diphenyl-1H-pyrazole, 98% *(628333-86-8)*
$C_{29}H_{33}N_2P$; FW: 440.56; white xtl.; m.p. 138-142°
air sensitive



250mg
1g

15-0837 NEW

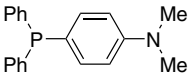
(11bS)-2,6-Di-9-phenanthrenyl-4-hydroxy-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2]dioxaphosphepin, 98% *(1043567-32-3)*
$C_{48}H_{29}O_4P$; FW: 700.71; red brown pwdr.
Note: Sold in collaboration with Daicel for research purposes only.



50mg

15-1380 NEW

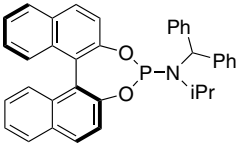
Diphenyl[4-(N,N-dimethylamino)phenyl] phosphine, min. 95% *(739-58-2)*
$C_{20}H_{20}NP$; FW: 305.35; white solid; m.p. 151-154°
air sensitive



1g
5g

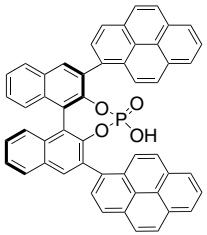
15-0860 NEW

(11bS)-N-(Diphenylmethyl)-N-isopropyldinaphtho[2,1-d:1',2'-f][1,3,2] dioxaphosphepin-4-amine *(1637749-69-9)*
$C_{36}H_{30}NO_2P$; FW: 539.6
Note: Patents: US20160074852, EP2986375



15-0364 NEW

(11bR)-2,6-Di-1-pyrenyl-4-hydroxy-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2]dioxaphosphepin, 98%, (99% ee)
$C_{52}H_{31}O_4P$; FW: 748.80; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.



50mg

15-0365 NEW

(11bS)-2,6-Di-1-pyrenyl-4-hydroxy-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2]dioxaphosphepin, 98%, (99% ee)
$C_{52}H_{31}O_4P$; FW: 748.8; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

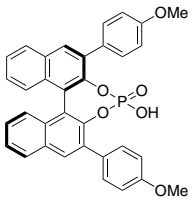
50mg

Technical Note:
1. See 15-0364 (page 74)

PHOSPHORUS (Compounds)

15-0309 NEW — 50mg

(11bR)-4-Hydroxy-2,6-bis(4-methoxyphenyl)-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2]dioxaphosphepin, 98%, (99% ee) *(695162-88-0)*
$C_{34}H_{25}O_6P$; FW: 560.50; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.



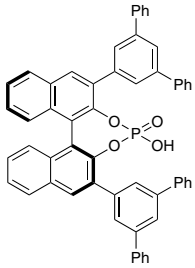
15-0308 NEW — 50mg

(11bS)-4-Hydroxy-2,6-bis(4-methoxyphenyl)-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2]dioxaphosphepin, 98%, (99% ee) *(1374030-19-9)*
$C_{34}H_{25}O_6P$; FW: 560.5; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

Technical Note:
1. See 15-0309 (page 75)

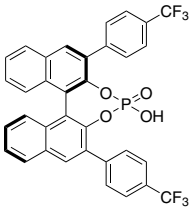
15-0317 NEW — 50mg

(11bS)-4-Hydroxy-2,6-bis([1,1':3',1''-terphenyl]-5'-yl)-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2]dioxaphosphepin, 98%, (99% ee) *(1496637-05-8)*
$C_{56}H_{37}O_4P$; FW: 804.90; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.



15-1392 NEW — 100mg

(11bR)-4-Hydroxy-2,6-bis[4-(trifluoromethyl)phenyl]-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2]dioxaphosphepin, 95%, (99% ee) *(791616-59-6)*
$C_{34}H_{19}F_6O_4P$; FW: 636.5; White to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.



15-1393 NEW — 100mg

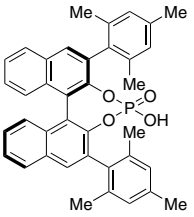
(11bS)-4-Hydroxy-2,6-bis[4-(trifluoromethyl)phenyl]-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2]dioxaphosphepin, 95%, (99% ee) *(1264573-23-0)*
$C_{34}H_{19}F_6O_4P$; FW: 636.5; White to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

15-3713 NEW — 50mg

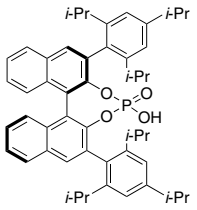
(11bS)-4-Hydroxy-2,6-bis(2,4,6-trimethylphenyl)-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2]dioxaphosphepin *(878111-18-3)*
$C_{38}H_{33}O_4P$; FW: 584.64; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

15-3712 NEW — 50mg

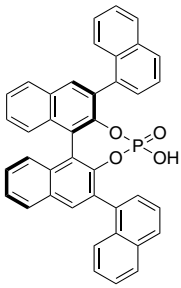
(11bR)-4-Hydroxy-2,6-bis(2,4,6-trimethylphenyl)-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2]dioxaphosphepin, 98%, (99% ee) *(695162-87-9)*
$C_{38}H_{33}O_4P$; FW: 584.64; white to yellow pwdr.; m.p. 224-230.5°
Note: Sold in collaboration with Daicel for research purposes only.



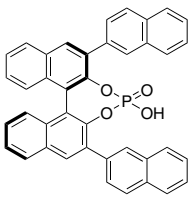
PHOSPHORUS (Compounds)

15-1381 NEW
(11bR)-4-Hydroxy-2,6-bis[2,4,6-tris(1-methylethyl)phenyl]-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2]dioxaphosphepin, 98%, (99% ee) *(791616-63-2)*
$C_{50}H_{57}O_4P$; FW: 753.0; White to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

100mg

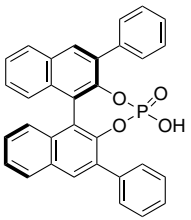
15-1382 NEW
(11bS)-4-Hydroxy-2,6-bis[2,4,6-tris(1-methylethyl)phenyl]-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2]dioxaphosphepin, 98%, (99% ee) *(874948-63-7)*
$C_{50}H_{57}O_4P$; FW: 753.0; White to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.
100mg

15-1388 NEW
(11bR)-4-Hydroxy-2,6-di-1-naphthalenyl-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2] dioxaphosphepin, 98%, (99% ee) *(864943-23-7)*
$C_{40}H_{25}O_4P$; FW: 600.6; White to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

100mg

15-1389 NEW
(11bS)-4-Hydroxy-2,6-di-1-naphthalenyl-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2]dioxaphosphepin, 98%, (99% ee) *(929097-93-8)*
$C_{40}H_{25}O_4P$; FW: 600.6; White to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.
25mg
100mg

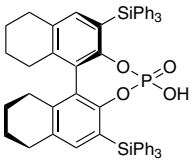
15-1390 NEW
(11bR)-4-Hydroxy-2,6-di-2-naphthalenyl-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2] dioxaphosphepin, 98%, (99% ee) *(791616-56-3)*
$C_{40}H_{25}O_4P$; FW: 600.6; White to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

100mg

15-1391 NEW
(11bS)-4-Hydroxy-2,6-di-2-naphthalenyl-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2]dioxaphosphepin, 98%, (99% ee) *(874948-60-4)*
$C_{40}H_{25}O_4P$; FW: 600.6; White to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.
25mg
100mg

15-1386 NEW
(11bR)-4-Hydroxy-2,6-diphenyl-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2]dioxaphosphepin, 98%, (99% ee) *(695162-86-8)*
$C_{32}H_{21}O_4P$; FW: 500.5; White to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

100mg

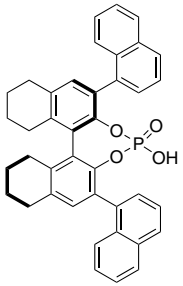
15-1387 NEW
(11bS)-4-Hydroxy-2,6-diphenyl-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2] dioxaphosphepin, 98%, (99% ee) *(874948-59-1)*
$C_{32}H_{21}O_4P$; FW: 500.5; White to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.
100mg

PHOSPHORUS (Compounds)

15-0820 NEW
(11bR)-8,9,10,11,12,13,14,15-Octahydro-4-hydroxy-2,6-bis(triphenylsilyl)-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2]dioxaphosphepin, 98%, (99% ee) *(957790-94-2)*
$C_{56}H_{49}O_4PSi_2$; FW: 873.13; white to yellow pwdr.; m.p. >264°
Note: Sold in collaboration with Daicel for research purposes only.


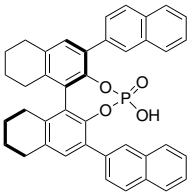
50mg

15-0821 NEW
(11bS)-8,9,10,11,12,13,14,15-Octahydro-4-hydroxy-2,6-bis(triphenylsilyl)-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2] dioxaphosphepin, 98%, (99% ee) *(1157989-25-7)*
$C_{56}H_{49}O_4PSi_2$; FW: 873.13; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.
50mg

15-1383 NEW
(11bR)-8,9,10,11,12,13,14,15-Octahydro-4-hydroxy-2,6-di-1-naphthalenyl-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2]dioxaphosphepin, 98%, (99% ee) *(1242066-20-1)*
$C_{40}H_{33}O_4P$; FW: 608.7; White to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.


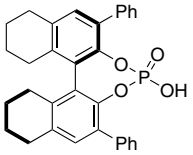
25mg
100mg

15-1384 NEW
(11bS)-8,9,10,11,12,13,14,15-Octahydro-4-hydroxy-2,6-di-1-naphthalenyl-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2] dioxaphosphepin, 98%, (99% ee)
$C_{40}H_{33}O_4P$; FW: 608.7; White to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.
25mg
100mg

15-1378 NEW
(11bR)-8,9,10,11,12,13,14,15-Octahydro-4-hydroxy-2,6-di-2-naphthalenyl-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2]dioxaphosphepin, 98%, (99% ee) *(922711-75-9)*
$C_{40}H_{33}O_4P$; FW: 608.7; White to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.


25mg
100mg

15-1379 NEW
(11bS)-8,9,10,11,12,13,14,15-Octahydro-4-hydroxy-2,6-di-2-naphthalenyl-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2] dioxaphosphepin, 98%, (99% ee)
$C_{40}H_{33}O_4P$; FW: 608.7; White to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.
25mg
100mg

15-1396 NEW
(11bR)-8,9,10,11,12,13,14,15-Octahydro-4-hydroxy-2,6-diphenyl-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2]dioxaphosphepin, 98%, (99% ee) *(791616-65-4)*
$C_{32}H_{29}O_4P$; FW: 508.5; White to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.


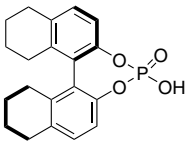
100mg

15-1397 NEW
(11bS)-8,9,10,11,12,13,14,15-Octahydro-4-hydroxy-2,6-diphenyl-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2]dioxaphosphepin, 98%, (99% ee) *(945852-48-2)*
$C_{32}H_{29}O_4P$; FW: 508.5; White to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.
100mg

PHOSPHORUS (Compounds)

15-1370 NEW — 100mg

(11bR)-8,9,10,11,12,13,14,15-Octahydro-4-hydroxy-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2] dioxaphosphepin, 98%, (99% ee) *(297752-25-1)*
$C_{20}H_{21}O_4P$; FW: 356.4; White to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

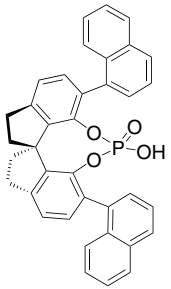


15-1371 NEW — 100mg

(11bS)-8,9,10,11,12,13,14,15-Octahydro-4-hydroxy-4-oxide-dinaphtho[2,1-d:1',2'-f][1,3,2]dioxaphosphepin, 98%, (99% ee)
(1193697-61-8)
$C_{20}H_{21}O_4P$; FW: 356.4; White to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

15-0377 — 50mg

(11aR)-10,11,12,13-Tetrahydro-5-hydroxy-3,7-di-1-naphthalenyl-5-oxide-diindeno[7,1-de:1',7'-fg][1,3,2]dioxaphosphocin, 98%, (99% ee)
(1297613-73-0)
$C_{37}H_{27}O_4P$; FW: 566.59; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

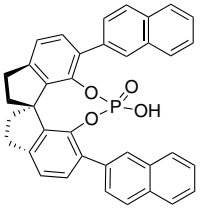


15-2185 NEW — 50mg

(11aS)-10,11,12,13-Tetrahydro-5-hydroxy-3,7-di-1-naphthalenyl-5-oxide-diindeno[7,1-de:1',7'-fg] [1,3,2]dioxaphosphocin 98% (99% ee)
(1258327-08-0)
$C_{37}H_{27}O_4P$; FW: 566.59; white to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

15-2190 NEW — 50mg

(11aR)-10,11,12,13-Tetrahydro-5-hydroxy-3,7-di-2-naphthalenyl-5-oxide-diindeno[7,1-de:1',7'-fg] [1,3,2]dioxaphosphocin, 98% (99% ee)
(1297613-74-1)
$C_{37}H_{27}O_4P$; FW: 566.59; white to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

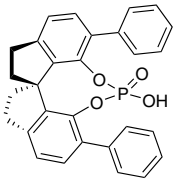


15-0290 NEW — 50mg

(11aS)-10,11,12,13-Tetrahydro-5-hydroxy-3,7-di-2-naphthalenyl-5-oxide-diindeno[7,1-de:1',7'-fg][1,3,2]dioxaphosphocin, 98%, (99% ee)
$C_{37}H_{27}O_4P$; FW: 566.59; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

15-2170 NEW — 50mg

(11aR)-10,11,12,13-Tetrahydro-5-hydroxy-3,7-diphenyl-diindeno[7,1-de:1',7'-fg] [1,3,2]dioxaphosphocin, 98% (99% ee) *(1297613-72-9)*
$C_{29}H_{23}O_4P$; FW: 466.46; white to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.



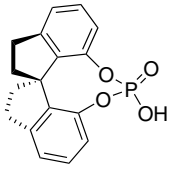
15-2171 NEW — 50mg

(11aS)-10,11,12,13-Tetrahydro-5-hydroxy-3,7-diphenyl-diindeno[7,1-de:1',7'-fg] [1,3,2]dioxaphosphocin, 98% (99% ee) *(1258327-04-6)*
$C_{29}H_{23}O_4P$; FW: 446.46; white to light-yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

PHOSPHORUS (Compounds)

15-5965 — 100mg

(11aR)-10,11,12,13-Tetrahydro-5-hydroxy-5-oxide-diindeno[7,1-de:1',7'-fg][1,3,2]dioxaphosphocin, 98%, (99%) *(1352810-35-5)*
$C_{17}H_{15}O_4P$; FW: 314.27; white to yellow pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

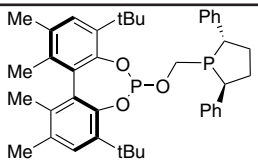


15-5966 NEW — 100mg

(11aS)-10,11,12,13-Tetrahydro-5-hydroxy-5-oxide-diindeno[7,1-de:1',7'-fg][1,3,2]dioxaphosphocin, 98%, (99% ee) *(1258327-03-5)*
$C_{17}H_{15}O_4P$; FW: 314.27; orange pwdr.
Note: Sold in collaboration with Daicel for research purposes only.

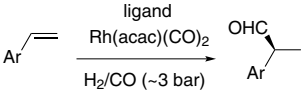
15-0557 NEW — 100mg, 500mg

(11aS)-1,2,10,11-Tetramethyl-4,8-bis(t-butyl)-6-[[(2S,5S)-(2,5-diphenyl-1-phospholanyl) methoxy]-dibenzo[d,f][1,3,2] dioxaphosphepin] S_{ax}S,S-BOBPHOS *(1373349-83-7)*
$C_{41}H_{50}O_3P_2$; FW: 652.78; white microxtl. pwdr.
moisture sensitive



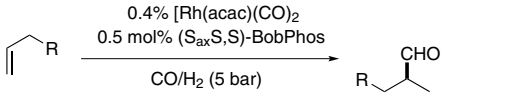
Technical Notes:

1. Rhodium/phospholane catalysts for the unusually high regioselectivity in the enantioselective hydroformylation of vinyl arenes.
2. An asymmetric hydroformylation catalyst that delivers branched aldehydes from alkyl alkenes



S/C up to 10000
up to 92% ee
B:L > 50/1

Tech. Note (1)
Ref. (1)



75-90% branched
aldehyde selectivity:
up to 93% ee

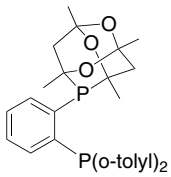
Tech. Note (2)
Ref. (2)

References:

1. *Chem Commun*., **2014**, *50*, 1475.
2. *Angew. Chem. Int. Ed.*, **2012**, *51*, 2477.

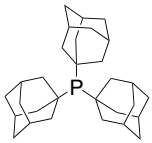
15-1099 NEW — 250mg, 1g

1,3,5,7-Tetramethyl-8-(2-di-o-tolylphosphinophenyl)-2,4,6-trioxa-8-phosphaadamantane PAd-DalPhos *(1902911-38-9)*
$C_{30}H_{34}O_3P_2$; FW: 504.54; white pwdr.
air sensitive, moisture sensitive



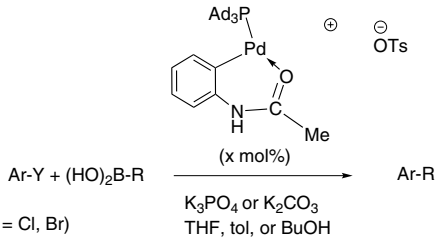
PHOSPHORUS (Compounds)

15-0935 NEW
Tris(1-adamantyl)phosphine, 97% *(897665-73-5)*
$C_{30}CH_{45}P$; FW: 436.65; white to off-white pwdr.
air sensitive
Note: Sold in collaboration with GreenCentre for research purposes only. Patents: 62248056.
250mg 1g 5g



Technical Note:

1. A stable phosphine ligand which can bind to metals such as palladium to be used in Suzuki-Miyaura couplings in making drug intermediates. Dramatic effects in catalysis are also accessible now by using PAd_3 as a ligand during Suzuki-Miyaura cross-coupling of chloro(hetero)arenes.[1,2]



Tech. Note (1)
Ref. (1,2)

References:

1. *Synlett.*, **2017**, *28(3)*, 280-288.
2. *J. Am. Chem. Soc.*, **2016**, *138*, 6392.

15-7725 NEW
Tris(2,6-dimethoxyphenyl)phosphine, min. 97% *(85417-41-0)*
$C_{24}H_{27}O_6P$; white to off-white pwdr.; m.p. 145-147°
air sensitive
5g

PLATINUM (Elemental Forms)

78-3015 NEW
Platinum nanoparticles, 1% on carbon black (surfactant and reactant-free)
(7440-06-4)
Pt; FW: 195.10; black solid
(store cold)
Note: Manufactured by laser ablation. Sold in collaboration with Particular® for research purposes only.
5g 25g

78-3020 NEW
Platinum nanoparticles, 5% on carbon black (surfactant and reactant-free)
(7440-06-4)
Pt; FW: 195.10; black solid
(store cold)
Note: Manufactured by laser ablation. Sold in collaboration with Particular® for research purposes only.
5g 25g

78-3030 NEW
Platinum nanoparticles, 10% on carbon black (surfactant and reactant-free)
(7440-06-4)
Pt; FW: 195.10; black solid
(store cold)
Note: Manufactured by laser ablation. Sold in collaboration with Particular® for research purposes only.
1g 5g

78-3032 NEW
Platinum nanoparticles, 20% on carbon black (surfactant and reactant-free)
(7440-06-4)
Pt; FW: 195.10; black solid
(store cold)
Note: Manufactured by laser ablation. Sold in collaboration with Particular® for research purposes only.
1g 5g

78-3035 NEW
Platinum nanoparticles, 30% on carbon black (surfactant and reactant-free)
(7440-06-4)
Pt; FW: 195.10; black solid
(store cold)
Note: Manufactured by laser ablation. Sold in collaboration with Particular® for research purposes only.
1g 5g

PLATINUM (Elemental Forms)

78-3012 NEW
Platinum nanoparticles, 1% on Titania (anatase) (surfactant and reactant-free) 5g 25g
(7440-06-4)
Pt; FW: 195.10; gray solid
(store cold)
Note: Manufactured by laser ablation. Sold in collaboration with Particular® for research purposes only.

78-3005 NEW
Platinum nanoparticles, 1% on Titania (rutile) (surfactant and reactant-free) 5g 25g
(7440-06-4)
Pt; FW: 195.10; light gray solid
(store cold)
Note: Manufactured by laser ablation. Sold in collaboration with Particular® for research purposes only.

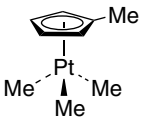
78-3026 NEW
Platinum nanoparticles, 10% on Titania (anatase) (surfactant and reactant-free) 1g 5g
(7440-06-4)
Pt; FW: 195.10; dark gray solid
(store cold)
Note: Manufactured by laser ablation. Sold in collaboration with Particular® for research purposes only.

78-3023 NEW
Platinum nanoparticles, 10% on Titania (rutile) (surfactant and reactant-free) 1g 5g
(7440-06-4)
Pt; FW: 195.10; dark gray solid
(store cold)
Note: Manufactured by laser ablation. Sold in collaboration with Particular® for research purposes only.

PLATINUM (Compounds)

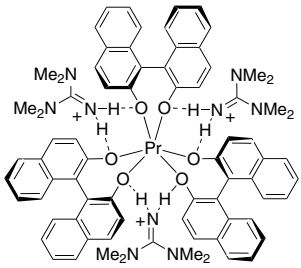
78-0455 NEW
cis-Dichlorodiammineplatinum (II), CISPLATIN (USP) *(15663-27-1)* 1g 5g
cis-$Pt(NH_3)_2Cl_2$; FW: 300.06; yellow to orange xtl.; m.p. 230°

98-1350 NEW
(Trimethyl)methylcyclopentadienylplatinum(IV), 99% (99.999%-Pt) PURATREM *(94442-22-5)* 500mg 2g 10g
$(CH_3)_3(CH_3C_5H_4)Pt$; FW: 319.32; off-white pwdr.; m.p. 30-31°; b.p. (subl. 23°C/0.053mm); d. 1.88
air sensitive, (store cold)



PRASEODYMIUM (Compounds)

59-1000 NEW
Tris[N,N,N,N-tetramethylguanidinium][-tris(1S)-(1,1'-binaphalene)-2,2'-diolato] praseodymate Pr-HTMG-B 250mg 1g
$C_{75}H_{78}N_9O_6Pr$; FW: 1342.38; off-white pwdr.
Note: U.S.Patent 14/898,925.

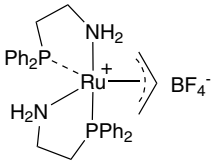


Technical Note:
1. See 57-1250 (page 43)

RUTHENIUM (Compounds)

44-6085 NEW

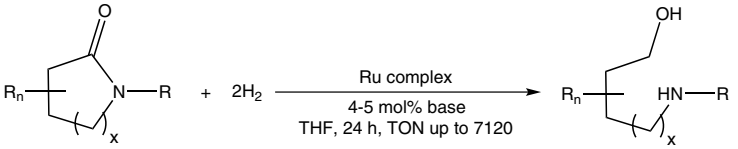
Allylbis(2-aminoethyldiphenylphosphino) ruthenium(II) tetrafluoroborate, 98%
(1352633-94-3)
$C_{31}H_{37}BF_4N_2P_2Ru$; FW: 687.46;
off-white to pale yellow solid
Note: Sold in collaboration with GreenCentre for research purposes only. Patents: PCT/2013/010275.



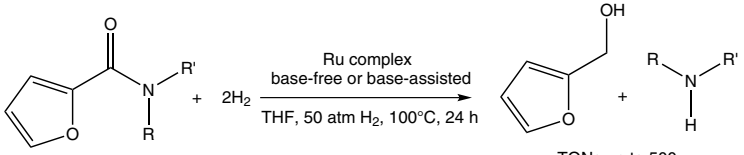
100mg
500mg

Technical Notes:

1. A highly active catalyst for the hydrogenation of amides to alcohols and amines.
2. Catalyst used for the hydrogenation of functionalized amides under basic and neutral conditions.



Tech. Note (1)
Ref. (1)



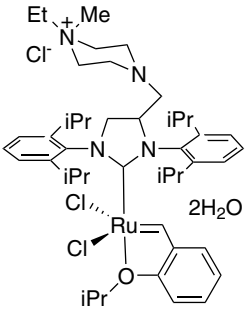
Tech. Note (2)
Ref. (2)

References:

1. *Angew. Chem. Int. Ed.*, **2011**, *50*, 10377.
2. *Catal. Sci. Technol.*, **2015**, *5*, 1186.

44-0759 NEW

(1,3-Bis(2,6-diisopropylphenyl)-4-((4-ethyl-4-methylpiperzain-1-ium-1-yl)methyl)imidazolidin-2-ylidene)(2-isopropoxybenzylidene) ruthenium(II) chloride dihydrate FixCat
(1799947-97-9)
$C_{45}H_{67}Cl_2N_4ORuCl$ 2(H_2O); FW: 887.47 (923.50);
green pwdr.
(store cold)
Note: Sold in collaboration with Apeiron Synthesis, Inc. U.S. Patent 61/603,790; PCT/EP2013/053967

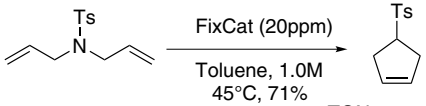


100mg
500mg

Technical Note:

1. Fixcat is a stable olefin metathesis initiator with very good solubility in neat water. The product efficiently promotes ring-closing, cross, and enyne metathesis reactions of water soluble substrates. Suitable for homogeneous and heterogeneous in batch or flow setup.

The Fixcat structure was also optimized to serve as a versatile and very stable catalyst, easily immobilized on solid supports. In its SCA-15 supported version, it showed exceptional efficiency in promoting ring-closing and cross-metathesis reactions, in both batch and continuous flow setups. Fix Cat is also applicable as a homogeneous catalyst, where compatible solvents include alcohols and halogenated solvents.



TON 35500
$TOF_{10\ min}$ 1590 min^{-1}

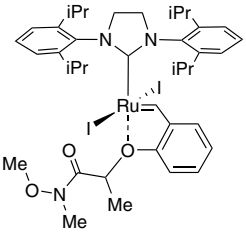
Tech. Note (1)
Ref. (1)

References:

1. *ChemSus Chem.*, **2015**, *8*, 4139.

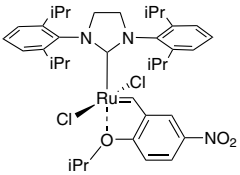
RUTHENIUM (Compounds)

44-0748
NEW
[1,3-Bis(2,6-di-i-propylphenyl)imidazolidin-2-ylidene][(2-((1-methoxy(methyl) amino)-1-oxopropan-2-yl)oxy] benzylidenediiodoruthenium(II) GreenCat-I2
$C_{39}H_{53}I_2N_3O_3Ru$; FW: 966.74; green solid
air sensitive, (store cold)
Note: Sold in collaboration with Apeiron Synthesis, Inc. U.S. Patent 61/666,009 PCT/EP2013/062435. Store at 2-8°C under inert atmosphere. Catalyst may be weighed in air



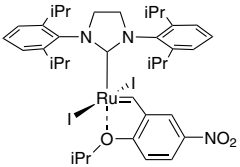
100mg
500mg

44-0770
NEW
1,3-Bis(2,6-di-i-propylphenyl)imidazolidin-2-ylidene)(2-i-propoxy-5-nitrobenzylidene) ruthenium(II) dichloride Nitro-Grela SiPr
(928795-51-1)
$C_{37}H_{49}Cl_2N_3O_3Ru$; FW: 755.78; green pwdr.
(store cold)
Note: Sold in collaboration with Apeiron Synthesis, Inc. U.S. Patent 6/867,303 PCT/EP2003/01122. Store at 2-8°C under inert atmosphere. Catalyst may be weighed in air



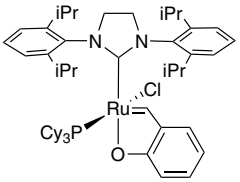
100mg
500mg

44-0782
NEW
[1,3-Bis(2,6-di-i-propylphenyl)imidazolidin-2-ylidene)(2-i-propoxy-5-nitrobenzylidene) ruthenium(II) diiodide nitro-Grela I2 SIPr
(1874265-00-5)
$C_{37}H_{49}I_2N_3O_3Ru$; FW: 938.68; olive brown pwdr.
air sensitive, (store cold)
Note: Sold in collaboration with Apeiron Synthesis, Inc. U.S. Patent 6/867,303 PCT/EP2003/01122. Store at 2-8ºC under inert atmosphere. Catalyst may be weighed in air



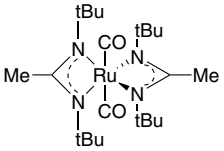
100mg
500mg

44-0793
NEW
[1,3-Bis(2,6-di-i-propylphenyl)imidazolidin-2-ylidene)(tricyclohexylphosphine)-(2-oxo-5-nitrobenzylidene)ruthenium(II) chloride LatMet SIPr *(1544328-59-7)*
$C_{52}H_{77}ClN_2OPRu$; FW: 913.68; dark green xtl.
air sensitive
Note: Sold in collaboration with Apeiron Synthesis, Inc. U.S. Patent 9,328,132, PCT/EP2013/065839.



100mg
500mg

44-0056
NEW
amp
Bis(N,N'-di-tert-butylacetamidinato)ruthenium(II) dicarbonyl, 98% (99.99%-Ru) PURATREM
(949113-49-9)
$C_{22}H_{42}N_4O_2Ru$; FW: 495.67; Beige to yellow solid; m.p. 204
air sensitive, moisture sensitive
Note: Product sold under, use subject to, terms and conditions of label license at www.strem.com/harvard2



1g
5g

RUTHENIUM (Compounds)

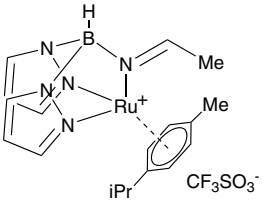
44-0355

NEW

[Bis(pyrazol-1-yl)(acetimino)hydridoborato](p-cymene)ruthenium(II) trifluoromethanesulfonate *(1607436-49-6)*

$C_{19}H_{25}BF_3N_5O_3RuS$; FW: 572.38; yellow pwdr.

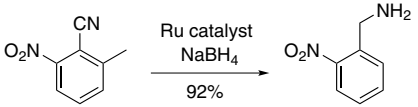
Note: Sold under license from USC for research purposes only. U.S. Patent No. 62/082,992.



100mg
500mg

Technical Note:

1. Dual site catalyst for the mild, selective nitrile reduction.



Tech. Note (1)
Ref. (1)

References:

1. *Chem. Comm.*, **2014**, *50(40),* 5391.

44-0755

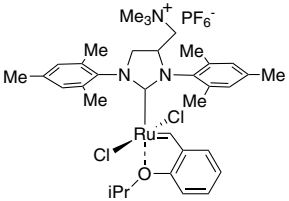
NEW

1,3-Bis(2,4,6-trimethylphenyl)-4-[(trimethylammonio)methyl]imidazolidin-2-ylidene]-(2-i-propoxybenzylidene) dichlororuthenium(II) hexafluorophosphate StickyCat PF6

$C_{35}H_{48}Cl_2F_6N_3OPRu$; FW: 843.72; green pwdr.

air sensitive, (store cold)

Note: Sold in collaboration with Apeiron Synthesis, Inc. U.S. Patent 61/603,790, PCT/EP2013/053967. Store at 2-8°C under inert atmosphere. Catalyst may be weighed in air.



100mg
500mg

44-0795

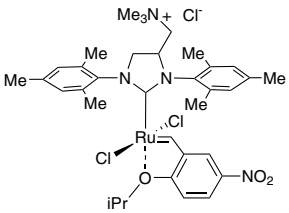
NEW

1,3-Bis(2,4,6-trimethylphenyl)-4-[(trimethylammonio)methyl]imidazolidin-2-ylidene]-(2-i-propoxy-5-nitrobenzylidene) dichlororuthenium(II) chloride nitro-StickyCat Cl *(1415661-45-8)*

$C_{35}H_{47}Cl_3N_4O_3Ru$; FW: 779.20; green pwdr.

air sensitive, (store cold)

Note: Sold in collaboration with Apeiron Synthesis, Inc. U.S. Patent 61/603,790 PCT/EP2013/053967. Store at 2-8°C under inert atmosphere. Catalyst may be weighed in air.



100mg
500mg

44-0767

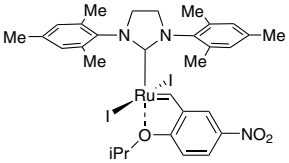
NEW

[1,3-Bis(2,4,6-trimethylphenyl)imidazolidin-2-ylidene)-(2-i-propoxy-5-nitrobenzylidene) ruthenium(II) diiodide nitro-Grela I2 *(1874264-99-9)*

$C_{31}H_{37}I_2N_3O_3Ru$; FW: 854.52; olive brown pwdr.

air sensitive, (store cold)

Note: Sold in collaboration with Apeiron Synthesis, Inc. U.S. Patent 6/867,303 PCT/EP2003/01122. Store at 2-8°C under inert atmosphere. Catalyst may be weighed in air.



100mg
500mg

44-0787

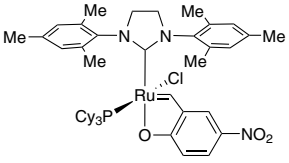
NEW

[1,3-Bis(2,4,6-trimethylphenylimidazolidin-2-ylidene)(tricyclohexylphosphine)-(2-oxo-5-nitrobenzylidene)ruthenium(II) chloride Nitro-LatMet *(1544328-53-1)*

$C_{46}H_{64}ClN_3O_3PRu$; FW: 874.52; brown xtl.

air sensitive, (store cold)

Note: Sold in collaboration with Apeiron Synthesis, Inc. U.S. Patent 9,328,132, PCT/EP2013/065839.

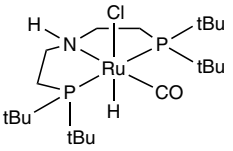


100mg
500mg

RUTHENIUM (Compounds)

44-1035 NEW

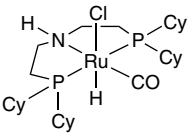
Carbonylchlorohydrido[bis(2-di-t-butylphosphinoethyl)amine]ruthenium(II), min. 97% *(1421060-10-7)*
$C_{21}H_{46}ClNOP_2Ru$; FW: 527.07; off-white solid
air sensitive



250mg
1g

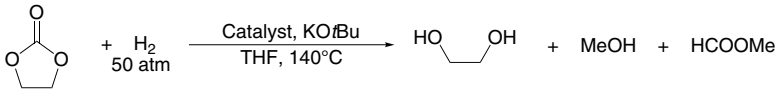
44-1043 NEW

Carbonylchlorohydrido[bis(2-di-cyclohexyl-phosphinoethyl)amine]ruthenium(II), min. 97% *(1421060-11-8)*
$C_{29}H_{54}ClNOP_2Ru$; FW: 631.22; white solid
air sensitive

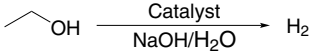


250mg
1g

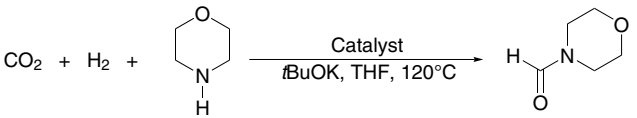
Technical Notes:
1. Catalyst for the hydrogenation of ethylene carbonate to methanol.
2. Catalyst for the generation of hydrogen from aqueous ethanol solution.
3. Catalyst for the N-formylation of morpholine with hydrogen and carbon dioxide.



Tech. Note (1)
Ref. (1)



Tech. Note (2)
Ref. (2)

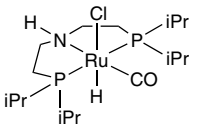


Tech. Note (3)
Ref. (3)

References:
1. *Angew. Chem. Int. Ed.*, **2012**, *51*, 13041.
2. *ChemSusChem*, **2014**, *7*, 2419.
3. *Angew. Chem. Int. Ed.*, **2015**, *54*, 6186.

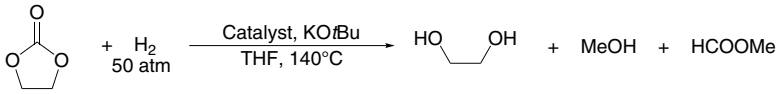
44-1032 NEW

Carbonylchlorohydrido[bis(2-di-i-propylphos-phinoethyl)amine]ruthenium(II), min. 97% *(1311164-69-8)*
$C_{17}H_{38}ClNOP_2Ru$; FW: 470.96; off-white solid
air sensitive

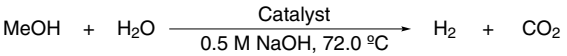


250mg
1g

Technical Notes:
1. Catalyst for hydrogenation of ethylene carbonate to methanol.
2. Catalyst for dehydrogenation of aqueous-phase methanol to hydrogen and carbon dioxide.
3. Catalyst for hydrogenation of diethyl oxalate.
4. Catalyst for generation of hydrogen from aqueous ethanol solution.
5. Ruthenium- catalyzed hydrogen generation from glycerol and selective synthesis of lactic acid.
6. Catalyst N-formylation of morpholine with hydrogen and carbon dioxide.



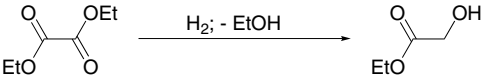
Tech. Note (1)
Ref. (1)



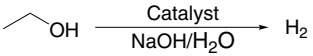
Tech. Note (2)
Ref. (2)

RUTHENIUM (Compounds)

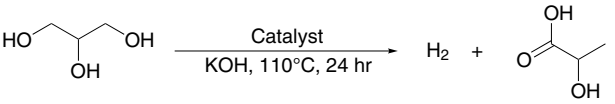
44-1032 (cont.) **Carbonylchlorohydrido[bis(2-di-i-propylphosphinoethyl)amine]ruthenium(II), min. 97%** *(1311164-69-8)*



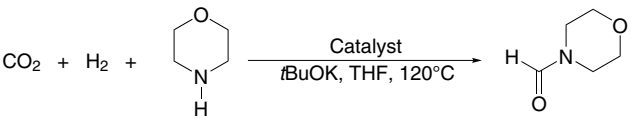
Tech. Note (3)
Ref. (3)



Tech. Note (4)
Ref. (4)



Tech. Note (5)
Ref. (5)



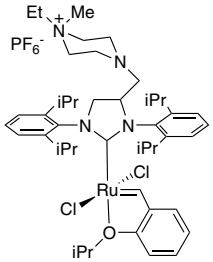
Tech. Note (6)
Ref. (6)

References:

1. *Angew. Chem. Int. Ed*., **2012**, *51*, 13041.
2. *Nature*, **2013**, *495*, 85.
3. *ChemCatChem*, **2013**, *5*, 3228.
4. *ChemSusChem*, **2014**, *7*, 2419.
5. *Green Chem*., **2015**, *17*, 193.
6. *Angew. Chem. Int. Ed*., **2015**, *54*, 6186.

44-0797 NEW

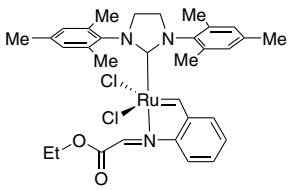
Dichloro(1,3-Bis(2,6-di-i-propylphenyl)-4-((4-ethyl-4-methylpiperzain-1-ium-1-yl)methyl)imidazolidin-2-ylidene)(2-isopropoxybenzylidene) ruthenium(II) hexafluorophosphate FixCat PF6
$C_{45}H_{67}Cl_2F_6N_4OPRu$; FW: 996.98; green pwdr.
air sensitive, (store cold)
Note: Sold in collaboration with Apeiron Synthesis, Inc. U.S. Patent 61/603,790 PCT/EP2013/053967. Store at 2-8°C under inert atmosphere. Catalyst may be weighed in air.



100mg
500mg

44-0760 NEW

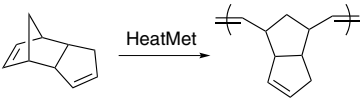
Dichloro(1,3-bis(2,4,6-trimethylphenyl)imidazolidin-2-ylidene){2-[(ethoxy-2-oxoethylidene) amino]benzylidene}ruthenium(II) HeatMet
$C_{32}H_{37}Cl_2N_3O_2Ru$; FW: 667.63; dark purple xtls.
(store cold)
Note: Sold in collaboration with Apeiron Synthesis, Inc. U.S. Patent 14/443,034; PCT/IN2013/002543.



100mg
500mg

Technical Note:

1. HeatMet catalyst is a highly efficient latent catalyst, requiring thermal activation to in initiate catalytic activity. Its characteristics are especially suitable to mold polymerization of reactive monomers such as dicyclopentadiene (DCPD). The product is soluble in toluene and dichloromethane.



Tech. Note (1)
Ref. (1)

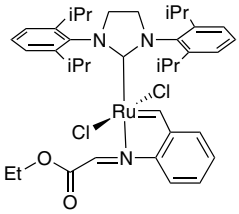
References:

1. *ChemSus Chem*., **2015**, *8*, 4139.

RUTHENIUM (Compounds)

44-0792 NEW

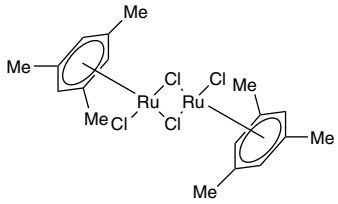
Dichloro(1,3-di-i-propylimidazolidin-2-ylidene){2-[(ethoxy-2-oxoethylidene)amino]benzylidene} ruthenium(II) HeatMet SIPr *(2097273-88-4)*
$C_{38}H_{49}Cl_2N_3O_2Ru$; FW: 751.79; dark violet pwdr.
air sensitive, (store cold)
Note: Sold in collaboration with Apeiron Synthesis, Inc. U.S. Patent 14/443,034.



100mg
500mg

44-0428 NEW

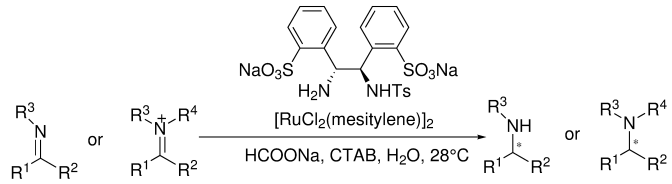
Dichloro(mesitylene)ruthenium(II) dimer, 98% *(52462-31-4)*
$C_{18}H_{24}Cl_4Ru_2$; FW: 584.33; red pwdr.
air sensitive, (store cold)



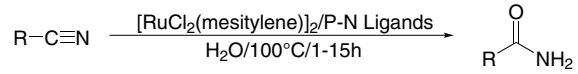
500mg
2g

Technical Notes:

1. Catalyst for asymmetric transfer hydrogenation of cyclic imines and iminiums in water.
2. Catalyst for selective hydration of nitriles to amides in pure aqueous medium under neutral conditions.
3. Catalyst for reduction of allylic alcohol using alcohols as solvent and hydrogen donor.
4. Catalyst for selective hydrosilylation of primary amides into secondary amines with $PhSiH_3$.

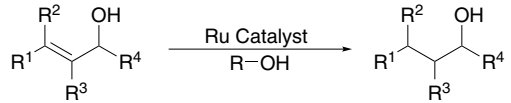


Tech. Note (1)
Ref. (1)

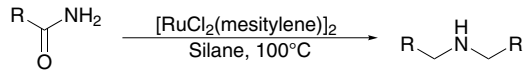


Tech. Note (2)
Ref. (2,5)

R = Alkyl, aryl, heteroaryl, alkenyl



Tech. Note (3)
Ref. (3,4)



Tech. Note (4)
Ref. (6)

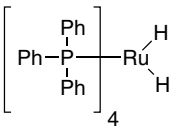
References:

1. *Chem. Commun.,* **2006**, 1766.
2. *Chem. Eur. J.* **2008**, *14*, 6601.
3. *Green Chem.*, **2009**, *11*, 1992.
4. *Catal. Commun*. **2011**, *13*, 91.
5. *Organometallics* **2011**, *30*, 5442.

RUTHENIUM (Compounds)

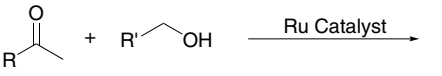
44-0460 NEW

Dihydrotetrakis(triphenylphosphine)ruthenium(II), 95% *(19529-00-1)*
$C_{72}H_{62}P_4Ru$; FW: 1152.23; yellow to green pwdr.; m.p. 181-183°
air sensitive

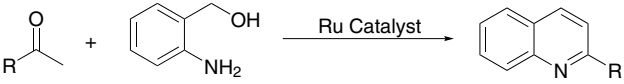


250mg
1g

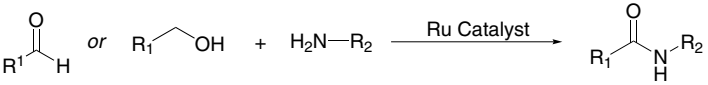
Technical Notes:
1. Catalyst for transfer hydrogenation of ketones with alcohols involving carbon-carbon bond formation.
2. Catalyst for oxidative cyclization of 2-aminobenzyl alcohol with ketones.
3. Amidation catalyst of alcohols or aldehydes with amines.
4. Stereoselective semireduction of internal alkynes to Z-olefins under transfer hydrogenation conditions.
5. Catalyst for synthesis of cyclic imides from nitriles and diols via hydrogen transfer mechanism.
6. Catalyst for direct hydrogenation of carboxylic acids using triphos-type ligands.



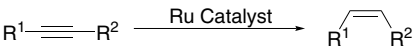
Tech. Note (1)
Ref. (1)



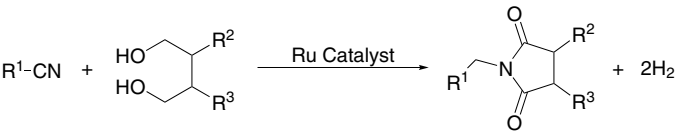
Tech. Note (2)
Ref. (2)



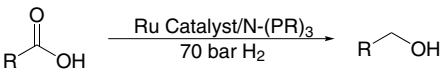
Tech. Note (3)
Ref. (3)



Tech. Note (4)
Ref. (4)



Tech. Note (5)
Ref. (5)

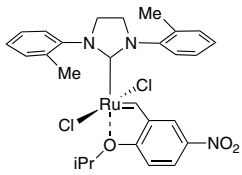


Tech. Note (6)
Ref. (6)

References:
1. *J. Org. Chem.*, **2001**, *66*, 9020.
2. *Chem. Commun.*, **2001**, 2576.
3. *J. Org. Chem.*, **2010**, *75*, 3002.
4. *Chem. Eur. J.*, **2010**, *16*, 12214.
5. *Org. Lett.*, **2014**, *16*, 4404.
6. *ChemSusChem.*, **2016**, *9*, 177.

44-0740 NEW

(1,3-Di-o-tolylimidazolidin-2-ylidene)(2-i-propoxy-5-nitrobenzylidene)dichlororuthenium(II) Nitro-Grela SI-o-Tolyl
$C_{27}H_{29}Cl_2N_3O_3Ru$; FW: 615.51; green pwdr.
(store cold)
Note: Sold in collaboration with Apeiron Synthesis, Inc. U.S. Patent 6/867,303 PCT/EP2003/01122. Store at 2-8°C under inert atmosphere. Catalyst may be weighed in air.

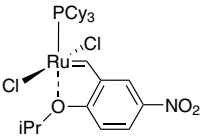


100mg
500mg

RUTHENIUM (Compounds)

44-0763 NEW

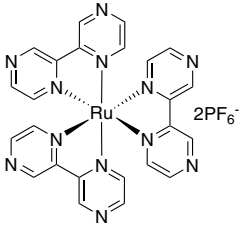
Tricyclohexylphosphine(2-i-propoxy-5-nitrobenzylidene)dichlororuthenium(II) Nitro-Grela 1 gen. *(625082-83-9)*
$C_{28}H_{44}Cl_2NO_3PRu$; FW: 645.60; brown pwdr.
air sensitive, (store cold)
Note: Sold in collaboration with Apeiron Synthesis, Inc. U.S. Patent 6/867,303 PCT/EP2003/01122. Store at 2-8°C under inert atmosphere. Catalyst may be weighed in air.



100mg
500mg

44-7910 NEW

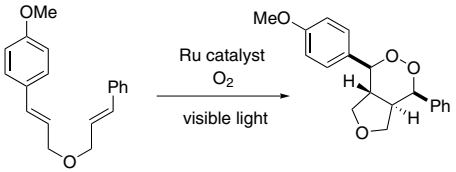
Tris(2,2'-bipyrazine)ruthenium(II) hexafluorophosphate, 95% *(80907-56-8)*
$C_{24}H_{18}F_{12}N_{12}P_2Ru$; FW: 865.48; red pwdr.
air sensitive
Note: Photocatalyst.



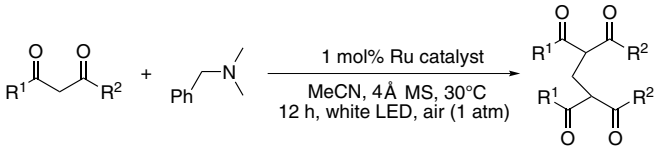
50mg
250mg

Technical Notes:

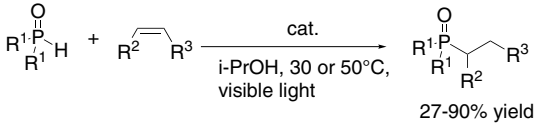
1. Endoperoxide synthesis by photocatalytic aerobic [2+2+2] cycloadditions.
2. Aerobic oxidation of a tertiary aliphatic amine under visible-light photocatalysis. Facile synthesis of methylene-bridged bis-1,3-dicarbonyl compounds.
3. Hydrophosphinylation of unactivated alkenes with secondary phosphine oxides under visible-light photocatalysis.
4. [3+2] Photooxygenation of aryl cyclopropanes via visible light photocatalysis.
5. Photocatalytic synthesis of dihydrobenzofurans by oxidative cycloaddition of phenols.



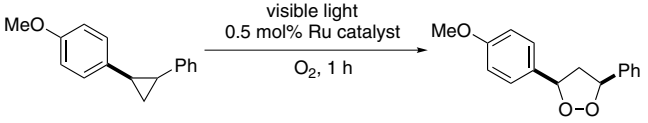
Tech. Note (1)
Ref. (1)



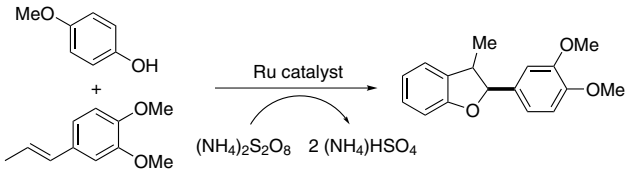
Tech. Note (2)
Ref. (2)



Tech. Note (3)
Ref. (3)



Tech. Note (4)
Ref. (4)



Tech. Note (5)
Ref. (5)

RUTHENIUM (Compounds)

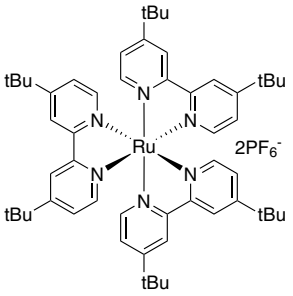
44-7910 (cont.) **Tris(2,2'-bipyrazine)ruthenium(II) hexafluorophosphate, 95%** *(80907-56-8)*

References:
1. *Org. Lett.*, **2012**, *14*, 1640.
2. *Chemistry – An Asian Journal*, **2012**, *7*, 2764.
3. *Green Chemistry*, **2013**, *15*, 1844.
4. *Advanced Synthesis & Catalysis*, **2014**, *356*, 2831.
5. *J. Am. Chem. Soc.*, **2015**, *137*, 5654.

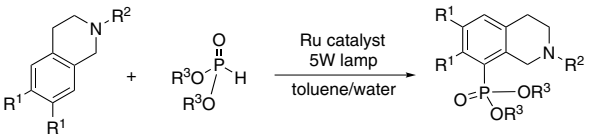
44-7940 NEW **Tris[4,4'-bis(t-butyl)-2,2'-bipyridine] ruthenium(II) hexafluorophosphate, 95%** *(75777-87-6)*

50mg
250mg

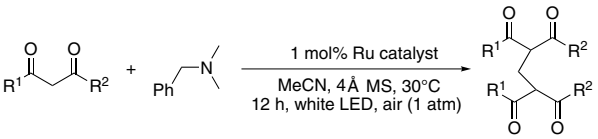
$C_{54}H_{72}F_{12}N_6RuP_2$; FW: 1196.19; red pwdr.
air sensitive
Note: Photocatalyst.



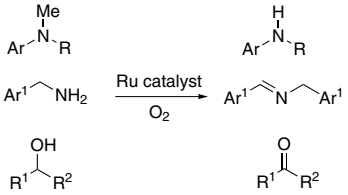
Technical Notes:
1. Photoredox catalysed C-P bond formation reactions – visible light mediated oxidative phosphonylations of amines.
2. Aerobic oxidation of a tertiary aliphatic amine under visible-light photocatalysis: facile synthesis of methylene-bridged bis-dicarbonyl compounds.
3. Photoredox catalysis as an efficient tool for the aerobic oxidation of amines and alcohols.
4. Visible-light induced, direct synthesis of polysubstituted furans from cyclopropyl ketones.



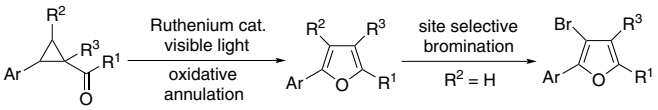
Tech. Note (1)
Ref. (1)



Tech. Note (2)
Ref. (2)



Tech. Note (3)
Ref. (3)



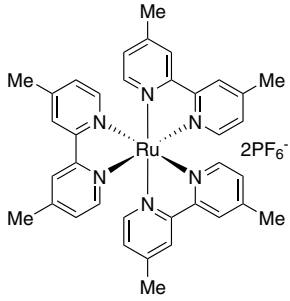
Tech. Note (4)
Ref. (4)

References:
1. *Chem. Commun.*, **2011**, *47*, 8679.
2. *Chemistry – An Asian Journal*, **2012,** *7*, 2764.
3. ACS Catalysis, **2012**, *2,* 2810.
4. *J. Org. Chem.*, **2016**, *81*, 7008.

RUTHENIUM (Compounds)

44-7930 NEW

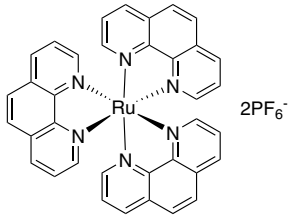
Tris(4,4'-dimethyl-2,2'-bipyridine) ruthenium(II) hexafluorophosphate, 95%, DMBPY *(83605-44-1)*
$C_{36}H_{36}F_{12}N_6RuP_2$; FW: 943.71; red pwdr.
air sensitive
Note: Photocatalyst.



50mg
250mg

44-7955 NEW

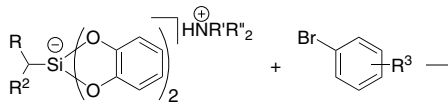
Tris(1,10-phenanthroline)ruthenium(II) hexafluorophosphate, 95% *(60804-75-3)*
$C_{36}H_{24}F_{12}N_6RuP_2$; FW: 931.62; red pwdr.
air sensitive
Note: Photocatalyst



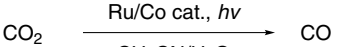
50mg
250mg

Technical Notes:

1. Photoredox catalyst for nickel assisted cross-coupling reactions of ammonium alkylsilicates with aryl bromides
2. A photosensitizer for cobalt catalyzed visible-light driven CO_2 - Reduction to CO in CH_3CN/H_2O Solution



Tech. Note (1)
Ref. (1)



Tech. Note (2)
Ref. (2)

References:

1. *J. Am. Chem. Soc.*, **2016**, *138*, 475.
2. *Angew. Chem. Int. Ed.*, **2017**, *56*, 738.

SAMARIUM (Elemental Forms)

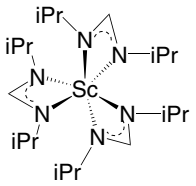
62-6235 NEW HAZ

Samarium powder (99.9% REO) 325 mesh *(7440-19-9)* — 5g, 25g
Sm; FW: 140.4; 325 mesh; m.p. 1072°; b.p. 1778°; d. 7.40
air sensitive, moisture sensitive

SCANDIUM (Compounds)

21-1200 NEW

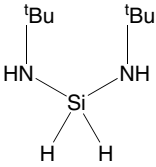
Tris(N,N'-di-i-propylformamidinato)scandium(III), (99.9%-Sc) — 1g, 5g
$C_{21}H_{45}ScN_6$; FW: 426.58; white to off-white pwdr.
air sensitive, moisture sensitive
Note: Product sold under, use subject to, terms and conditions of label license at www.strem.com/harvard2



SILICON (Compounds)

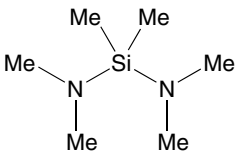
14-1072 NEW

Bis(t-butylamino)silane, BTBAS (99.999%-Si) PURATREM *(186598-40-3)* — 1g, 5g, 25g
$C_8H_{22}N_2Si$; FW: 174.36; colorless liq.; b.p. 167°C; f.p. 30°C; d. 0.816
moisture sensitive



14-1530 NEW

Bis(dimethylamino)dimethylsilane, 99+% BDMADMS *(3768-58-9)* — 5g, 25g
$[N(CH_3)_2]_2(CH_3)_2Si$; FW: 146.31; colorless liq.; b.p. 128-129°; f.p. -3°C; d. 0.81
moisture sensitive



Technical Notes:
1. Used in the chemical vapor deposition of silicon nitride films, and also the atomic layer deposition of SiNxCy dielectric sealing layers using plasma-enhanced atomic layer deposition (PE-ALD).[1,2,3,4]
2. Used as a reagent for silylation.[5,6]

References:

1. *AIP Conference Proceedings*, **2015**, *1649(1, Irago Conference 2014)*, 41-46.
2. *Materials Science in Semiconductor Processing,* **2015**, *29*, 139-142.
3. *Applied Surface Science*, **2010**, *257(4),* 1196-1203.
4. *Surface and Coatings Technology*, **2008**, *202(9),* 1606-1614.
5. *Microelectronic Engineering,* **1991**, *13(1-4)*, 47-50.
6. *Journal of Vacuum Science & Technology, B: Microelectronics and Nanometer Structures*, **1990**, *8(6)*, 1481-7.

14-6100 NEW

High Surface area Silica nanoparticles, large, particle size ~900-1000 nm, surface area ~700 m²/g, (KCC-1 L1) *(112945-52-5)* — 1g, 5g
SiO_2; FW: 60.09; white pwdr.; SA: ~700 m²/g; P.Vol. ~1.4 cm³/g
Note: Diameter: ~900-1000nm; This product is under license of patented Technology from King Abdullah University of Science and Technology – KAUST. Patent PCT/IB2010/002421.

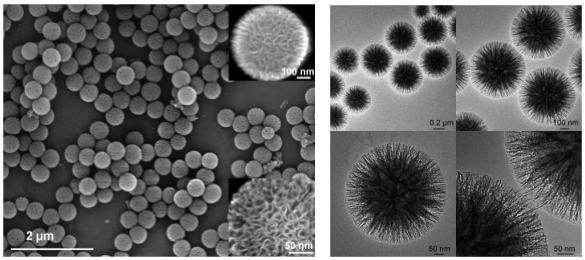
Technical Note:
1. Novel fibrous shaped silica nanospheres, denoted as KCC-1 (KAUST Catalysis Center)[1], have unique physical properties which have never before been reported in silica materials. These nanomaterials have been developed by Prof. J. M. Basset of King Abdullah University of Science and Technology (KAUST). A fibrous surface morphology arranged in three-dimensional structure forms the spheres (Fig. 1). Unlike traditional pore-based silica, these nanospheres possess a fibrous structure that increases accessibility to the available surface area; this in turn, significantly increases the catalytic activity.

   These materials exhibit excellent physical properties, including a high surface area, a fibrous surface morphology, good thermal and hydrothermal stabilities and high mechanical stability (Table 1). The fibrous morphology of KCC-1 remains unaffected even after mechanical compression up to 216 MPa pressure. This is superior to the conventional MCM-41 type of silica, which is affected at pressure 86 MPa.[1]

SILICON (Compounds)

14-6100 (cont.) **High Surface area Silica nanoparticles, large, particle size ~900-1000 nm, surface area ~700 m²/g, (KCC-1 L1)** *(112945-52-5)*

A range of heterogeneous catalysts, prepared using KCC-1 as a supporting material, have been showing excellent catalytic activity for various transformations of research and industrial importance. As a catalyst support, sorbent or carrier, KCC-1 is able to demonstrate superior activity as compared to regular mesoporous silica materials in energy related processes[2-3], a variety of organic reactions[4-7], biomedical applications and drug delivery systems[8], optoelectronic devices[9] and many others.



Product #	Category	Grade	Particle Size (nm)	Surface Area (m^2/g)	Pore Volume (cm^3/g)
14-6100	Large	(KCC-1 L1)	~900-1000	~700	~1.4
14-6110	Large	(KCC-1 L2)	~900-1000	~600	~1.2
14-6120	Large	(KCC-1 L3)	~900-1000	~550	~0.9
14-6200	Medium	(KCC-1 M1)	~400-450	~400	~0.7
14-6210	Medium	(KCC-1 M2)	~300-350	~600	~0.6
14-6300	Small	(KCC-1 S1)	~130-190	~380	~0.8

References:
1. *Angew. Chem. Int. Ed*. **2010**, *49*, 9652
2. *Chem. Mater*. **2015**, *27*, 8237
3. *ACS Catalysis*. **2016**, *6*, 2770
4. *ChemSusChem* **2012**, *5*, 85
5. *Green Chem*., **2016**, *18*, 5890
6. *Angew. Chem. Int. Ed*. **2011**, *50*, 2747
7. *RSC Adv*., **2017**, *7,* 24885
8. *Langmuir* **2014**, *30*, 10886
9. *J. Mater. Chem. B*, **2015**, *3*, 3201

14-6110 NEW **High Surface area Silica nanoparticles, large, particle size ~900-1000 nm, surface area ~600 m²/g, (KCC-1 L2)** *(112945-52-5)* 1g 5g
SiO_2; FW: 60.09; white pwdr.; SA: ~600 m^2/g; P.Vol. ~1.20 cm^3/g
Note: Diameter: ~900-1000nm; This product is under license of patented Technology from King Abdullah University of Science and Technology – KAUST. Patent PCT/IB2010/002421.
Technical Note:
1. See 14-6100 (page 92)

14-6120 NEW **High Surface area Silica nanoparticles, large, particle size ~900-1000 nm, surface area ~550 m²/g (KCC-1 L3)** *(112945-52-5)* 1g 5g
SiO_2; FW: 60.09; white pwdr.; SA: ~550 m^2/g; P.Vol. ~0.97 cm^3/g
Note: Diameter: ~900-1000nm; This product is under license of patented Technology from King Abdullah University of Science and Technology – KAUST. Patent PCT/IB2010/002421.
Technical Note:
1. See 14-6100 (page 92)

14-6200 NEW **High Surface area Silica nanoparticles, medium, particle size ~400-450 nm, surface area ~400 m²/g, (KCC-1 M1)** *(112945-52-5)* 1g 5g
SiO_2; FW: 60.09; white pwdr.; SA: ~400 m^2/g; P.Vol. ~0.7 cm^3/g
Note: Diameter: ~400-450nm; This product is under license of patented Technology from King Abdullah University of Science and Technology – KAUST. Patent PCT/IB2010/002421.
Technical Note:
1. See 14-6100 (page 92)

SILICON (Compounds)

14-6210 NEW
High Surface area Silica nanoparticles, medium, particle size ~300-350 nm, surface area ~600 m²/g, (KCC-1 M2) *(112945-52-5)* 1g 5g
SiO_2; FW: 60.09; white pwdr.; SA: ~600 m²/g; P.Vol. ~0.6 cm³/g
Note: Diameter: ~300-350nm; This product is under license of patented Technology from King Abdullah University of Science and Technology – KAUST. Patent PCT/IB2010/002421.
Technical Note:
1. See 14-6100 (page 92)

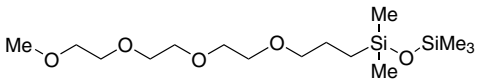
14-6300 NEW
High Surface area Silica nanoparticles, small, particle size ~130-190 nm, surface area ~380 m²/g, (KCC-1 S1) *(112945-52-5)* 1g 5g
SiO_2; FW: 60.09; white to beige pwdr.; SA: ~380 m²/g; P.Vol. ~0.8 cm³/g
Note: Diameter: ~130-190nm; This product is under license of patented Technology from King Abdullah University of Science and Technology – KAUST. Patent PCT/IB2010/002421.
Technical Note:
1. See 14-6100 (page 92)

14-6310 NEW
High Surface area Silica nanoparticles, small, particle size ~40-50 nm, surface area ~520 m²/g, (KCC-1 S2) *(112945-52-5)* 1g 5g
SiO_2; FW: 60.09; white to beige pwdr.; SA: ~520 m²/g; P.Vol. ~1.3 cm³/g
Note: Diameter: ~40-50nm; This product is under license of patented Technology from King Abdullah University of Science and Technology – KAUST. Patent PCT/IB2010/002421.

14-1445 NEW HAZ
Silicon(IV) bromide, (99.99% Si) PURATREM *(7789-66-4)* 5g 25g
$SiBr_4$; FW: 347.72; colorless liq.; m.p. 5.4º; b.p. 154º; d. 2.772
moisture sensitive

14-1943 NEW
2,2,4,4-Tetramethyl-3,8,11,14,17-pentaoxa-2,4-disilaoctadecane, 99+% Electrolyte solvent ANL-2SM3 *(855996-83-7)* 5g 25g
$C_{15}H_{36}O_5Si_2$; FW: 352.61; colorless liq.
Note: Use for batteries for medical devices expressly excluded. U.S. Patent: 8,076,031 B1; 14/266,052.

Organosilicon Electrolytes for Lithium Ion Batteries



1. Silicon based electrolytes with polyethylene glycol oligomers improve thermal and electrochemical stability of lithium-ion batteries.
2. Increases battery long-term stability.
3. Are less flammable than conventional organic carbonate-based solvents and maintain the safe operation of batteries.
4. Improves conductivity and kinetics of the lithium salts.

Electrochemical and Physical Properties:

1. Disiloxane liquid electrolyte ANL-2SM3 exhibits electrochemical stability, high thermal stability, and low viscosity.- **Viscosity** 3.8 cP at 25ºC; **The conductivity and viscosity** of ANL-2SM3-based electrolyte are $3.65x10^{-4}$ Scm^{-1} and 18 cP at 25ºC [1,2] Charged cathode material is more thermally stable in the siloxane-based electrolyte than in the carbonate-based electrolyte [1]. Boiling point 269-271ºC; Glass transition temperature -103.0ºC
2. Soluble electrolytic lithium salts: LiBOB, $LiPF_6$, ANL2SM3, and LiTFSIANL-2SM3 is compatible with nanostructured material-based electrodes [3].
3. Disiloxane/LiBOB or Disiloxane /$LiPF_6$ electrolytes show conductivities up to $6.2x10^{-4}$ Scm^{-1} at room temperature. Disiloxane electrolytes doped with 0.8MLiBOB are stable to 4.7 V. The LiBOB/disiloxane combinations were found to be good electrolytes for lithium-ion cells [4].

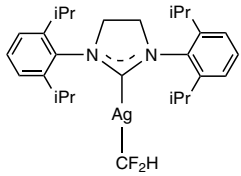
References:

1. *J. Power Sources,* **2006**, *160*, 645
2. *J. Power Sources,* **2006**, *160*, 1355
3. *Chem. Mater.,* **2007**, *19*, 5734
4. *J. Power Sources,* **2010**, *195*, 6062

SILVER (Compounds)

47-2575 NEW

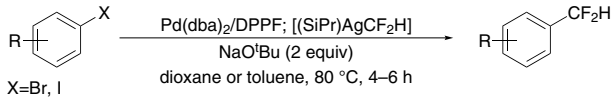
[1,3-Bis[2,6-bis(i-propyl)phenyl]-2-imid-azolidinylidene]difluoromethylsilver(I)
(1643366-13-5)
$C_{28}H_{39}AgF_2N_2$; FW: 549.50; off-white pwdr.
air sensitive, (store cold)



100mg
500mg

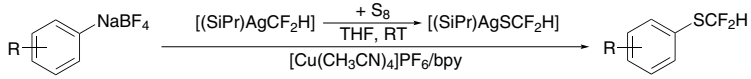
Technical Notes:

1. Catalyst for Pd(dba)2/DPPF assisted direct difluoromethylation of aryl bromides and iodides.
2. Pre-catalyst for copper assisted difluoromethylthiolation of aryl and heteroaryl diazonium salts.
3. Pre-catalyst for palladium assisted difluoromethylthiolation of pyridyl, quinolinyl, benzothiazolyl, thiophenyl, carbazolyl and pyazolyl heteroaryl bromides, iodides, triflates and aryl iodides.

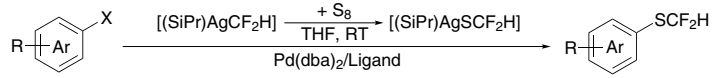


X=Br, I

Tech. Note (1)
Ref. (1)



Tech. Note (2)
Ref. (2)



X=Br, I, OTf
Ar = pyridyl, quinolinyl, benzothiazolyl, thiophenyl, carbazolyl, pyazolyl

Tech. Note (3)
Ref. (3)

References:

1. *Nat. Commun*. **2014**, *5*, 5405.
2. *Angew. Chem. Int. Ed*. **2015**, *54*, 7648.
3. *Chem. Sci.,* **2016**, *7*, 3757.

SODIUM (Compounds)

11-1146 NEW

Sodium hexafluorophosphate 99% (99.99%-Na) PURATREM
(21324-39-0)
F_6NaP; FW: 167.95; white pwdr.; d. 2.37
air sensitive, moisture sensitive, hygroscopic

$Na^+ PF_6^-$

2g
10g

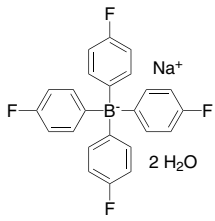
11-1147 NEW HAZ

Sodium hexafluorophosphate 99% (99.99%-Na) PURATREM (<10ppm H2O) *(21324-39-0)*
$NaPF_6$; FW: 167.95; white pwdr.
air sensitive, moisture sensitive, hygroscopic
Note: Suitable for battery applications

1g
5g

11-1015 NEW

Sodium tetrakis(4-fluorophenyl)borate dihydrate, 97%
(207683-22-5)
$C_{24}H_{20}BF_4NaO_2$; FW: 414.18(450.21); white xtl.

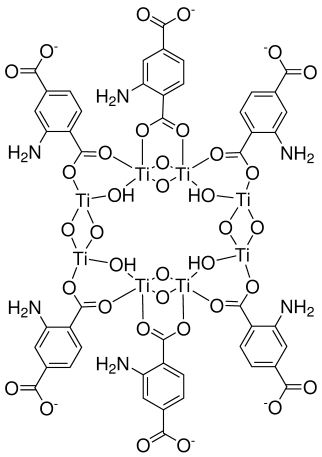


250mg
1g
5g

TITANIUM (Compounds)

22-1070 NEW

Hexakis[μ-(2-amino-1,4-benzenedicarboxylato)][tetra-μ-hydroxyocta-μ-oxooctatitanium], NH2-MIL-125(Ti), CONEKTIC™ T125 *(1309760-94-8)*
$C_{48}H_{34}N_6O_{36}Ti_8$; FW: 1653.74; yellow pwdr.; SA: ~1530; P.Vol. ~0.74
Note: Sold in collaboration with framergy for research purposes only.
Patents: US8940392; EP2398812; JP5850750; KR101732623; CA2750746.



250mg
1g

22-2240 NEW HAZ

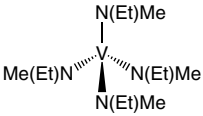
Tetrakis(dimethylamino)titanium(IV), 99% TDMAT (99.99%-Ti)
PURATREM *(3275-24-9)*
$Ti[N(CH_3)_2]_4$; FW: 224.20; yellow to orange liq.; f.p. -22°F
air sensitive, moisture sensitive

1g
5g
25g

VANADIUM (Compounds)

23-0365 NEW

Tetrakis(ethylmethylamino)vanadium(IV), 98% TEMAV *(791114-66-4)*
$C_{12}H_{32}N_4V$; FW: 283.35; dark green liq.
air sensitive, moisture sensitive



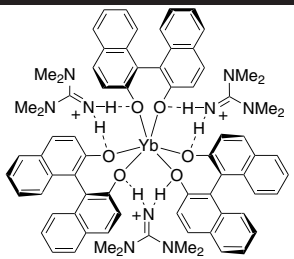
250mg
1g
5g

YTTERBIUM (Compounds)

70-0130 NEW

Tris[N,N,N,N-tetramethylguanidinium] [tris(1S)-(1,1'-binaphalene)-2,2'-diolato] ytterbate Yb-HTMG-B *(1611526-75-0)*
$C_{75}H_{78}N_9O_6Yb$; FW: 1374.52;
off-white to pale yellow pwdr.
Note: U.S. Patent 14/898,925.

Technical Note:
1. See 57-1250 (page 43)



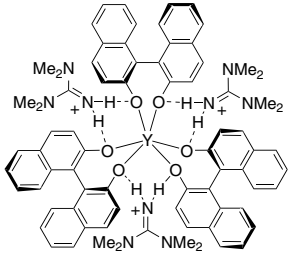
250mg
1g

YTTRIUM (Compounds)

39-5850 NEW

Tris[N,N,N,N-tetramethylguanidinium] [tris(1S)-(1,1'-binaphalene)-2,2'-diolato] yttrate Y-HTMG-B *(1611526-73-8)*
$C_{75}H_{78}N_9O_6Y$; FW: 1290.39; orange pwdr.
Note: U.S. Patent 14/898,925.

250mg
1g



Technical Note:
1. See 57-1250 (page 43)

ZIRCONIUM (Compounds)

98-4042 NEW HAZ

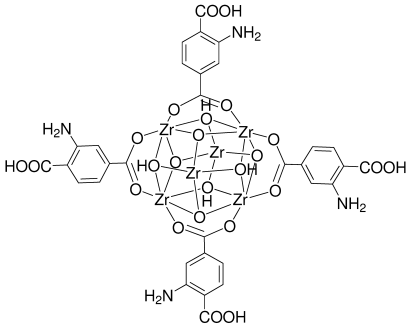
Tetrakis(dimethylamino)zirconium(IV), 99% (99.99%-Zr) TDMAZ, 40-4115, contained in 50ml Swagelok® cylinder (96-1070) for CVD/ALD *(19756-04-8)*
$Zr[N(CH_3)_2]_4$; FW: 267.53; light yellow xtl.
moisture sensitive, (store cold)
Note: Product sold under, use subject to, terms and conditions of label license at www.strem.com/harvard1

25g

40-1109 NEW

Zirconium aminobenzenedicarboxylate MOF (UiO-66-BDC-NH2, BDC-NH2:Zr=0.9-1.0) *(1260119-00-3)*
$Zr_6O_4(OH)_4(C_8H_5NO_4)_x$, X = 5.4-6.0;
yellow solid; SA: 800-1075 m^2/g;
P.Vol. 0.31-0.41 cm^3/g
Note: Particle size: 0.1-0.5 micron,
Thermal stability: 300ºC,
Activation temperature: 150ºC
Sold under license from Inven2 AS for research purposes only.
PCT/GB2009/001087.

500mg
2g



Technical Notes:
1. Useful MOF for adsorption of CO_2 applications[1].
2. Catalyst MOF used in the conversion of toxic agents to non-toxic products[2].

References:

1. *Carbon Dioxide Adsorption in Amine-Functionalized Mixed-Ligand Metal-Organic Frameworks of UiO-66 Topology.,* Chem.Sus.Chem. **2014**.
2. *Tailoring the Pore Size and Functionality of UiO-Type Metal−Organic Frameworks for Optimal Nerve Agent Destruction,* Inorg. Chem. **2015**.
3. *Towards Metal-Organic Framework based Field Effect Chemical Sensors: UiO-66-NH2 for Nerve Agent Detection,* Chem. Sci., **2016**, *7*, 5827.

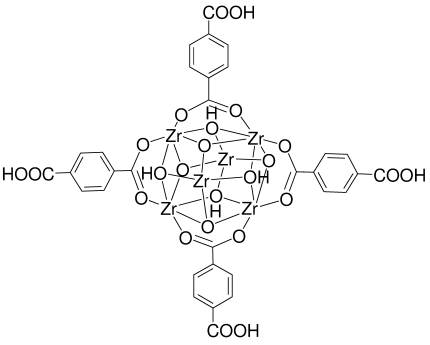
ZIRCONIUM (Compounds)

40-1108 NEW

Zirconium benzenedicarboylate MOF (UiO-66-BDC, BDC: Zr=0.66-0.98)

$Zr_6O_4(OH)_4(C_8H_4O_4)_x$ X = 3.96-5.88;
white solid; SA: 1050-1400 m^2/g;
P.Vol. 0.42-0.58 cm^3/g
Note: Particle size: 0.2-0.5 micron,
Thermal stability: 400ºC,
Activation temperature: 300ºC
Sold under license from Inven2 AS for research purposes only.
PCT/GB2009/001087.

500mg
2g



Technical Note:

1. New zirconium-based inorganic building brick that allows the synthesis of very high surface area MOF's with unprecedented stability[3].

References:

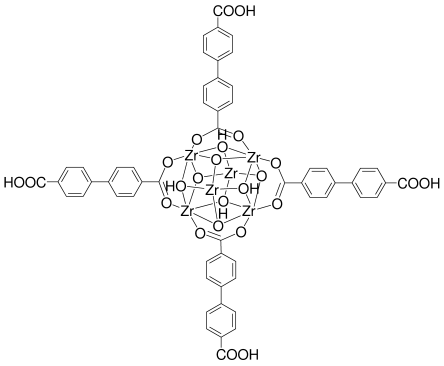
1. *Tuned to Perfection: Ironing Out the Defects in Metal−Organic Framework UiO-66* Chem. Mater. **2014**, *26*, 4068−4071.
2. *H_2 storage in isostructural UiO-67 and UiO-66 MOFs* Phys. Chem. Chem. Phys., **2012**, *14*, 1614–1626.
3. *A New Zirconium Inorganic Building Brick Forming Metal Organic Frameworks with Exceptional Stability*. J. Am. Chem. Soc. **2008**, *130*, 13850–13851.

40-1112 NEW

Zirconium biphenyldicarboxylate MOF (UiO-66-BPDC/UiO-67, BPDC:Zr=0.9-1.0)

$Zr_6O_4(OH)_4(C_{14}H_8O_4)_x$, X = 5.4-6.0;
white solid; SA: 2400-2500 m^2/g;
P.Vol. 0.85-0.98 cm^3/g
moisture sensitive
Note: Particle size: 0.4-0.7µ,
Thermal stability: 450ºC
Sold under license from Inven2 AS for research purposes only.
PCT/GB2009/001087.

250mg
1g



Technical Notes:

1. Metal−organic framework showing excellent stability to water, reversible water vapor adsorption, and increased volumetric capacity for methane adsorption[1]
2. Remarkable stability at high temperatures, high pressures and in the presence of different solvents, acids and bases[2,3]

References:

1. *UiO-67-type Metal−Organic Frameworks with Enhanced Water Stability and Methane Adsorption Capacity*, Inorg. Chem. **2016**, *55*, 1986−1991.
2. *H_2 storage in isostructural UiO-67 and UiO-66 MOFs*, Phys. Chem. Chem. Phys., **2012**, *14*, 1614–1626.
3. *A New Zirconium Inorganic Building Brick Forming Metal Organic Frameworks with Exceptional Stability.* J. Am. Chem. Soc. **2008**, *130*, 13850–13851, Jasmina Hafizovic Cavka, Søren Jakobsen, Unni Olsbye, Nathalie Guillou, Carlo Lamberti, Silvia Bordiga, and Karl Petter Lillerud.

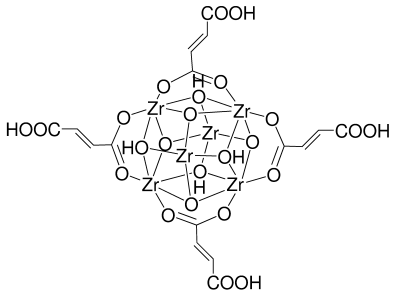
ZIRCONIUM (Compounds)

40-1114 NEW

Zirconium Fumarate MOF (UiO-66-FA, FA:Zr=0.66-0.98)

$Zr_6O_4(OH)_4(C_4H_2O_4)_x$, X = 3.96-5.88; white solid; SA: 650-960 m^2/g; P.Vol. 0.26-0.4 cm^3/g
Note: Particle size: 0.1-0.5 micron, Thermal stability: 200ºC, Activation temperature: 130ºC
Sold under license from Inven2 AS for research purposes only.
PCT/GB2009/001087.

500mg
2g



Technical Notes:

1. Metalorganic framework used in a large number of studies for the storage of hydrogen or methane[2]
2. Water adsorption in MOF's for many applications such as dehumidification, thermal batteries, and delivery of drinking water in remote areas[3]

References:

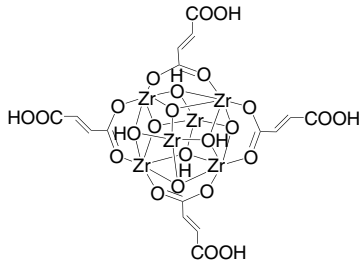
1. *Water harvesting from air with metal-organic frameworks powered by natural sunlight*. Science, **2017**, *356*, 430–434.
2. *A Facile "Green" Route for Scalable Batch Production and Continuous Synthesis of Zirconium MOFs.* Eur. J. Inorg. Chem. **2016**, 4490–4498.
3. *Water Adsorption in Porous Metal−Organic Frameworks and Related Materials*, J. Am. Chem. Soc., **2014**, *136*, 4369−4381.
4. *A water-born Zr-based porous coordination polymer: Modulated synthesis of Zr-fumarate MOF*. Microporous and mesoporous materials , **2015**, *203*,186-194.

40-1106 NEW

Zirconium trans-1, 2-ethylenedicarboxylic acid MOF (UiO-66-FA, FA:Zr=1)

$Zr_6O_4(OH)_4(C_4H_2O_4)_6$; cream solid; SA: 720-770 m^2/g; P.Vol. 0.29-0.32 cm^3/g
Note: Particle size: 0.1-0.5 micron, Thermal stability: 200ºC, Activation temperature: 150ºC
Sold under license from Inven2 AS for research purposes only.
PCT/GB2009/001087.

500mg
2g



Technical Notes:

1. Metalorganic framework used in a large number of studies for the storage of hydrogen or methane[2]
2. Water adsorption in MOF's for many applications such as dehumidification, thermal batteries, and delivery of drinking water in remote areas[3]

References:

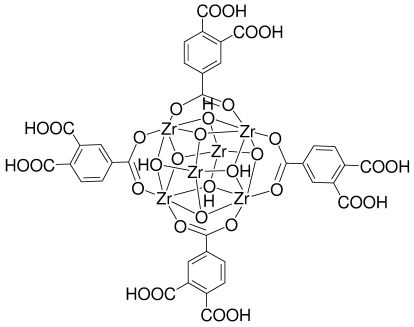
1. *Water harvesting from air with metal-organic frameworks powered by natural sunlight.* Science, **2017**, *356*, 430–434.
2. *A Facile "Green" Route for Scalable Batch Production and Continuous Synthesis of Zirconium MOFs.* Eur. J. Inorg. Chem. **2016**, 4490–4498.
3. *Water Adsorption in Porous Metal−Organic Frameworks and Related Materials*, J. Am. Chem. Soc., **2014**, *136*, 4369−4381.
4. *A water-born Zr-based porous coordination polymer: Modulated synthesis of Zr-fumarate MOF*. Microporous and mesoporous materials , **2015**, *203*,186-194.

ZIRCONIUM (Compounds)

40-1111 NEW

Zirconium trimellitate MOF (UiO-66-BDC-COOH, BDC-COOH:Zr=0.9-1.0)
$Zr_6O_4(OH)_4(C_9H_4O_6)_x$,
X = 5.4-6.0; white solid;
SA: 550-600 m^2/g;
P.Vol. 0.25-0.27 cm^3/g
Note: Particle size: 0.2-0.5 micron,
Thermal stability: 350ºC,
Activation temperature: 150ºC
Sold under license from Inven2 AS for research purposes only.
PCT/GB2009/001087.

500mg
2g



Technical Notes:

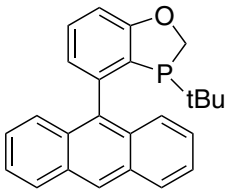
1. MOF for which the introduction of copper markedly increases ammonia adsorption capacities[1]
2. Functionalized forms show the highest selectivity, good working capacity and medium ranged CO_2 adsorption enthalpy that make these materials very promising for physi-sorption-based processes[2]

References:

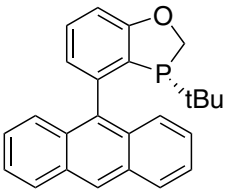
1. *Engineering Copper Carboxylate Functionalities on Water Stable Metal−Organic Frameworks for Enhancement of Ammonia Removal Capacities*. J. Phys. Chem. C, **2017**, *121*, 3310−3319.
2. *Functionalizing porous zirconium terephthalate UiO-66(Zr) for natural gas upgrading: a computational exploration.,* Chem. Commun., **2011**, *47*, 9603–9605.

KITS - AntPhos and WingPhos Kit

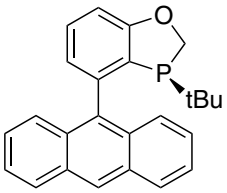
96-3810 **AntPhos and WingPhos Kit**
Sold in collaboration with Zejun for research purposes only.
Patents ZL201310020371.1, CN 201610056390.
Components also available for individual sale.
Contains the following:



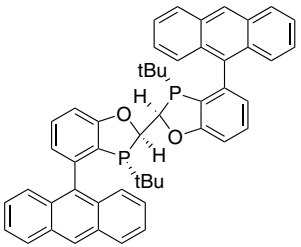
15-1960 25mg



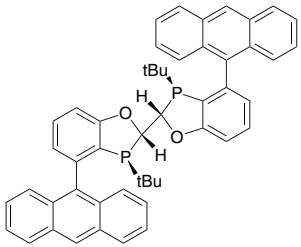
15-1963 25mg



15-1967 25mg



15-1970 25mg



15-1975 25mg

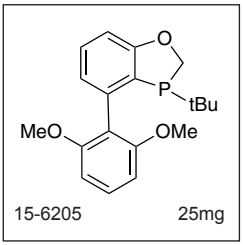
15-1960	4-(Anthracen-9-yl)-3-(t-butyl-2,3-dihydrobenzo[d][1,3] oxaphosphole, 98+% rac-AntPhos *(1268693-24-8)*	25mg	See page 66
15-1963	(R)-4-(Anthracen-9-yl)-3-(t-butyl-2,3-dihydrobenzo[d][1,3] oxaphosphole,98+% (>99% ee) [(R)-AntPhos] *(1456816-37-7)*	25mg	See page 66
15-1967	(S)-4-(Anthracen-9-yl)-3-(t-butyl-2,3-dihydrobenzo[d][1,3] oxaphosphole,99+% (>99% ee) [(S)-AntPhos] *(1807740-34-6)*	25mg	See page 67
15-1970	(2R,2'R,3R,3'R)-4,4'-Di(anthracen-9-yl)-3,3'-di-t-butyl-2,2',3,3'-tetrahydro-2,2'-bibenzo[d][1,3]oxaphosphole, min 98% (>90% ee), [(2R,2'R,3R,3'R)-WingPhos] *(1884680-45-8)*	25mg	See page 73
15-1975	(2S,2'S,3S,3'S)-4,4'-Di(anthracen-9-yl)-3,3'-di-t-butyl-2,2',3,3'-tetrahydro-2,2'-bibenzo[d][1,3]oxaphosphole, min 98%, (>99% ee), [(2S,2'S,3S,3'S)-WingPhos] *(1435940-19-4)*	25mg	See page 73

KITS - BI-DIME Ligand Kit

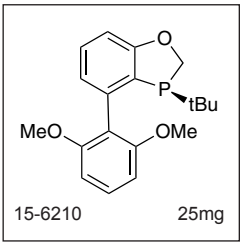
96-0650 **BI-DIME Ligand Kit**

NEW

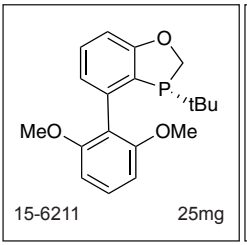
Sold in collaboration with Zejun for research purposes only.
Patents: ZL2013105048267, CN104558038.
Components also available for individual sale.
Contains the following:



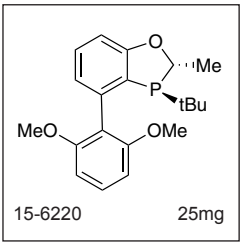
15-6205 25mg



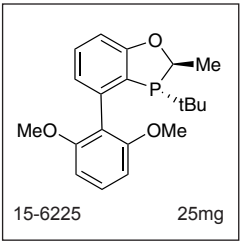
15-6210 25mg



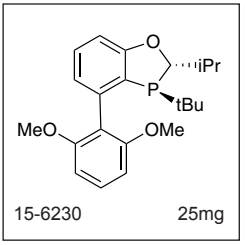
15-6211 25mg



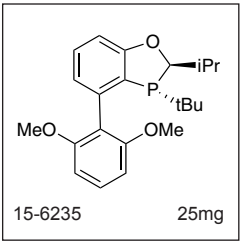
15-6220 25mg



15-6225 25mg



15-6230 25mg



15-6235 25mg

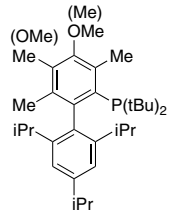
15-6205	3-(t-Butyl)-4-(2,6-dimethoxyphenyl)-2,3-dihydrobenzo[d][1,3]oxaphosphole, min. 97% rac-BI-DIME *(1246888-90-3)*	25mg	See page 70
15-6210	(S)-3-(t-Butyl)-4-(2,6-dimethoxyphenyl)-2,3-dihydrobenzo[d][1,3]oxaphosphole, min. 97% (S)-BI-DIME *(1373432-09-7)*	25mg	See page 72
15-6211	(R)-3-(t-Butyl)-4-(2,6-dimethoxyphenyl)-2,3-dihydrobenzo[d][1,3]oxaphosphole, min. 97% (R)-BI-DIME *(1373432-03-7)*	25mg	See page 71
15-6220	(2S,3S)-3-(t-Butyl)-4-(2,6-dimethoxyphenyl)-2-methyl-2,3-dihydrobenzo[d][1,3]oxaphosphole, min. 97% (S,S)-Me-BI-DIME *(1373432-11-1)*	25mg	See page 72
15-6225	(2R,3R)-3-(t-Butyl)-4-(2,6-dimethoxyphenyl)-2-methyl-2,3-dihydrobenzo[d][1,3]oxaphosphole, min. 97% (R,R)-Me-BI-DIME *(1477517-18-2)*	25mg	See page 72
15-6230	(2S,3S)-3-(t-Butyl)-4-(2,6-dimethoxyphenyl)-2-i-propyl-2,3-dihydrobenzo[d][1,3]oxaphosphole, min. 97% (S,S)-iPr-BI-DIME *(1477517-21-7)*	25mg	See page 72
15-6235	(2R,3R)-3-(t-Butyl)-4-(2,6-dimethoxyphenyl)-2-i-propyl-2,3-dihydrobenzo[d][1,3]oxaphosphole, min. 97% (R,R)-iPr-BI-DIME *(1477517-19-3)*	25mg	See page 72

KITS - Buchwald Biaryl Phosphine Ligand Mini Kit 3

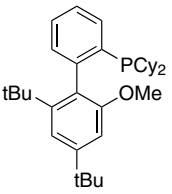
96-5495 **Buchwald Biaryl Phosphine Ligand Mini Kit 3 for Aromatic Carbon-Heteroatom Bond Formation, Suzuki Coupling and Negishi Cross-coupling**

NEW

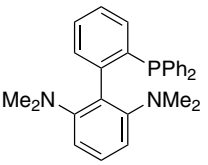
For aromatic carbon-heteroatom bond formation and Suzuki Coupling.
Patents: US 6,395,916, US 6,307,087.
Components also available for individual sale.
Contains the following:



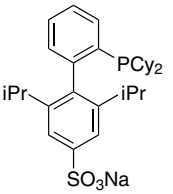
15-1063 250mg



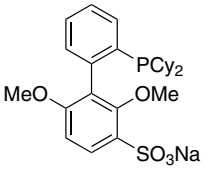
15-1105 250mg



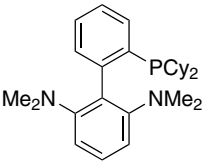
15-1125 100mg



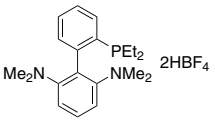
15-1135 100mg



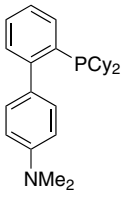
15-1142 500mg



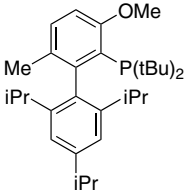
15-1147 250mg



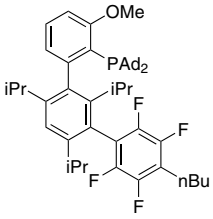
15-1151 100mg



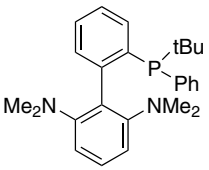
15-1154 250mg



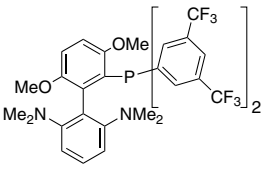
15-1168 100mg



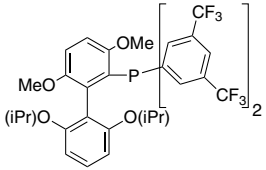
15-2065 100mg



15-3010 250mg



15-3015 100mg



15-3020 250mg

KITS - Buchwald Biaryl Phosphine Ligand Mini Kit 3

96-5495 *(cont.)* **Buchwald Biaryl Phosphine Ligand Mini Kit 3 for Aromatic Carbon-Heteroatom Bond Formation, Suzuki Coupling and Negishi Cross-coupling**
For aromatic carbon-heteroatom bond formation and Suzuki Coupling.

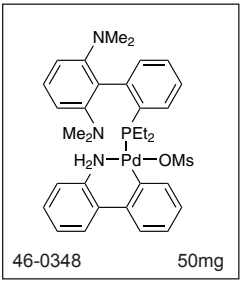
15-1063	2-Di-t-butylphosphino-4-methoxy-3,5,6-trimethyl-2',4',6'-tri-i-propyl)-1,1'-biphenyl, min. 98% [~1:1 mixture with regioisomer, 2-Di-t-butylphosphino-5-methoxy-3,4,6-trimethyl-2',4',6'-tri-i-propylbiphenyl] *(1359986-21-2)*	250mg	Visit strem.com
15-1105	2-Dicyclohexylphosphino-2'-methoxy-4',6'-di-t-butyl-1,1'-biphenyl, min. 98% VPhos *(1848244-75-6)*	250mg	Visit strem.com
15-1125	2-Diphenylphosphino-2',6'-bis(dimethylamino)-1,1'-biphenyl, min. 98% PhCPhos *(1447963-71-4)*	100mg	Visit strem.com
15-1135	2'-Dicyclohexylphosphino-2,6-di-i-propyl-4-sulfonato-1,1'-biphenyl hydrate sodium salt (XPhos-SO_3Na) *(870245-84-4)*	100mg	Visit strem.com
15-1142	2'-Dicyclohexylphosphino-2,6-dimethoxy-3-sulfonato-1,1'-biphenyl hydrate sodium salt (water soluble SPhos), min. 98% *(1049726-96-6)*	500mg	Visit strem.com
15-1147	2-Dicyclohexylphosphino-2',6'-bis(dimethylamino)-1,1'-biphenyl, min. 98% CPhos *(1160556-64-8)*	250mg	Visit strem.com
15-1151	2-Diethylphosphino-2',6'-bis(dimethylamino)-1,1'-biphenyl di(hydrogen tetrafluoroborate) salt, min. 98% EtCPhos	100mg	Visit strem.com
15-1154	2-Dicyclohexylphosphino-4'-(N,N-dimethylamino)-1,1'-biphenyl, 98% *(1185899-00-6)*	250mg	Visit strem.com
15-1168	2-(Di-t-butylphosphino)-3-methoxy-6-methyl-2',4',6'-tri-i-propyl-1,1'-biphenyl, min. 98% RockPhos *(1262046-34-3)*	100mg	Visit strem.com
15-2065	2-(Diadamantylphosphino)-3-methoxy-2',4',6'-tri-i-propyl-3'-(2,3,5,6-tetrafluoro-4-butylphenyl)-1,1'-biphenyl, AlPhos *(1805783-60-1)*	100mg	Visit strem.com
15-3010	2-(t-Butylphenylphosphino)-2',6'-dimethylamino-1,1'-biphenyl, 98% (t-Bu)PhCPhos *(1660153-91-2)*	250mg	Visit strem.com
15-3015	2-[Bis(3,5-trifluoromethylphenylphosphino)-3,6-dimethoxy]-2',6'-dimethylamino-1,1'-biphenyl, 98% *(1810068-30-4)*	100mg	Visit strem.com
15-3020	2-[Bis(3,5-trifluoromethylphenylphosphino)-3,6-dimethoxy]-2',6'-di-i-propoxy-1,1'-biphenyl, 98% *(1810068-31-5)*	250mg	Visit strem.com

KITS - Buchwald Palladacycle Precatalyst Kit 2b

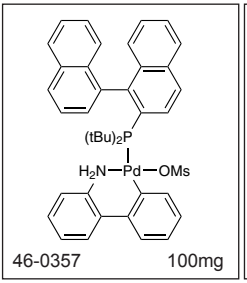
96-5506 **Buchwald Palladacycle Precatalyst Kit 2b**
(Methanesulfonato-2'-amino-1,1'-biphenyl-2-yl- Palladacycles Gen. 3)

NEW

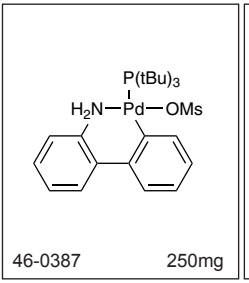
Patents: US 6,395,916, US 6,307,087.
Components also available for individual sale.
Contains the following:



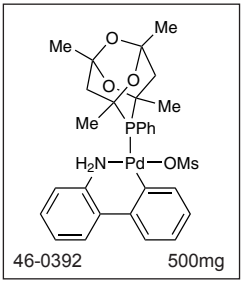
46-0348 50mg



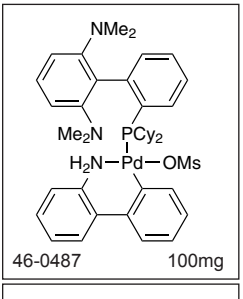
46-0357 100mg



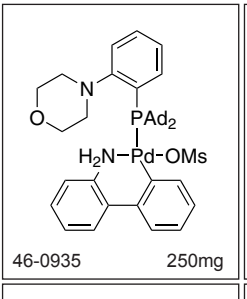
46-0387 250mg



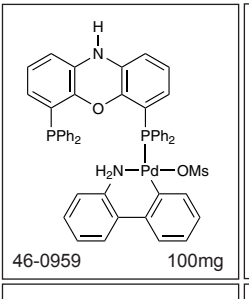
46-0392 500mg



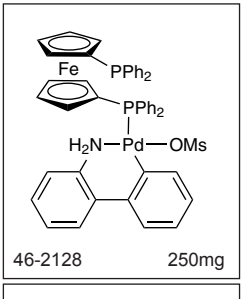
46-0487 100mg



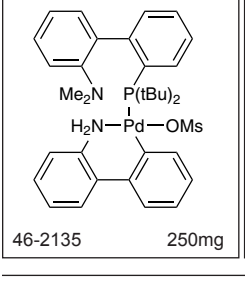
46-0935 250mg



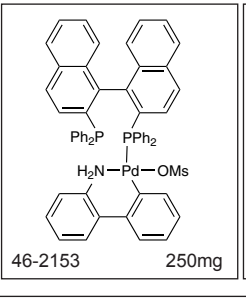
46-0959 100mg



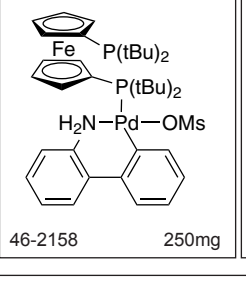
46-2128 250mg



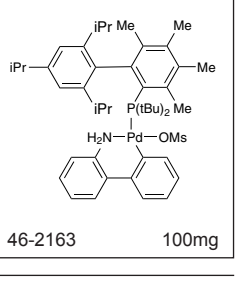
46-2135 250mg



46-2153 250mg



46-2158 250mg



46-2163 100mg

KITS - Buchwald Palladacycle Precatalyst Kit 2b

96-5506 *(cont.)*	**Buchwald Palladacycle Precatalyst Kit 2b (Methanesulfonato-2'-amino-1,1'-biphenyl-2-yl- Palladacycles Gen. 3)**		
46-0348	Methanesulfonato[2-diethylphosphino-2',6'-bis(dimethylamino)-1,1-biphenyl](2'-amino-1,1'-biphenyl-2-yl)palladium(II), min. 98% [EtCPhos Palladacycle Gen. 3]	50mg	Visit strem.com
46-0357	Methanesulfonato(2-di-t-butylphosphino-1,1'-binaphthyl)(2'-amino-1,1'-biphenyl-2-yl)palladium(II), min. 95% [TrixiePhos Palladacycle Gen. 3]	100mg	Visit strem.com
46-0387	Methanesulfonato(tri-t-butylphosphino)(2'-amino-1,1'-biphenyl-2-yl)palladium(II), 98% [P(t-Bu)3 Palladacycle Gen. 3] *(1445086-17-8)*	250mg	Visit strem.com
46-0392	Methanesulfonato(1,3,5,7-tetramethyl-8-phenyl-2,4,6-trioxa-8-phosphaadamantane)(2'-amino-1,1'-biphenyl-2-yl)palladium(II) dichloromethane adduct, min. 98% [MeCgPPh Palladacycle Gen. 3]	500mg	Visit strem.com
46-0487	Methanesulfonato(2-dicyclohexylphosphino-2',6'-bis(dimethylamino)-1,1'-biphenyl)(2'-amino-1,1'-biphenyl-2-yl)palladium(II), 98% [CPhos Palladacycle Gen. 3] *(1447963-73-6)*	100mg	Visit strem.com
46-0935	Methanesulfonato{N-[2-(di-1-adamantylphosphino)phenyl]morpholine}(2'-amino-1,1'-biphenyl-2-yl)palladium(II) dichloromethane adduct, min. 98% [Mor-Dalphos Palladacycle Gen. 3]	250mg	See page 64
46-0959	Methanesulfonato[4,6-bis(diphenylphosphino)phenoxazine](2'-amino-1,1'-biphenyl-2-yl)palladium(II), 98% [NiXantphos Palladacycle Gen. 3] *(1602922-03-1)*	100mg	Visit strem.com
46-2128	Methanesulfonato[1,1'-bis(diphenylphosphino)ferrocene)](2'-amino-1,1'-biphenyl-2-yl)palladium(II), min. 98% [DPPF Palladacycle Gen. 3] *(1445086-28-1)*	250mg	Visit strem.com
46-2135	Methanesulfonato[2-(di-t-butylphosphino)-2'-(N,N-dimethylamino)-1,1'-biphenyl](2'-amino-1,1'-biphenyl-2-yl)palladium(II) dichloromethane adduct, min. 98% [t-BuDavePhos Palladacycle Gen. 3] *(1445085-92-6)*	250mg	Visit strem.com
46-2153	Methanesulfonato[2,2'-bis(diphenylphosphino)-1,1'-binaphthyl](2'-amino-1,1'-biphenyl-2-yl)palladium(II), min. 98% [BINAP Palladacycle Gen. 3]	250mg	Visit strem.com
46-2158	Methanesulfonato(1,1'-bis(di-t-butylphosphino)ferrocene)(2'-amino-1,1'-biphenyl-2-yl)palladium(II), min. 98% [DTBPF Palladacycle Gen. 3]	250mg	Visit strem.com
46-2163	Methanesulfonato(2-di-t-butylphosphino-3,4,5,6-tetramethyl-2',4',6'-tri-i-propylbiphenyl)(2'-amino-1,1'-biphenyl-2-yl)palladium(II), min. 95% [Me4 t-ButylXPhos Palladacycle Gen. 3] *(1507403-85-1)*	100mg	Visit strem.com

KITS - CalB immo KIT™ - Immobilized enzyme

96-4050 NEW

CalB immo KIT™ - Immobilized enzyme
Store in dry conditions (2-8°C). Do not freeze. Shelf Life: 1 year;
Sold in collaboration with Purolite for research purposes only.
Components also available for individual sale.
Contains the following:

07-3130	CalB immo Plus™ - Immobilized enzyme	10g	See page 27
07-3142	CalB immo 8285™ - Immobilized enzyme	10g	See page 27
07-3148	CalB immo 8806™ - Immobilized enzyme	10g	See page 27
07-3152	CalB immo 5587™ - Immobilized enzyme	10g	See page 26
07-3155	CalB immo 1090™ - Immobilized enzyme	10g	See page 26
07-3159	CalB immo 5872™ - Immobilized enzyme	10g	See page 26

Item #	Immobilized on	Immobilization	Enzyme activity (PLU/g dry)
07-3130	DVB/methacrylate	Adsorption	>9,000
07-3142	Epoxy/butyl methacrylate	Covelent	>10,000
07-3148	Octadecyl methacrylate	Adsorption	>10,000
07-3152	Styrene/DVB copolymer	Adsorption	>4,000
07-3155	Macroporous styrene/DVB	Adsorption	>8,000
07-3159	Styrene/DVB	Adsorption	>3,500

Appearance: White to slightly yellow spherical beads, free from foreign matter
Pricipal Applications: Screening of immobilized lipases for process development, Esterifications (regio- and stereo-selective), Transesterfication, Amidation, Fats and oils modification
Advantages: Fast screening in process development, Wide selection of enzyme carriers for different applications

KITS - Enzyme Carrier Lifetech™ ECRKIT1

96-0255 NEW

Enzyme carrier Lifetech™ ECRKIT1
Store in dry conditions (2-20°C). Do not freeze. Shelf Life: 5 years; This enzyme carrier kit allows rapid screening of different methods of enzyme immobilization. Sold in collaboration with Purolite for research purposes only.
Components also available for individual sale.
Contains the following:

06-0810	Enzyme carrier Lifetech™ ECR8204F	50g	See page 29
06-0828	Enzyme carrier Lifetech™ ECR8285	50g	See page 33
06-0913	Enzyme carrier Lifetech™ ECR1090M	50g	See page 29
06-0925	Enzyme carrier Lifetech™ ECR1030M	50g	See page 27
07-1512	Enzyme carrier Lifetech™ ECR8309F	50g	See page 30
07-1532	Enzyme carrier Lifetech™ ECR8806F	50g	See page 32

KITS - Graphene Quantum Dots (GQDs) Master Kit

96-7410 NEW

Graphene Quantum Dots (GQDs) Master Kit
Sold in collaboration with Dotz Nano Ltd. for research purposes only. Suggested use within 6 months of purchase. Do not freeze. Store in DARK.
Components also available for individual sale.
Contains the following:

06-0330	Graphene Quantum Dots (GQDs), Aqua-Green Luminescent *(1034343-98-0)*	100mg	See page 48
06-0332	Graphene Quantum Dots (GQDs) in water, Aqua-Green Luminescent *(1034343-98-0)*	100ml	See page 48
06-0334	Graphene Quantum Dots (GQDs), Blue Luminescent *(1034343-98-0)*	100mg	See page 49
06-0336	Graphene Quantum Dots (GQDs) in water, Blue Luminescent *(1034343-98-0)*	100ml	See page 49
06-0340	Graphene Quantum Dots (GQDs) in water, Cyan Luminescent *(1034343-98-0)*	100ml	See page 49

Item #	Photoluminescence			
	QY⁺ *	λ max *	Max emission	FWHM *
06-0330 / 06-0332	>17%	485 nm	525 nm	70 nm
06-0334 / 06-0336	>65%	350 nm	445 nm	65 nm
06-0340	>25%	420 nm	490 nm	80 nm

Particle diameter: <5 nm
Topographic height: 1.0 - 2.0 nm
Concentration: 1mg/ml (for liquid items)

Abbreviations: QY⁺ = *Quantum Yield*; λ max = *Maximum excitation wavelength*; FWHM = *Full width at half maximum*

KITS - Graphene Quantum Dots (GQDs) Mini Kit (Powders)

96-7425 NEW

Graphene Quantum Dots (GQDs) Mini Kit (Powders)
Sold in collaboration with Dotz Nano Ltd. for research purposes only. Suggested use within 6 months of purchase. Do not freeze. Store in DARK.
Components also available for individual sale.
Contains the following:

06-0330	Graphene Quantum Dots (GQDs), Aqua-Green Luminescent *(1034343-98-0)*	100mg	See page 48
06-0334	Graphene Quantum Dots (GQDs), Blue Luminescent *(1034343-98-0)*	100mg	See page 49

Item #	Color & Form	Photoluminescence			
		QY⁺ *	λ max *	Max emission	FWHM *
06-0330	dark red-brown pwdr.	>17%	485 nm	525 nm	70 nm
06-0334	dark brown pwdr.	>65%	350 nm	445 nm	65 nm

Particle diameter: <5 nm
Topographic height: 1.0 - 2.0 nm

Abbreviations: QY⁺ = *Quantum Yield*; λ max = *Maximum excitation wavelength*; FWHM = *Full width at half maximum*

KITS - Graphene Quantum Dots in water (GQDs) Mini Kit (Liquids)

96-7420 NEW

Graphene Quantum Dots in water (GQDs) Mini Kit (Liquids)
Sold in collaboration with Dotz Nano Ltd. for research purposes only. Suggested use within 6 months of purchase. Do not freeze. Store in DARK.
Components also available for individual sale.
Contains the following:

06-0332	Graphene Quantum Dots (GQDs) in water, Aqua-Green Luminescent *(1034343-98-0)*	100ml	See page 48
06-0336	Graphene Quantum Dots (GQDs) in water, Blue Luminescent *(1034343-98-0)*	100ml	See page 49
06-0340	Graphene Quantum Dots (GQDs) in water, Cyan Luminescent *(1034343-98-0)*	100ml	See page 49

Item #	Color & Form	Photoluminescence			
		QY+ *	λ max *	Max emission	FWHM *
06-0332	cloudy orange liq.	>17%	485 nm	525 nm	70 nm
06-0336	cloudy colorless liq.	>65%	350 nm	445 nm	65 nm
06-0340	cloudy brown liq.	>25%	420 nm	490 nm	80 nm

Particle diameter: <5 nm
Topographic height: 1.0 - 2.0 nm
Concentration: 1mg/ml

Abbreviations: QY+ = *Quantum Yield*; λ max = *Maximum excitation wavelength*; FWHM = *Full width at half maximum*

KITS - Lipase immo Kit - Immobilized enzymes

96-4065 NEW

Lipase immo Kit - Immobilized enzymes
The KIT contains 10g of each of the following:
- CalB immo Plus™(Lipase from Candida antarctica B)*07-3130*
- CalA immo (Lipase from Candida antarctica A)
- TL immo (Lipase from Thermomyces lanuginosa)
- RM immo (Lipase from Rhizomucor miehei)
- CR immo (Lipase from Candida rugosa)
- PS immo (Lipase from Pseudomonas cepacia)

A selection of immobilized lipases on different Lifetech™ ECR enzyme carrier resins for screening purposes.
Store in dry conditions (2-8°C). Do not freeze.
Sold in collaboration with Purolite for research purposes only.

Components also available for individual sale.
Contains the following:

Pricipal Applications: Esterifications (regio - and stereo-selective), Transesterfication, Kinetic resolution of racemic alcohols, amines, esters and triacylclycerides, Fats and oils modification, Hydrolysis of esters

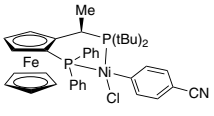
Advantages: Fast screening in process development, Wide selection of immobilized lipases, Optimal for all applictions in organic solvents.

KITS - Solvias Josiphos Nickel Catalyst Kit

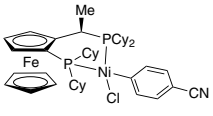
96-3660 **Solvias Josiphos Nickel Catalyst Kit**

NEW

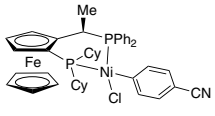
Sold in collaboration with Solvias for research purposes only.
Components also available for individual sale.
Contains the following:



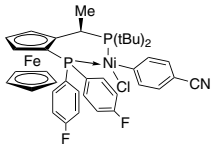
28-0170 100mg



28-0172 100mg



28-0175 100mg



28-0178 100mg

28-0170	Chloro(4-cyanophenyl){(R)-1-[(S)-2-(diphenylphosphino) ferrocenyl]ethyl(di-t-butyl)phosphine} nickel(II) *(2049086-34-0)*	100mg	See page 51
28-0172	Chloro(4-cyanophenyl){(R)-1-[(S)-2-(dicyclohexylphosphino) ferrocenyl]ethyl (dicyclohexylphosphine)}nickel(II) *(2049086-35-1)*	100mg	See page 50
28-0175	Chloro(4-cyanophenyl){(R)-1-[(S)-2-(dicyclohexylphosphino) ferrocenyl]ethyl (diphenylphosphine)}nickel(II) *(2049086-36-2)*	100mg	See page 51
28-0178	Chloro(4-cyanophenyl){(R)-1-[(S)-2-(bis(4-fluorophenyl) phosphinoferrocenyl]ethyl(di-t-butylphosphine)}nickel(II) *(2049086-37-3)*	100mg	See page 50

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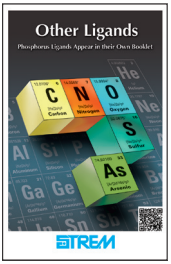

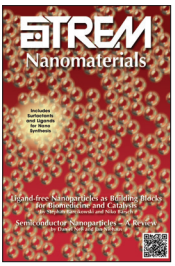

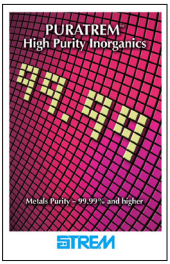

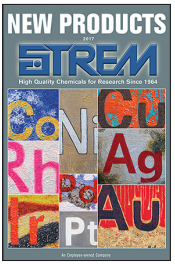

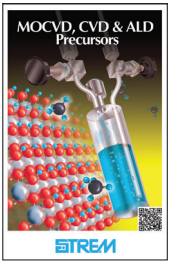

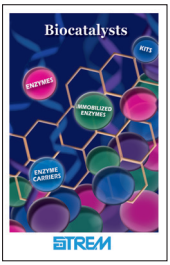

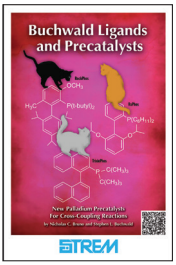

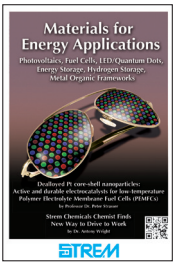

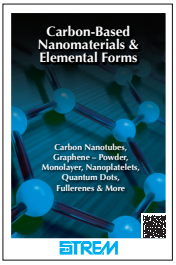

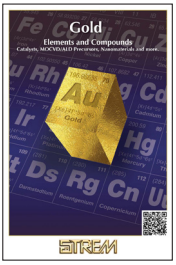

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