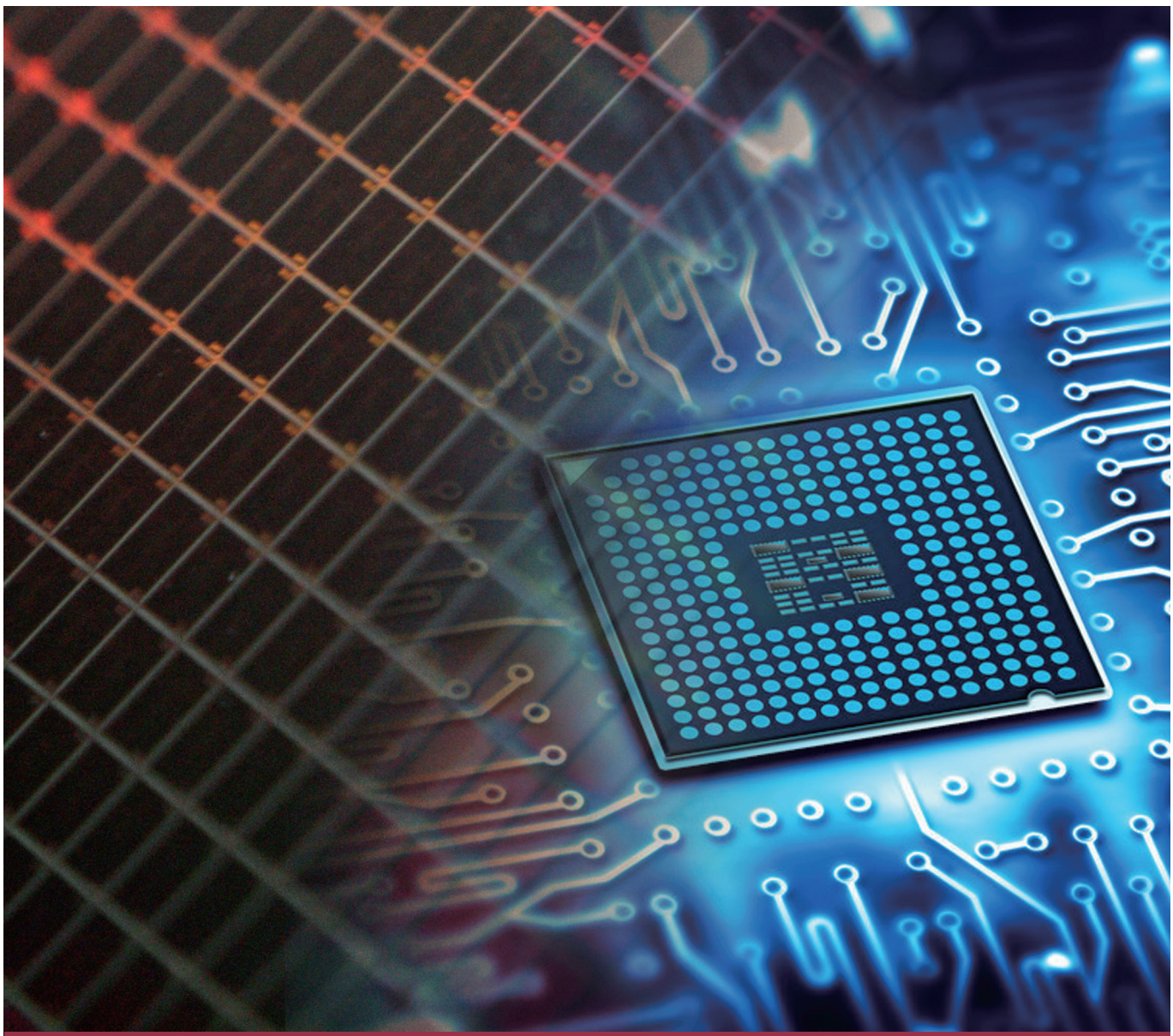
Dow Industrial Solutions

# Enable Electronics Processing




# Content



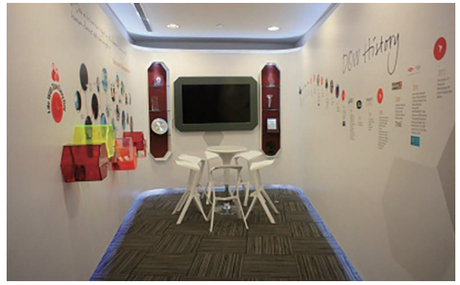
"If we can't do it better than others, why do it?"

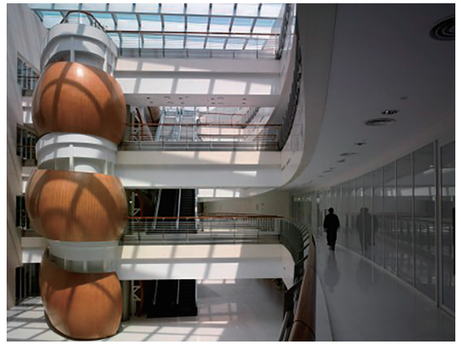
– Herbert H. Dow

(1866–1930)

# Dow Chemical

The Dow Chemical Company (Dow) combines science and technology knowledge to develop premier materials science solutions that are essential to human progress. Dow has one of the strongest and broadest toolkits in the industry, with robust technology, asset integration, scale and competitive capabilities that enable it to address complex global issues. Dow's market-driven, industry-leading portfolio of advanced materials, industrial intermediates, and plastics businesses deliver a broad range of differentiated technology-based products and solutions for customers in high-growth markets such as packaging, infrastructure, and consumer care.



## Dow Industrial Solutions Highlights

**Integrated production sites and global logistics**

- Over 1,000 products made in 50 manufacturing facilities on 18 Dow sites around the globe

- Manufacturing Location
- External Manufacturing Location




## Customized Electronic-Grade Products and Strong Quality Control

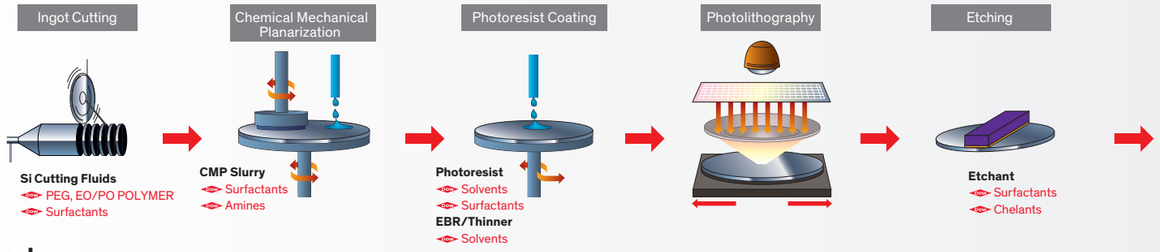
- Focused on electronic market and holistically serving our customers
- Various electronic grade materials to serve diverse needs
- Continuous improvement of processes at all levels of our operations
- Clean room with Inductively Coupled Plasma Mass Spectrometer (ICP-MS)
- Dedicated logistic processes to minimize contamination

**Chemical know-how and technical support**

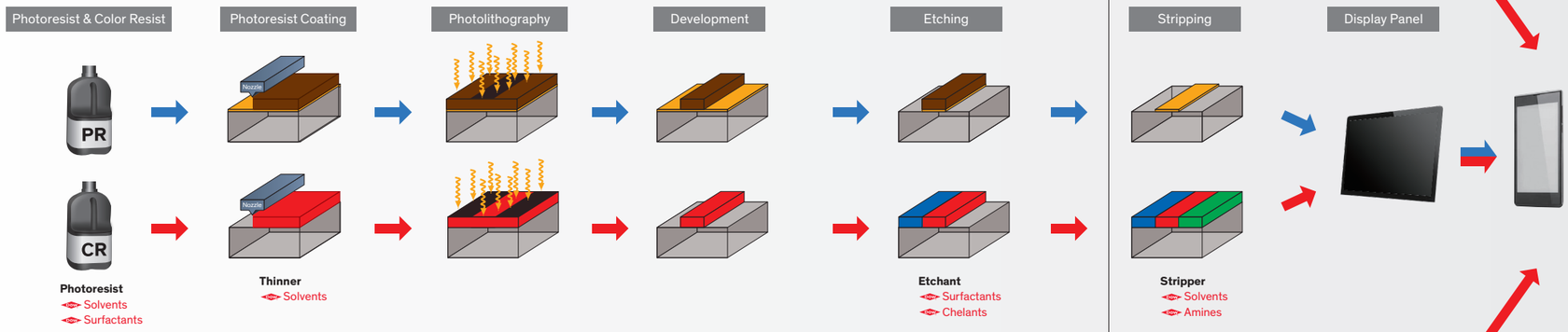
- Multiple pilot plants and research labs
- 80+ years of research and application expertise on our core molecules
- Leading analytical capabilities with reliable analytical services
- Real time technical support to optimize the use of Dow materials and make our customers more successful
- Innovative product joint development with strategic customers

# Chemistries to Enable Electronics Processing

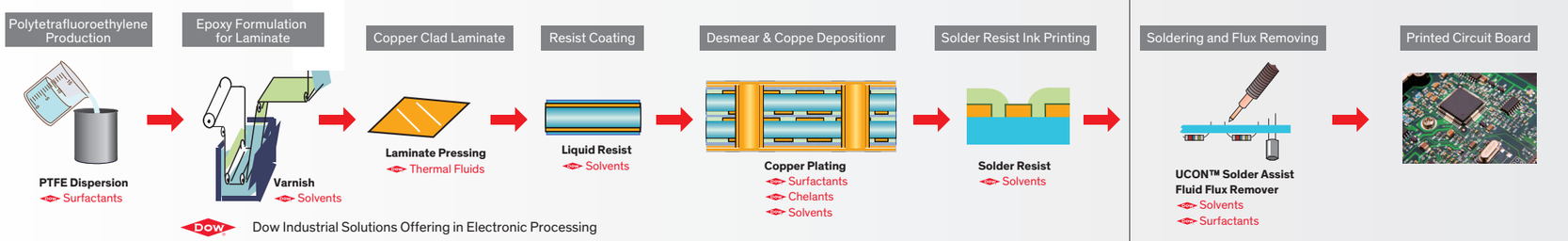
## Semiconductor




## Display




## Printed Circuit Board




DOW Dow Industrial Solutions Offering in Electronic Processing

### Dow Industrial Solutions Products Highlight

Dow Industrial Solutions combines the power of different product groups, including Amines & Chelants, Oxygenated Solvents and Polyglycols, Surfactants & Fluids. We customize selected products to the standard which meet specific electronics application requirements

- Controlled low metal concentration
- High purity
- Consistent quality control

Our product offerings include, but not limited to, below highlighted products.

## Oxygenated Solvents

Dow offers the world's largest portfolio of oxygenated solvents, including a wide selection of alcohols, esters, ketones and ethylene- and propylene-based glycol ethers. We provide excellent solvency, high dilution ratios, low surface tension and a broad range of evaporation rates, which help you formulate differentiated products for semiconductor, display and printed circuit board industries. We are capable to supply consistent quality-controlled solvents with low metal concentration and high purity.

| | | | | | | | | | | | | | Hansen Solubility Parameters (joules/cm$^3$)1/2 | | | Solubility wt% at 20°C | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Oxygenated Solvents | Chemical Nomenclature | Structural Formula | CAS Number | Molecular Weight, g/mol | Boiling Point °C at 760mm Hg | Flash Point °C | Evaporation Rate nBuAc=1 | Specific Gravity at 25°C/25°C | Viscosity cP at 25°C | Vapor Pressure (mm Hg @ 20°C) | Surface Tension, dynes/cm at 20°C | Dispersion | Polar | H Bonding | In Water | Water In | Features |
| P-Series Glycol Ethers | DOWANOL™ PM Glycol Ether | Propylene Glycol Methyl Ether | $CH_3OCH_2CHOHCH_3$ | 107-98-2 | 90.1 | 120 | 31[1] | 0.62 | 0.919 | 1.7 | 8.7 | 27.7 | 15.6 | 7.2 | 13.6 | ∞ | ∞ | Standard solvent for display/semiconductor application. Fast evaporation rate. Water miscible. |
| | DOWANOL™ DPM Glycol Ether | Dipropylene Glycol Methyl Ether | $CH_3O[CH_2CH(CH_3)O_2H$ | 34590-94-8 | 148.2 | 190 | 75[1] | 0.035 | 0.951 | 3.7 | 0.28 | 28.8 | 15.5 | 4.0 | 10.3 | ∞ | ∞ | Moderate evaporation rate. Water miscible. |
| | DOWANOL™ PMA Glycol Ether | Propylene Glycol Methyl Ether Acetate | $CH_3OCH_2CH(CH_3)OOCCH_3$ | 108-65-6 | 132.2 | 146 | 42[2] | 0.33 | 0.966 | 1.1 | 2.8 | 28.9 | 15.6 | 5.6 | 9.8 | 16.0 | 3.0 | Acetate of PM. Standard solvent for display/semiconductor application. Aproticity. |
| | DOWANOL™ DPMA Glycol Ether | Dipropylene Glycol Methyl Ether Acetate | $CH_3OCH2CH(CH3)O_2OCCH_3$ | 88917-22-0 | 190.2 | 209 | 86[2] | 0.015 | 0.977 | 1.7 | 0.08 | 27.3 | 16.3 | 4.9 | 8.0 | 16.0 | 3.5 | Acetate of DPM. Aproticity |
| | DOWANOL™ PnP Glycol Ether | Propylene Glycol n-Propyl Ether | $C_3H_7OCH_2CHOHCH_3$ | 1569-01-3 | 118.2 | 149 | 48[1] | 0.21 | 0.883 | 2.4 | 1.53 | 25.4 | 15.3 | 4.9 | 11.2 | ∞ | ∞ | C3 alkyl group. Moderate evaporation rate. Water miscible. |
| | DOWANOL™ DPnP Glycol Ether | Dipropylene Glycol n-Propyl Ether | $C_3H_7O[CH_2CH(CH_3)O]_2H$ | 29911-27-1 | 176.2 | 213 | 88[1] | 0.014 | 0.919 | 3.9 | 0.08 | 27.8 | 15.0 | 2.9 | 9.2 | 19.6 | 20.3 | C3 alkyl group. Slow evaporation rate. |
| | DOWANOL™ PnB Glycol Ether | Propylene Glycol n-Butyl Ether | $C_4H_9OCH_2CHOHCH_3$ | 5131-66-8 | 132.2 | 171 | 63[1] | 0.093 | 0.878 | 2.8 | 0.85 | 27.5 | 15.2 | 4.2 | 10.5 | 5.5 | 15.5 | C4 alkyl group. Moderate evaporation rate. |
| | DOWANOL™ PPh Glycol Ether | Propylene Glycol Phenyl Ether | $C_6H_5OCH_2CHOHCH_3$ | 770-35-4 | 152.2 | 243 | 119[1] | 0.002 | 1.062 | 25.2 | 0.01 | 38.1 | 17.4 | 5.3 | 11.5 | 1.0 | 6.0 | Phenolic glycol ether. Slow evaporation rate. High hydrophobicity. High viscosity |
| | DOWANOL™ PGDA Glycol Ether | Propylene Glycol Diacetate | $CH_3COOCH_2CH(CH_3)OOCCH_3$ | 623-84-7 | 160.0 | 161 | 86[2] | 0.039 | 1.056 | 2.6 | 0.23 | 32.5 | 15.8 | 3.5 | 8.8 | 7.4 | 4.1 | Di-acetate. Aproticity |
| | PROGLYDE™ DMM Glycol Diether | Dipropylene Glycol Dimethyl Ether | $CH_3O[CH_2CH(CH_3)O]_2CH_3$ | 111109-77-4 | 162.2 | 175 | 65[1] | 0.13 | 0.902 | 1.0 | 0.55 | 26.3 | 14.9 | 2.1 | 3.8 | 35.0 | 4.5 | Di-ether. Aproticiity. Moderate water compatibility. Low polarity |
| E-Series Glycol Ethers | CARBITOL™ Solvent | Diethylene Glycol Ethyl Ether | $C_2H_5O[CH_2CH_2O]_2H$ | 111-90-0 | 134.2 | 202 | 96[2] | 0.013 | 0.989 | 3.6 | 0.09 | 31.8 | 16.1 | 9.2 | 12.2 | ∞ | ∞ | Water miscible. Slow evaporation rate. |
| | Methyl CARBITOL™ Solvent | Diethylene Glycol Methyl Ether | $CH_3O[CH_2CH_2O]_2H$ | 111-77-3 | 120.1 | 194 | 92[2] | 0.019 | 1.020 | 3.5 | 0.23 | 32.5 | 16.2 | 7.8 | 12.6 | ∞ | ∞ | Water miscible. Moderate evaporation rate. |
| | Butyl CARBITOL™ Solvent | Diethylene Glycol n-Butyl Ether | $C_4H_9O[CH_2CH_2O]_2H$ | 112-34-5 | 162.2 | 230 | 99[2] | 0.004 | 0.951 | 4.9 | 0.028 | 30.0 | 16.0 | 7.0 | 10.6 | ∞ | ∞ | C4 alkyl group. Water miscible. Slow evaporation rate. |
| | Hexyl CARBITOL™ Solvent | Diethylene Glycol Hexyl Ether | $C_6H_{13}O[CH_2CH_2O]_2H$ | 112-59-4 | 190.3 | 259 | 135[2] | 0.0006 | 0.931 | 6.2 | 0.001 | 29.2 | 16.0 | 6.0 | 10.0 | 2.0 | 53.4 | C6 alkyl group. Slow evaporation rate. Effective reduction of water surface tension. |
| | Butyl CARBITOL™ Acetate | Diethylene Glycol n-Butyl Ether Acetate | $C_4H_9O[CH_2CH_2O]_2OCCH_3$ | 124-17-4 | 204.3 | 245 | 102[2] | 0.0017 | 0.978 | 4.5 | 0.007 | 30 | 16.0 | 4.1 | 8.2 | 4.0 | 3.4 | Acetate of Butyl CARBITOL™. Aproticity. Slow evaporation rate. |
| | Propyl CELLOSOLVE™ Solvent | Ethylene Glycol Propyl Ether | $C_3H_7OCH_2CH_2OH$ | 2807-30-9 | 104.2 | 151 | 51[2] | 0.22 | 0.91 | 2.7 | 1.77 | 26.3 | 16.1 | 8.0 | 13.1 | ∞ | ∞ | Fast evaporation rate. Water miscible. |
| | Butyl CELLOSOLVE™ Solvent | Ethylene Glycol n-Butyl Ether | $C_4H_9OCH_2CH_2OH$ | 111-76-2 | 118.2 | 171 | 65[2] | 0.079 | 0.901 | 2.9 | 0.66 | 27.4 | 16.0 | 7.6 | 12.3 | ∞ | ∞ | C4 alkyl group. Moderate evaporation rate. Water miscible. |
| | Butyl CELLOSOLVE™ Acetate | Ethylene Glycol n-Butyl Ether Acetate | $C_4H_9OCH_2CH_2OOCCH_3$ | 112-07-2 | 160.2 | 192 | 71[2] | 0.04 | 0.941 | 1.6 | 0.38 | 29.6 | 16.0 | 4.5 | 8.8 | 1.6 | 1.8 | Acetate of Butyl CELLOSOLVE™. Aproticity. Slow evaporation rate. |
| | DOWANOL™ EPh Glycol Ether | Ethylene Glycol Phenyl Ether | $C_6H_5OCH_2CH_2OH$ | 122-99-6 | 138.2 | 244 | 121[1] | 0.001 | 1.109 | 21.5 | 0.004 | 42.0 | 17.8 | 5.7 | 14.3 | 2.5 | 9.0 | Phenolic glycol ether. Slow evaporation rate. Very hydrophobic. High viscosity. |
| Esters | UCAR™ Ester EEP | Ethyl 3–Ethoxypropionate | $C_2H_5OC_2H_4C(O)OCH_2CH_3$ | 763-69-9 | 146.2 | 170 | 60 | 0.12 | 0.951 | 1.3 | 0.9 | 28.1 | 16.2 | 3.3 | 8.8 | 5.2 | 2.2 | Ester. Aproticity. Low surface tension. |
| Alcohols | Isopropanol | Isopropanol | $(CH_3)_2CHOH$ | 67-63-0 | 60.1 | 82 | 12 | 1.11 | 0.787 | 2.4 | 31.0 | 21.4 | 15.8 | 6.1 | 16.4 | ∞ | ∞ | Common solvent used in semiconductor/display process. |
| | DIBC | Diisobutyl Carbinol | $[(CH_3)_2CHCH_2]_2CHOH$ | 108-82-7 | 144.3 | 178 | 65 | 0.06 | 0.811 | 15.4 | 0.2 | 26.0 | 14.9 | 3.1 | 10.8 | 0.06 | 1.0 | Secondary alcohol. Sow evaporating solvent. Limited water solubility. |
| | MIBC | Methyl Isobutyl Carbinol | $(CH3)_2CHCH_2CH(OH)CH_3$ | 108-11-2 | 102.2 | 132 | 41 | 0.27 | 0.807 | 5.2 | 3.8 | 23.0 | 15.4 | 3.3 | 12.3 | 1.7 | 6.2 | Secondary alcohol. Slightly soluble in water. Low surface tension. |
| Ketones | DIBK | Diisobutyl Ketone | $(CH_3)_2CHCH_2C(O)CH_2CH(CH_3)_2$ | 108-83-8 | 142.2 | 169 | 49 | 0.19 | 0.807 | 1.0 | 1.2 | 24.1 | 16.0 | 3.7 | 4.1 | 0.04 | 0.5 | High boiling point. Slow evaporating rate. Limited water solubility. Low surface tension. |
| | MIBK | Methyl Isobutyl Ketone | $CH_3C(O)CH_2CH(CH_3)_2$ | 108-10-1 | 100.2 | 116 | 18 | 1.66 | 0.802 | 0.6 | 15.3 | 24.0 | 15.3 | 6.1 | 4.1 | 1.8 | 1.9 | Medium-evaporating rate. Slightly soluble in water |

These properties are typical of the product, but should not be confused with, or regarded as, sales specifications.
1 Setaflash Method (Closed Cup); 2 Tag Closed Cup (TCC); ∞ Miscible

## Amines & Chelants

Dow offers versatile family of ethanolamines, isopropanolamines and alkyl alkanolamines, which are diversified, polyfunctional molecules that combine the characteristics of amines and alcohols. They can provide alkalinity, corrosion inhibition, photoresist removal and cleaning function in various formulations. We are capable to provide selected products with strong photoresist removal capability and low corrosion to metal like copper. Our VERSENE™ Chelating Agents neutralize harmful metal ions found in water-based formulations and processes.

| Amines | Chemical Nomenclature | Structural Formula | CAS Number | Molecular Weight, g/mol | Freezing Point °C | Boiling Point °C at 760mm Hg | Flash Point °C | Specific Gravity at 20°C/20°C | Viscosity cP at 20°C | Vapor Pressure (mm Hg @ 20°C) | Solubility in Water at 20°C | Features |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MEA | Monoethanolamine | $HOC_2H_4NH_2$ | 141-43-5 | 61.1 | 10 | 171 | 96[1] | 1.01 | 24 | 0.50 | ∞ | Strong alkalinity Primary amine |
| TEA | Triethanolamine | $(HOC_2H_4)_3N$ | 102-71-6 | 149.2 | 21 | 335 | 208[1] | 1.13 | 404(30°C) | <0.001 | ∞ | Alkalinity Hygroscopic tertiary amine |
| MIPA | Monoisopropanol-amine | $CH_3CH(OH)CH_2NH_2$ | 78-96-6 | 75.1 | 3 | 159 | 73[2] | 0.96 | 23 (25°C ) | 0.53 | ∞ | Strong alkalinity Primary amine |
| MDEA | N-methyldiethanol-amine | $CH_3N-(CH2CH2OH)_2$ | 105-59-9 | 119.2 | -21 | 247 | 138[1] | 1.04 | 101 | <0.01 | ∞ | Alkalinity Tertiary amine |
| NMEA | N-Methylethanol-amine | $CH_3NHCH-_2CH_2OH$ | 109-83-1 | 75.1 | -5 | 160 | 73[2] | 0.94 | 13 | 0.48 | ∞ | Strong alkalinity Secondary amine |
| AEEA | Aminoethylethanol-amine | $(HOC_2H_4)NH(C_2H_4NH_2)$ | 111-41-1 | 104.2 | -45 | 243 | 127[1] | 1.03 | 141 | <0.01 | ∞ | Alkalinity |

1 Pensky-Martens Closed Cup
2 Setaflash Method (Closed Cup)

| Chelants | Chemical Nomenclature | Appearance | Chelation Value (mg as $C_aCO_3$ per g) | % Assay | Molecular Weight | Specific Gravity (@ 25/ 25°C) | Bulk Density kg/m$^3$ | pH (1 wt% Aqueous Solution) | Features |
|---|---|---|---|---|---|---|---|---|---|
| VERSENE™ 100 Chelating Agent | Tetrasodium ethylene-diaminetetraacetate | Amber, light | 102 | 39 wt% as $Na_4EDTA$ | 380.2 | 1.3 | 1270 | 11.0 – 11.8 | Most cost effective chelant |
| VERSENE™ Diammonium EDTA Chelating Agent | Diammonium ethylene-diaminetetraacetate | Light, straw-colored liquid | 137 | 45 wt% as $(NH_4)_2EDTA$ | 328.2 | 1.2 | 1200 | 4.6 – 5.3 | Neutral pH High EDTA solubility |
| VERSENE™ 220 Crystals Chelating Agent | Tetrasodium ethylene-diaminetetraacetate tetrahydrate | White crystaline powder | 219 | 99.0 wt% as $Na_4EDTA{\cdot}4H_2O$ | 452.2 | - | 720 | 10.5 – 11.5 | Dry and crystalized |
| VERSENEX™ 80 Chelating Agent | Pentasodium diethylene-triaminepentaacetate | Light, straw-colored liquid | 80 | 40.2 wt% as $Na_5DTPA$ | 503.1 | 1.3 | 1310 | 11.0 – 11.8 | Extra strength with bleach stability |
| VERSENOL™ 120 Chelating Agent | Trisodium N-(hydroxyethyl)-ethylenediaminetriacetate | Light, straw-colored liquid | 120 | 41 wt% as $Na_3HEDTA$ | 344.2 | 1.3 | 1290 | 11.0 – 11.8 | Iron control |



## Polyglycols, Surfactants and Fluids

Dow Polyglycols, Surfactants and Fluids include some of the most familiar anionic and nonionic surfactants, polyglycols, EO/PO copolymers and solder assistant fluids. Dow surfactants and polyglycols are known for excellent wetting, emulsification, dispersion, and foam control. Water-soluble UCON™ fluids are well-suited as base solder assist fluids. With Dow polyglycols, surfactants and fluids, you can also receive a wide range of available chemistries, extensive applications expertise, a global technical support network and stable product supply from world-class manufacturing facilities.

| Nonionic Surfactants | Chemical Nomenclature | Actives | Form at 25°C | Cloud Point (°C, 1 wt% aq) | HLB | Critical Micelle Concentration (ppm at 25°C) | Surface Tension (dynes/cm at 1% actives, 25°C) | Foam Height [1] | Pour Point (°C) | Features |
|---|---|---|---|---|---|---|---|---|---|---|
| TERGITOL™ 15-S-9 | Secondary Alcohol Ethoxylate | 100% | Liquid | 60 | 13.3 | 52 | 30 | 124/43 | 9 | Excellent detergency, rapid dissolution and good rinseability, low odor, excellent formulation and handling properties |
| TRITON™ HW-1000 | Secondary Alcohol Ethoxylate | 100% | Liquid | Insoluble | 10.8 | Insoluble | Insoluble | Insoluble | -18 | Non-silicone-based, superior wetting & leveling agent, low foam, wets various substrates, narrow gel range |
| ECOSURF™ EH-9 | 2-Ethylhexanol Alkoxylate | 100% | Liquid | 61 | 12.5 | 1066 | 31 | 60/0 | 16 | Exceptional wetting, low odor, excellent formulation properties, very low aquatic toxicity |
| TERGITOL™ TMN-6 (90%) | Branched Secondary Alcohol Ethoxylate | 90% | Liquid | 36 | 13.1 | 800 | 27 | 130/22 | -40 | Excellent wetting, penetrating & dispersing agent, narrow gel range |
| TRITON™ RW-150 | Alkyl Amine Ethoxylate | 100% | Liquid | > 100 | > 16 | 860 (pH=12) - (pH=2) | 30 (pH=12) 54 (pH=2) | 135/15 pH=12 | 11 | Good detergency and wetting. pH reversible |
| TERGITOL™ XD | EO/PO Copolymer | 100% | Solid | 74 | - | - | 38 | 60/25 | 34 | Excellent steric and freeze thaw stabilizer |
| TRITON™ CG-110 | Alkyl Polyglucoside | 60% | Liquid | >100 | - | 1748 | 27 | 105/100 | -15 | Mild, good detergent and wetter, soluble in highly alkaline solutions |
| DOWFAX™ DF-103 | Polyether Polyol | 100% | Liquid | 22 | - | Insoluble | Insoluble | 1/0 | < -20 | Long-lasting defoaming efficacy, pH stability (pH 2~12). |

| Anionic Surfactants | Chemical Nomenclature | Actives | Diluent | Form at 25°C | Surface Tension (dynes/cm at 1% actives, 25°C) | | Foam Height [1] | | Features |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Neutral [2] | Alkaline [3] | Neutral [2] | Alkaline [3] | |
| DOWFAX™ 2A1 | Alkyldiphenyloxide Disulfonate | 45% | Water | Liquid | 34 | 35 | 140/130 | 145/145 | Excellent solubility & stability in acidic, alkaline, bleach and other oxidizing systems, rinses easily from surfaces |
| TRITON™ GR-5M | Dioctyl Sulfosuccinate | 60% | Isopropanol / Water | Liquid | 26 | NR [4] | 190/180 | NR [4] | Excellent wetting, emulsifying & dispersing ability |

Footnotes: (1) Ross-Miles foam height: mm at 0.1 wt% actives, 25°C, initial / 5 minute; (2) Actual pH = 7 (distilled water); (3) Actual pH = 12.5 (sodium hydroxide solution); (4) NR = Not recommended; can hydrolyze under some alkaline conditions

| UCON™ Solder Assist Fluids | Viscosity (cP at 40°C) | Specific Gravity at 20°C | Pour Point (°C) | Flash Point, Closed Cup / Open Cup (°C / °C) | Surface Tension (dynes/cm at 1% actives, 25°C) | Water Solubility at 25°C | Cloud Point (°C, 1 wt% aq) | Features |
|---|---|---|---|---|---|---|---|---|
| SAF-10 | 280 | 1.088 | -15 | 177 / 318 | 38.7 | ∞* | 85 | Excellent thermal and oxidative stability make them ideal for formulations used in printed circuit board manufacturing and assembly. Inhibited fluids provide high temperature stability, high flash and fire points, and low foaming tendencies. |
| SAF-24 | 123 | 1.139 | -5 | 268 / 218 | 45.5 | ∞* | >99 | |
| SAF-25 | 90 | 1.151 | -34 | 182 / 279 | 37.8 | ∞* | >99 | |
| SAF-26 | 90 | 1.152 | -34 | 279 / 310 | 38.1 | ∞* | >99 | |

* Product contains small amounts of water insoluble additives, which are present to improve thermal stability.

For more information about Dow products, please contact Dow Customer Information Group (CIG):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