

Optical Metrology 2021

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Plan to Participate



Take this opportunity to share your research at SPIE Optical Metrology 2021. Come to Munich to meet with users and researchers to discuss the latest inventions and applications in the field of optical metrology. The symposium will highlight new optical principles and systems for metrology, multimodal sensing, and machine vision with applications in industrial design, production engineering, process monitoring, maintenance support, biotechnology, vehicle navigation, multimedia technology, architecture, archaeology, and arts. Special emphasis is directed to model-based, remote and active approaches, sensor fusion, robot guidance, image sequence processing and scene modelling, and biomaterials characterization, as well as to the preservation of our shared cultural heritage.

We invite engineers, scientists, researchers, trustees, and managers to attend this year's meeting.

Co-located with Laser 2021 in Munich, Germany, this symposium will address the role of optics and lasers in the following areas:

- Optical Measurement Systems for Industrial Inspection
- Modeling Aspects in Optical Metrology
- Optical Methods for Inspection, Characterization and Imaging of Biomaterials
- Multimodal Sensing: Technologies and Applications
- Automated Visual Inspection and Machine Vision
- Optics for Arts, Architecture, and Archaeology

Take advantage of this unique opportunity to hear about the latest solutions to practical problems in industrial design and production engineering. Learn about recent advances in using optical technologies to preserve our shared cultural heritage. Find out about new approaches that push optical principles of measurement and testing at the macro, micro- and nanoscales to the forefront of metrology. Exchange new ideas, address your shared concerns, and get access to information not yet published in the mentioned topical areas. Share your research with other engineers, scientists, researchers, and managers. Presentations will be permanently archived in the SPIE Digital Library, and made available to others in the international scientific community who seek to learn, make discoveries, and innovate.

We invite you to join your colleagues and share the most recent developments and applications at SPIE Optical Metrology 2021.

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PLEASE NOTE: Authors are encouraged to include figures and diagrams in a supplemental file to illustrate the concepts outlined in the abstract.

If submitting an abstract with figures and graphs in the supplemental file format, please be aware that this submission is optional and needs to be made IN ADDITION to the plain-text only abstract and following the online instructions at the time of submission.

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Optical Measurement Systems for Industrial Inspection XII (OM101)

Conference Chair: **Peter Lehmann**, Univ. Kassel (Germany)

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The conference addresses optical measuring methods and their application to solve measurement problems in production engineering, process and product monitoring, and industrial design. Respective applications range from the optical inspection of large-scale industrial components to the investigation of microsystems and nanostructures using ultraviolet, visible, or infrared wavelengths. Both, measurement systems fulfilling the requirements of high-volume industrial manufacturing as well as new approaches related to measurement capabilities such as resolution enhancement and uncertainty reduction are in the focus of the conference. Special emphasis shall be put on the implementation of new methods, algorithms and sensor components into higher-level measurement systems. In particular, the design and implementation of optical systems close-to-production as a prerequisite of ongoing digitization is of interest.

Scientific contributions related to one of the following topics are greatly appreciated.

GENERAL ITEMS

- optical metrology
- reliable and robust measurement systems
- process integrated and in-process measurement and inspection
- resolution enhancement
- metrology for efficient use of resources
- measurement uncertainty
- features of performance assessment.

METHODOLOGY AND TECHNIQUES

- interferometry
- holographic and speckle techniques
- Moire and structured illumination techniques
- deflectometry and image correlation techniques
- 3D microscopy
- hyperspectral techniques
- confocal and focus scanning techniques
- coherence scanning, time-of-flight techniques
- light scattering and diffraction-based analysis

continued

Optical Measurement Systems for Industrial Inspection XII (OM101 continued)

- reconstruction/retrieval algorithms and approaches
 - advanced image and signal processing
 - fiber and micro-optical sensors
 - smart sensors and measurement systems using artificial intelligence
 - multisensor approaches and sensor fusion
 - multiscale inspection and measurement techniques.
- APPLICATIONS**
- micro-, nanostructure, and roughness measurement
 - measurement of precision components
 - measurement of optical components and systems
 - measurement and inspection in additive manufacturing
 - shape measurement/reverse engineering
 - nondestructive testing and fault detection
 - thickness measurement
 - inspection of functional surfaces
 - stress and vibration analysis
 - inspection of components for renewable energy systems
 - inspection of large-scale objects
 - inspection of 2d-material (meta-surfaces)
 - inspection of scattering surfaces and volumes
 - high-speed measurement/high-volume production
 - measurement systems related to industry 4.0
 - remote technologies
 - determination of material properties and parameters.

Save the date

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19 May 2021 (Conference OM103 only)

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Modeling Aspects in Optical Metrology VIII (OM102)

Conference Chair: **Bernd Bodermann**, Physikalisch-Technische Bundesanstalt (Germany)

Conference Co-Chairs: **Karsten Frenner**, Institut für Technische Optik (Germany); **Bryan M. Barnes**, National Institute of Standards and Technology (USA)

Programme Committee: **Markus Bär**, Physikalisch-Technische Bundesanstalt (Germany); **Jörg Bischoff**, Osires Optical Engineering (Germany); **Sven Burger**, Konrad-Zuse-Zentrum für Informationstechnik (Germany); **Peter Evanschitzky**, Fraunhofer-Institut für Integrierte Systeme und Bauelementetechnologie IISB (Germany); **Liwei Fu**, Univ. Stuttgart (Germany); **Wolfgang Holzapfel**, DR. JOHANNES HEIDENHAIN GmbH (Germany); **Norbert Kerwien**, Carl Zeiss AG (Germany); **Rainer Köning**, Physikalisch-Technische Bundesanstalt (Germany); **Stefanie Kroker**, Physikalisch-Technische Bundesanstalt (Germany); **Johannes Ruoff**, Carl Zeiss SMT GmbH (Germany); **Thomas Siefke**, Physikalisch-Technische Bundesanstalt (Germany); **Frank Wyrowski**, Friedrich-Schiller-Univ. Jena (Germany)

This conference will focus on essentially any optical metrology, where modelling aspects play a crucial role and accurate modelling is a prerequisite for traceable and comparable measurements. One important topic is the development and verification of methods to describe the interaction of light with matter for quantitative characterization of micro- and nanostructures. The verification of these methods often relies on comparison measurements with independent metrology methods. Improved data analysis is often achieved applying sophisticated hybrid metrology and holistic approaches. Relevant applications include e.g. optical metrology and inspection of nanostructures for semiconductor and nanotechnologies, display production to the investigation of grating structures and grating-based devices. In most of the applications nanometer or sub-nanometer measurement uncertainties are required. Thus, complex and increasingly challenging metrology applications emphasize even more the importance of error modelling for optical systems. Special emphasis shall be placed on the description and modelling of new methods, algorithms, components or complete measurement systems up to the treatment of big data.

The topics will include, but are not limited to:

- optical metrology
- image modelling
- lensless imaging, coherent diffraction imaging
- modelling of sensor response, parametric modelling
- modelling of optical metrology systems
- novel microscopy methods
- super-resolution
- reference metrology
- measurement uncertainty and error modelling in optical systems
- multiprobe characterization

- hybrid metrology
- scatterometry, OCD
- inverse problems in optics
- Maxwell equation solving algorithms
- algorithms for real 3D simulations
- modelling of material properties in optics
- modelling of polarization effects, ellipsometry and Mueller ellipsometry
- optimization for diffractive optical elements
- 3D shape metrology
- placement, registration, alignment and overlay metrology
- modelling for nanomanufacturing and nanolithography
- metrology for multi patterning/exposure and EUV lithography
- modelling of stochastic parameters, objects and interactions
- phase metrology, phase retrieval techniques
- flatness metrology, deflectometry
- high-precision interferometry
- high-precision displacement metrology
- grating characterization and modelling
- optical scattering, SERS and related
- time dependent phenomena, modelling of ultrafast processes
- new materials, metamaterials
- plasmonics for metrological applications
- photonic crystals, photonic devices
- modelling of optomechanical systems (NOMS, MOMS, MOEMS...)
- modelling of line-edge roughness
- modelling of photometry and radiometry.

The Conference will organize a joint session together with the CLEO/Europe-EQEC Conference dedicated to modern approaches in computational photonics for metrology.

Optics for Arts, Architecture, and Archaeology (O3A) VIII (OM103)

Conference Chairs: **Haida Liang**, Nottingham Trent Univ. (United Kingdom); **Roger M. Groves**, Technische Univ. Delft (Netherlands)

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The Optics for Arts, Architecture and Archaeology Conference, 8th under the O3A series and 10th since its conception, is being held again in Munich as part of the SPIE Optical Metrology Symposium at the World of Photonics Congress in June 2021. We are proud to celebrate 20 years of this optics community in 2021.

O3A is an established event for discussing advanced methods and new instruments for the historical study, conservation and documentation of cultural heritage. The symposium is a unique forum focused on optics research in the field of heritage science. Optics applications in cultural heritage has a long and dynamic history owing to the non-destructive nature of optical imaging starting with microscopy, infrared photography and X-radiography. Optical imaging provided the most popular methods of examination for cultural heritage before micro-chemical analysis became possible. In recent years, the development of new imaging and spectroscopic techniques have revitalized the application of optics in cultural heritage. The non-invasive nature of these techniques has meant that whole objects and collections can now be examined with multiple techniques which will inevitably result in an unprecedented amount of data collected that will in turn push new boundaries in data and image processing methods. The demand of the developing European Research Infrastructure for Heritage Science (www.e-rihs.eu) for news instruments, data processing methods and facilities will no doubt advance the field even further.

The 2021 symposium will cover instruments and techniques that span the entire electromagnetic spectrum covering a broad range of scales along with the associated data and image processing and visualization methods. New instruments and techniques, multi-modal imaging and multi-technique integrated analysis and data fusion techniques that meets the challenges of big data analytics are expected to be the focus.

Contributions are welcome and will be considered in all fields of research for cultural and natural heritage including the following areas of interest:

- 3D topographic scanning, surface examination and analysis (e.g. RTI, structured light and other imaging and triangulation based methods, optical profilometry etc.)
- 3D tomographic imaging, stratigraphic and depth resolved methods (e.g. optical coherence tomography, non-linear microscopy, terahertz imaging, micro-CT etc.)
- structural analysis (e.g. holography and other interferometric techniques)
- imaging and spectroscopy for material analyses (e.g. the various spectral imaging modalities such as reflectance imaging from UV to infrared, fluorescence imaging and fluorescence lifetime imaging, laser induced breakdown spectroscopy, laser induced fluorescence and Raman spectroscopy, X-ray imaging, synchrotron based techniques etc.)
- remote imaging, sensing and spectroscopy at large stand-off distances including drone based methods

Multimodal Sensing and Artificial Intelligence: Technologies and Applications II (OM104)

Conference Chair: **Ettore Stella**, CNR (Italy)

Conference Co-Chairs: **Shahriar Negahdaripour**, Univ. of Miami (USA); **Dariusz Ceglarek**, The Univ. of Warwick (United Kingdom); **Christian Möller**, Fraunhofer-Institut für Fertigungstechnik und Angewandte Materialforschung (Germany)

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- new portable instruments for in situ applications
- multimodal imaging and multitechnique analysis
- multiscale and multiwavelength imaging for structural and material analysis
- light-matter interactions (e.g. fundamentals of laser interactions with materials, light induced material degradation, including those used for the illumination and excitation in the various techniques)
- advanced image processing methods including artificial intelligence and machine learning method to tackle big data problems
- new data visualization methods
- new methods and applications to cultural heritage research.

The symposium will be an ideal forum to introduce new applications, to exchange ideas and to discuss methods and best practices for optics applied to heritage science. The World of Photonics Congress offers a perfect opportunity for instrumentalists to engage with industry finding out the latest developments in sensor technology and optical components at the accompanying exhibition. Senior researchers, early career researchers, and students are encouraged to participate.

Save the date

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The conference goal is to provide a unique forum for discussing how Artificial Intelligence could provide benefits to multi-modal image analysis and processing. Multi-modal imaging refers to systems able to acquire multiple 2D or 3D information about real scenes, with different sensing modality (ex: 3D point clouds, visible and infrared images, thermal images, hyperspectral sensing, and so on) and is used on a broad range of sensing-based applications. Artificial Intelligence, on the other hand, found recently a new renaissance, thanks to Machine Learning and Deep Learning paradigms successfully applied for addressing very challenging image interpretation tasks. In this context, researchers, developers and practitioners are encouraged to present the latest advance, highlighting how multi-modal sensing technologies and applications can benefit from using Artificial Intelligence based methodologies. The conference, with a specific emphasis on exploiting Artificial Intelligence methodologies, is focused on both: a) the metric performance of

continued

Multimodal Sensing and Artificial Intelligence: Technologies and Applications II (OM104 continued)

sensors and algorithms for producing the most accurate and reliable geometric measurements and models; and b) applications in different fields.

The conference targets topics related to multimodal imaging systems (calibration, performance, accuracy, etc.) and their application in various tasks such as object recognition, motion estimation, 3D reconstruction, autonomous mobile robot navigation, quality control, assembly in manufacturing, security, environment monitoring, medical imaging, holography, biomedical imaging.

Themes such as industrial inspection, material and component testing, virtual museums, motion analysis, mobile robot navigation, marketing and tourism, human body modeling, maritime sciences, medicine, aerospace, automotive, agrifood, security and the exploration of remote and hazardous sites, just to name a few, provide the contexts in which multi-modal sensing and AI methodologies can be synergically applied.

We invite submission of original research contributions, as well as demonstrations of successful applications in, but not limited to, the following technical areas

MULTIMODAL SENSING: TECHNOLOGY

- 3D passive sensors
- 3D active sensors
- hyperspectral imaging
- light-field 3D sensing
- full-field methods for inspection (holography, shearography, DIC)
- thermography
- interferometry.

MULTIMODAL SENSING: PROCESSING

- calibration and measurements
- pose estimation
- image and range based modelling
- 3D passive reconstruction
- 3D active reconstruction
- motion analysis

- multiview analysis
- real-time processing technology
- expert system for detection and diagnosis of defects
- embedded vision systems.

MULTIMODAL SENSING: APPLICATIONS

- object recognition
- scene interpretation
- autonomous robot navigation
- robotics
- surveillance
- environmental monitoring
- surface quality control
- industrial inspection
- face analysis
- nondestructive testing methods
- noninvasive inspection techniques
- automation for material testing
- development compact systems for in-situ inspection
- monitoring of civil infrastructures (bridges, highways, buildings, Railways)
- sensors for homeland-security
- innovative systems for imaging and display systems
- intelligent farm
- intelligent factory
- intelligent building
- intelligent systems in health and medicine
- bio-informatics.

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Optical Methods for Inspection, Characterization, and Imaging of Biomaterials V (OM105)

Conference Chairs: **Pietro Ferraro**, Institute of Applied Sciences and Intelligent Systems (ISASI-CNR) (Italy); **Simonetta Grilli**, Institute of Applied Sciences and Intelligent Systems (ISASI-CNR) (Italy); **Monika Ritsch-Marte**, Medizinische Univ. Innsbruck (Austria); **Christoph K. Hitzemberger**, Medizinische Univ. Wien (Austria)

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Biocompatible materials (or “Biomaterials”) are substances that are intended to mimic and interact with biological systems. For the safe and reliable function of implants, composition and materials are as important as form. Surfaces may require appropriate coatings or functionalization. Therefore the last two decades have seen strong advancements in biomaterials and related science, with capital investments and research efforts into the development of new products in several fields of applications. Biomaterials science embraces several disciplines such as materials science, tissue engineering, chemistry, biology, and medicine.

When a new material is designed and created or optimized and adopted, application specific characterization is of paramount importance. The need of imaging and metrological tools is very important in defining and measuring properties of the materials from different points of view: morphological properties and their spatio-temporal changes, mechanical properties (stress and strain analysis), surface characterization, reaction to stimulus, degradation, assembling, and many more.

INNOVATIVE ASPECTS

Optical techniques have some advantageous features: they are largely non-invasive, non-contact, possibly have a large field of view and high spatial resolution and very high sensitivity for measuring

and evaluating most of physical and material parameters. This gives them a prominent role among diagnostic tools. The requirements depend on the situation, varying substantially from single cell and tissue engineering to complex biological systems or components. In analogy to what occurred in „Photomechanics“ which furnished many decisive answers in the past 40 years, in a variety of engineering problems (in materials engineering, testing and characterization of components and structures for aerospace, automobile industry, optics and micromechanics industries), optical metrology can provide answers for emerging problems and key issues in biomaterials research.

INTENTION

The intention of this conference is to bring together researchers working in the emerging fields of biomaterials, either at microscopic or at macroscopic scale. The conference will provide a rare platform for detailed exchange between groups working on the development of “biomaterials” and experts in “optical metrology”, in order to promote and stimulate stronger interaction between these topics. We invite experts from very different areas, who are usually not attending the same conferences, and we expect new collaborations to come into being from these encounters. The emphasis of the conference lies on the development of new and smart diagnostic metrological

continued

Optical Methods for Inspection, Characterization, and Imaging of Biomaterials V (OM105 continued)

tools of biomaterials, to furnish quantitative data to optimize engineering design, fabrication and characterization of biomaterials.

Expected topics among contributions include:

- characterization of implantable devices and materials
- visualization and evaluation of self-assembly processes at the nanoscale/microscale of biological/polymeric matter
- biodegradable and/or biocompatible polymers and their characterization
- mechanical strength, viscoelastic, optical and other properties of bone, cartilage, and other soft tissues
- measurements polymer scaffold characterization for tissue engineering
- single cell mechanics, cell motility, cell adhesion and morphological evolution and correlation to biomechanisms and cell fate
- collagen and other tissue investigation
- optics of the eye and vision correction (i.e. characterization of intraocular lenses)
- materials for dental applications
- diagnostic systems on innovative phase-contrast imaging and optical tomography
- innovative approaches for biomarker sensing
- optical micro-manipulation for materials characterization
- study of liquid-solid interfaces by optical/imaging methods
- bioinspired biomimetic and nanobiomaterials
- investigation and characterization of biological nano-diffractive materials/surfaces
- characterization of soft-like biomaterials
- optical method for study fluids at micro and nanoscale.

Contributions are expected but not limited to the following approaches and multimodal methods:

- quantitative phase contrast imaging
- digital differential image contrast imaging
- interference microscopy
- holographic interferometry
- deep learning in microscopy
- SLM-based microscopy
- lensless imaging
- photoacoustic imaging
- ultrasound imaging
- spectroscopy, microscopy, and endoscope optics
- optical absorption, reflection, transmission and scattering techniques
- 3D modeling and profiling
- speckle interferometry and imaging
- optical methods for biomechanics of materials and evaluation of its functionalities
- fluorescence microscopy techniques
- optical coherence tomography and microscopy
- wavefront sensing
- fringe projection accurate shape measurement
- topography and 3D shape measurements
- optical elastography methods.

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Automated Visual Inspection and Machine Vision IV (OM106)

Conference Chairs: **Jürgen Beyerer**, Fraunhofer-Institut für Optronik, Systemtechnik und Bildauswertung IOSB (Germany), Karlsruher Institut für Technologie (Germany); **Michael Heizmann**, Karlsruher Institut für Technologie (Germany)

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The 2021 conference will be held in honor of Professor Fernando Puente León.

An SPIE member and SPIE volunteer, chairman of the SPIE Automated Visual Inspection and Machine Vision conference at SPIE Optical Metrology, Professor Puente León, Karlsruhe Institute of Technology (Germany), passed away on 1 July 2020. Professor Puente León enjoyed an excellent reputation as a committed scientist, as the editor of the journal *tm-Technisches Messen*, and as the author and co-author of several textbooks. He was a director of the Institute of Industrial Information Technology at KIT since 2008 and significantly shaped the organization during this time.

This conference addresses image acquisition and image exploitation topics to solve visual inspection and machine vision tasks automatically. Since elaborated approaches for acquiring images constitute the crucial base to successfully accomplish inspection tasks, particularly illumination, optics, sensors, and the complete acquisition setup composed of these ingredients are within the focus of the conference. Moreover, to extract the inspection-relevant information from images, signal processing and exploitation methods that account for the physical formation of the images are of great interest. As many inspection tasks cannot be solved based on a single image, frequently it is necessary to acquire sequences of images that have to be fused in an adequate manner to draw a final inspection decision. Therefore, the question is not only how to acquire appropriate single images, but how to acquire controlled image series that comprise sufficient information with respect to the inspection task and how such image series can be exploited efficiently.

GENERAL ITEMS

- automated visual inspection
- machine vision
- robust, high performance inspection
- visual quality monitoring and control
- image acquisition and exploitation.

METHODOLOGY

- image data based on diverse optical properties of materials (reflectance, roughness, spectrum, complex refraction index, etc.)
- illumination techniques
- deflectometry
- mathematical models and methods
- image series, image fusion and active vision
- image processing and exploitation methods
- detection and classification
- physically-based image formation models
- pattern recognition
- light field methods
- machine learning for automated visual inspection.

APPLICATIONS

- automated inspection of industrially produced goods
- material recognition and verification
- detection of surface defects
- image-based measurement and control
- inspection of specular surfaces
- safety, security, and biometrics
- medicine and biology
- other application fields.

GENERAL INFORMATION

TECHNICAL PROGRAMME

Available March 2021

The comprehensive Advance Technical Programme for this symposium will list conferences, paper titles, and authors in order of presentation; an outline of all planned special events; and hotel and registration information.

REGISTRATION

Available Online March 2021

All participants, including invited speakers, contributed speakers, session chairs, co-chairs, and committee members, must pay a registration fee.

Fee information for conferences, courses, a registration form, and technical and general information will be available on the SPIE website in March 2021.

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FOR CONFERENCE CHAIRS, TECHNICAL COMMITTEE MEMBERS, AND AUTHORS: If you are listed as an author on a paper, or as a participant in the programme, and you require an Official Invitation Letter for visa application purposes, please look for the instructions published at the Optical Metrology website www.spie.org/om following the Optical Metrology 2021 acceptance notifications on 26 February 2021.

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