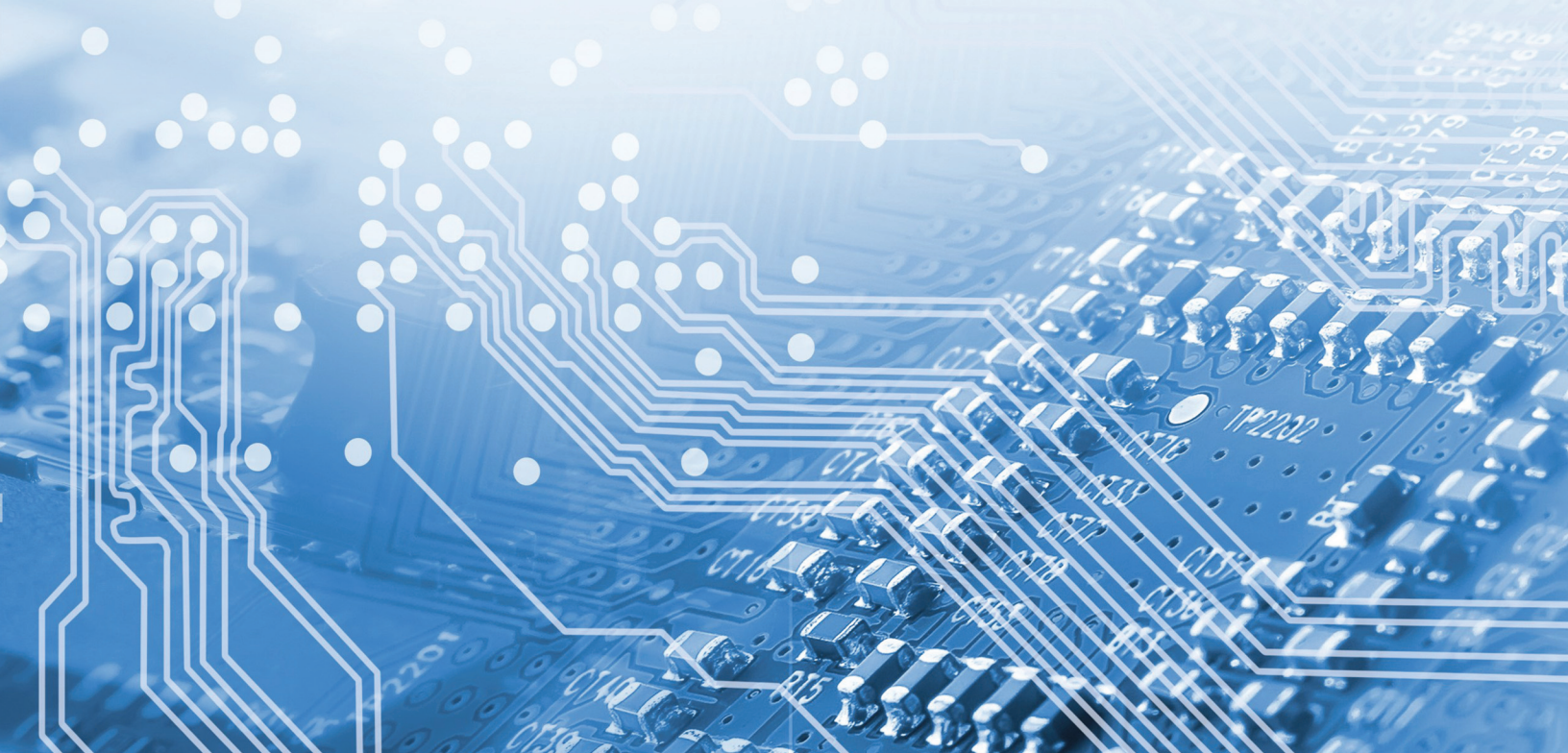
PROMERUS®

Subsidiary of Sumitomo Bakelite Co., Ltd.

HIGH PERFORMANCE POLYMERS TAILORED TO YOUR APPLICATION



PROMERUS is a global leader in Cyclic Olefin Polymers (COP) and is driven to provide advanced material solutions for your challenges in semiconductor, optoelectronics, electronic packaging, and emerging applications. As a subsidiary of Sumitomo Bakelite Co., Ltd., Promerus is well positioned to deliver our unique material sets to the market. We would love to have a discussion with you about your polymer application requirements.

Promerus History: A Leader in Cyclic Olefin Polymer (COP) Technology

1992 — Breakthrough catalytic event involving new high activity catalyst and novel high temperature poly (norbornene) at BFGoodrich

1995 — Awarded National Institute of Standards and Technology's Advanced Technology Program Grant for "Tailored Optical Polymers through Catalysis"

1997 — Development program targeting photoresist polymers for semiconductor fabrication applications initiated

1998 — Awarded National Institute of Standards and Technology's Advanced Technology Program Grant for "Optical Polymers and Manufacturing Processes for Low-Cost WDM Devices and Systems"

1999 — Secured United States Display Consortium contract for development of engineered substrate for flat panel display applications

2000 — BFGoodrich Announces Sale of Performance Materials Group

2001 — Acquisition of Electronic Materials Group by Sumitomo Bakelite Co., Ltd.

SUMITOMO BAKELITE CO.,LTD.

2003 — Promerus receives 1st & 2nd President's Award for New Product Development

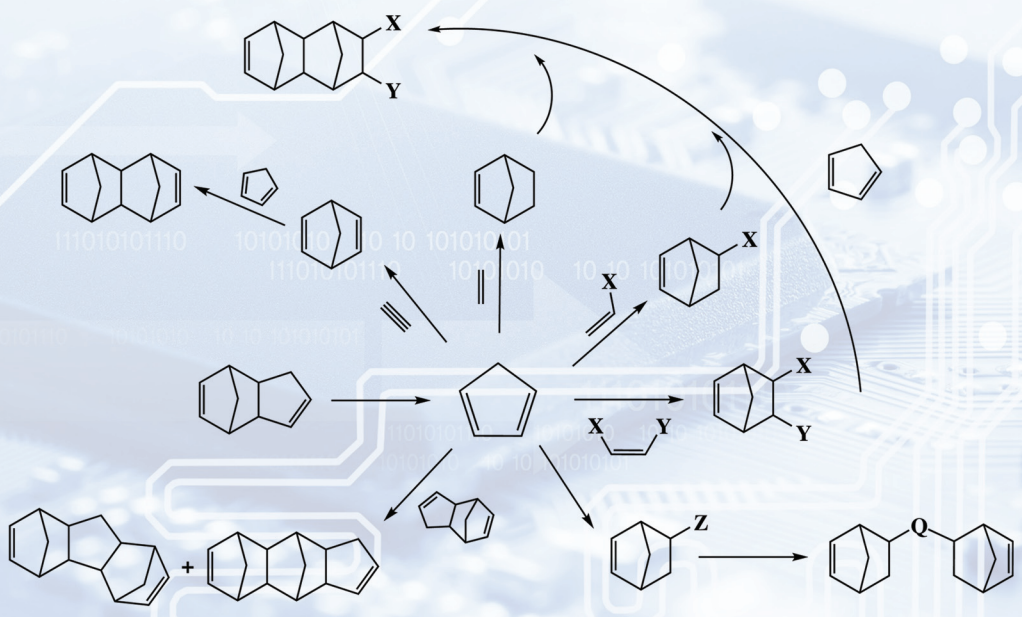
2006 — ISO 9001

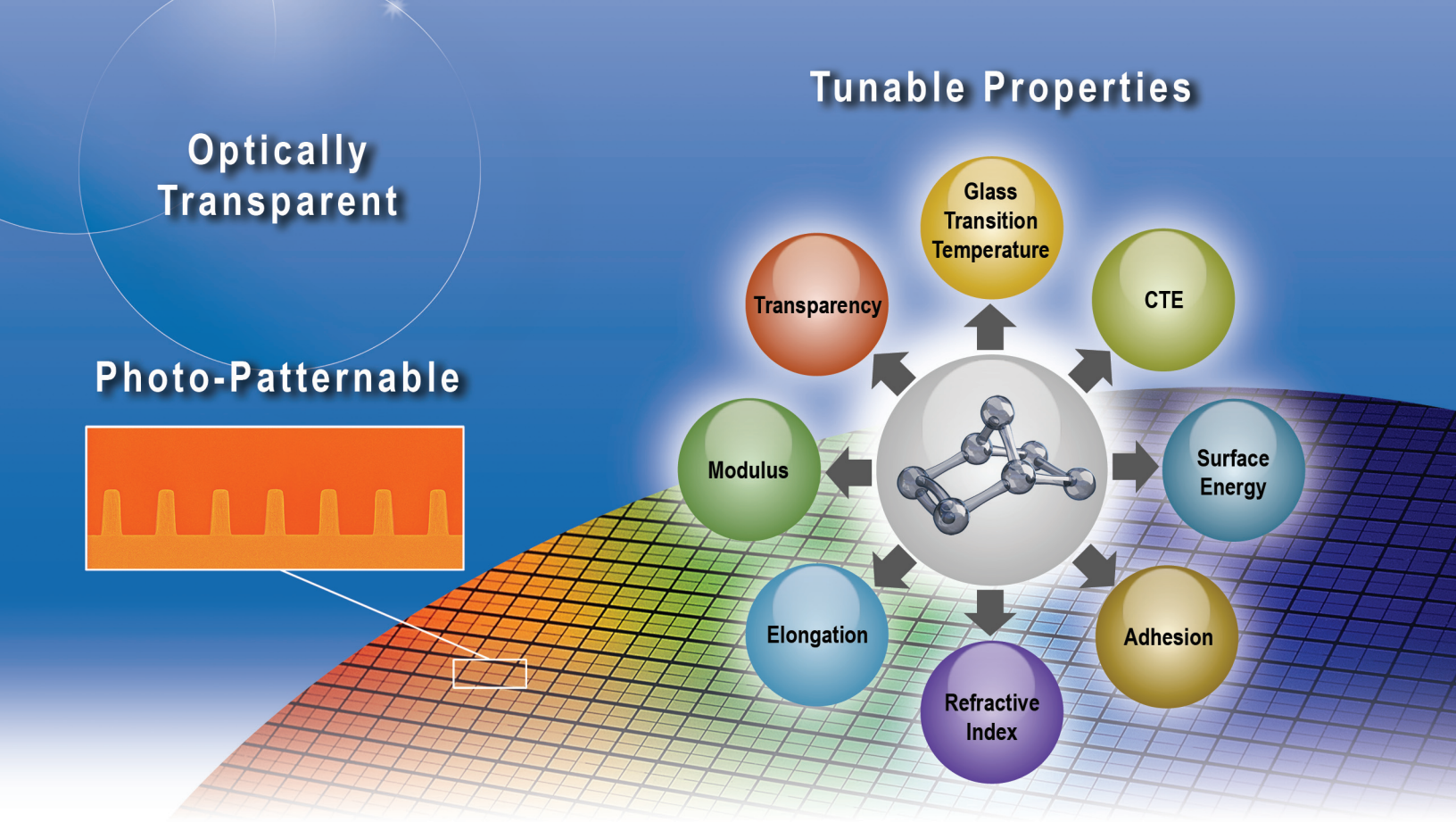
2013 — Obtained 100th U.S. Patent

2016 — Recognized as a Top 20 "High Quality Patent Power Index Company" in NE Ohio by Crain's Cleveland Business

Award for Cooperative Research from the ACS Polymer Materials Science and Engineering Division

Promerus Monomers: Customized Building Blocks

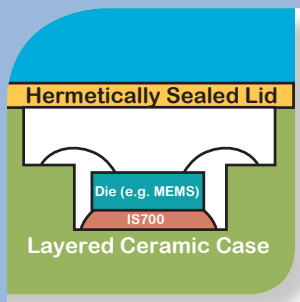




Comparative Polymer	T_g °C	Modulus GPa	Elongation %	CTE ppm/°C	Adhesion tape test	Refractive Index at 589 nm	Contact Angle deg (H_2O)	Transparency % (400-700 nm)
Promerus Polynorbornene	**110 - 330**	**0.5 - 3.5**	**5 - 100**	**~50 - 200**	**Si, Glass, SiO_2, Si_3N_4, Cu, Au, Ti, Al, etc**	**1.49 - 1.64+**	**40 - 109°**	**>92%**
Polystyrene	90 - 110	3 - 3.5	<1	70	Unlikely to adhere	1.59	87°	90
PMMA	85 - 105	2.2 - 3.8	~3%	70 - 77		1.49	71°	>92%
Zeonex®	69 - 163	1.8 - 2.4	10 - 120	60 - 70		1.51 - 1.53	>100°	>92%
Topas®	70 - 180	2.6 - 3.2	<10	60 - 70		1.53	>100°	>92%

PROMERUS pioneered the catalyst technology that enabled addition polymerization of polynorbornenes (PNB). PNB is a class of COP which maintains the bicyclic ring structure in the backbone without the use of comonomers. This allows the PNB backbone to remain rigid, effectively raising the T_g from 100 to >300° C. Unlike polyimides which stiffen as they cure via an outgassing mechanism at elevated cure temperatures, PNB does not require high cure temperatures in order to achieve a high T_g. The ability to maintain high thermal characteristics with glass-like transparency is unique to the industry. In addition, we can copolymerize a wide variety of norbornenes with functional groups to tailor the PNB polymer to meet your requirements. Through this unique ability to tailor PNB polymer compositions, we are able to adjust the modulus for stress compliance, the elongation by controlled cross-linking, the adhesion through heat/humidity reliability to a wide array of substrates, the refractive index, and the surface energy with polynorbornenes that range from hydrophobic to water-soluble. All of this can be accomplished while maintaining transparency across a broad spectrum of wavelengths (157, 193, 365, 400-700, 1080 and 1550 nm).

Promerus Materials and Applications



PDM-5001 Aprima® IS700 Adhesive Paste

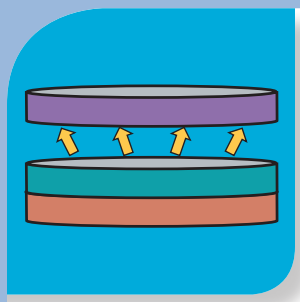
- Dispensable
- No outgassing
- No residue under hermetically sealed lid

This adhesive paste is thixotropically controlled. It is typically dispensed via syringe into a cavity. A die (e.g., MEMS) can be placed onto the IS700 adhesive and cured. After the IS700 adhesive has been cured, the package can be hermetically sealed. IS700 adhesive does not produce any residue at temperatures up to 330°C, thus preventing stiction of MEMS devices. Its uses include die-attach and coating/lamination of flexible circuits and circuit boards.

PDM-5004

- LED or OLED
- Light Extraction
- Low Viscosity
- 100% Reactive
- High Refractive Index

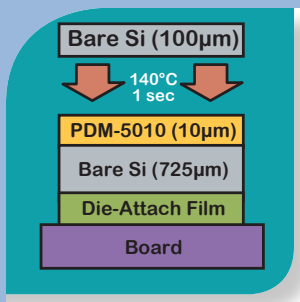
This system is designed to be 100% reactive with no need for solvent. Our proprietary blend is <30 cP, but can also be tailored to a variety of viscosities for dispense techniques including ink-jetting and traditional jet-dispensing. After a brief thermal cure, it polymerizes and solidifies in place to a thermoset. When blended with additives, it can be designed to have excellent adhesion for mechanical durability and/or high refractive index for improved light extractability.



PDM-5007

- Temporary Wafer Bonding Adhesive
- Thermally Decomposable
- Spin-coatable

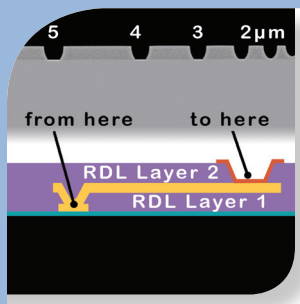
Temporary Wafer Bonding is a technique implemented to handle thin or fragile wafers. After being attached to a temporary adhesive on a rigid carrier wafer, a device wafer can undergo more rigorous processing. After the wafer has been processed, it is often in a very fragile state due to back-grinding or choice of substrate (e.g., GaAs). This temporary wafer bonding adhesive was designed for low thermal budgets and decomposes thermally.



PDM-5010

- Spin-coatable
- Photopatternable
- Thermocompressive adhesive

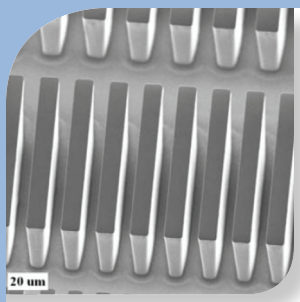
This polymer is specially formulated to combine adhesion and photo-patternability. After spin-coating onto a wafer or other preferred substrate, it undergoes standard i-line photolithography. Once features are defined by developing in TMAH, the wafer can be baked, diced, and subjected to thermo-compressive bonding (e.g., 140˚C/1 sec). After a no-outgassing low temperature (175˚C) cure, a high strength bond is created between substrates which can endure wire-bonding or solder reflow temperatures (>4MPa at 260˚C).



PDM-5013

- Photopatternable
- TMAH-Developable
- Redistribution, RDL
- Low K Dielectric
- Adhesion to Metals
- Low Cure Temperature

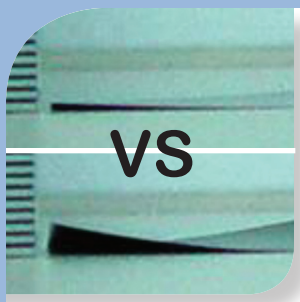
Redistribution is a process which utilizes photo-patternable dielectrics to encapsulate electrically conductive relocation traces. Polynorbornenes are finding their advantage in an industry moving toward smaller features and lower cure temperatures (170-200˚C). PDM-5013 has an inherently high T_g from its rigid polycyclic olefin backbone. Unlike its competition, it does not need a high cure temperature to increase the T_g. This low cure temperature and a balance of strength approaching 100 MPa and an elongation beyond 40% is making it an attractive candidate for next-generation technologies.



PDM-5019

- Photopatternable
- Thick Film
- Straight Sidewalls
- High Contrast
- High Aspect Ratio

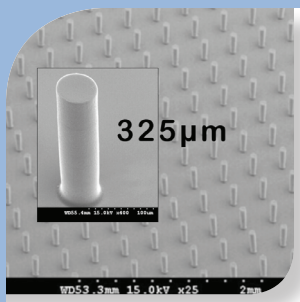
In conjunction with Georgia Institute of Technology, PDM-5019 was evaluated as a thick film photo-patternable material capable of 70-100 µm single-spin coatings. Its inherent high transparency makes high contrast and straight sidewalls achievable. PDM-5019 is also e-beam sensitive at 10 µC/cm^2. Overall, this material is capable of SU-8 like structures with simplified processing.



PDM-5022

- Photopatternable
- Low Wafer Stress
- Adhesion to Metals
- Low Cure Temperature

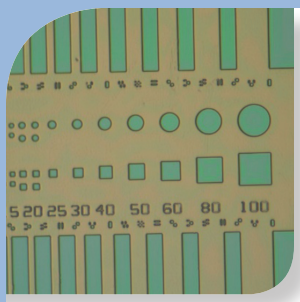
Packaging stress can add up, and PDM-5022 has been utilized to minimize stresses caused by polymer coatings. Typical materials like polyimide have high modulus, high cure temperatures, and shrink during cure, all of which are counter-productive to low wafer stress. By employing a non-shrinking, low cure temperature (180˚ C) mechanism in combination with low modulus (1.2 GPa), PDM-5022 was designed to reduce wafer curvature (15 µm; 7 MPa stress) helping to reduce overall package stress.



PDM-5025

- Photopatternable
- Thick Film
- Negative-Tone
- High Degree of Planarization (DOP)

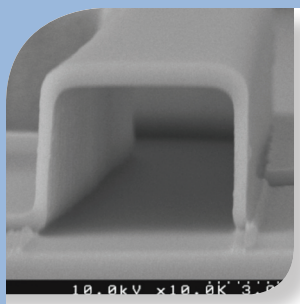
PDM-5025 is a photo-patternable formulation capable of single spin-coatings of more than 50 µm in thickness. PDM-5025 was designed to have a high degree of planarization. Its degree of planarization is calculated to be more than 90% over 7µm topology. It has been commercially utilized as a stand-off layer surrounding wafer-level CMOS Image-Sensors.



PDM-5028

- Self-Photopatternable
- No additives required
- Turn thermoplastics to thermosets

The PDM-5028 platform was designed to eliminate the effects of formulation additives. Two technologies were developed. One technology relies on a proprietary, self-reacting UV sensitive polymer. The second complementing technology is based on our ability to convert almost any traditionally non-reactive thermoplastic into a thermoset. Both technologies can be used to make photo-patterns with feature sizes less than 50 µm, the diameter of a human hair.



PDM-5031

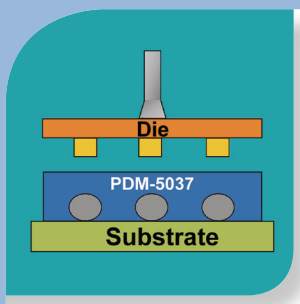
- Spin-Coatable
- Photopatternable
- Dry-Etchable to form cavities

Both MEMS and other wafer-level packages often require formation and enclosure. PDM-5031 can be spin-coated and processed per standard photoresist processing techniques. After features have been defined, they can be over-coated and subsequently dry-etched to reveal the desired shape. With its low/no Si-content, PDM-5031 has been demonstrated to be cleanly dry-etched through large openings or smaller vent holes.

PDM-5034

- Air Gap Formation
- 1.00 Dielectric Constant
- Thermally Decomposable

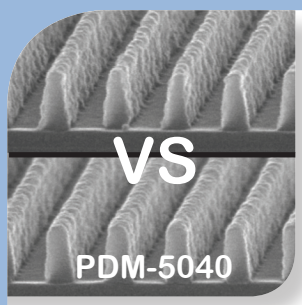
PDM-5034 was designed to produce air gaps on wafer-level substrates. Whether it is to reap the benefits of a near-perfect dielectric constant of air, or to set the stage for the encapsulation of movable device (e.g., MEMS), our PDM-5034 may aid your development. PDM-5034 has thermally decomposable grades which cover a decomposition range from 150-400˚ C.



PDM-5037

- Tacky Solder Flux
- Non-halogenated
- Thermally decomposable
- No corrosive residue

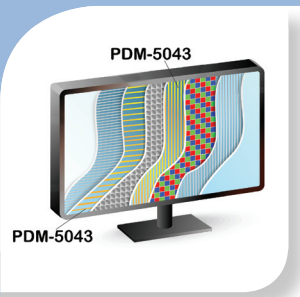
Traditional "No-clean" fluxes, some including rosin, may leave residues which can be difficult to remove. No-residue flux is the technical solution to finer pitch, smaller form factor, and higher I/O density packaging where residue cleaning is not preferred. Our non-halogenated PDM-5037 Tacky Flux is used for strong solder joints with low/no residue after removal by thermal decomposition.



PDM-5040

- Photoresist
- Inherently etch resistant
- Low Optical Density
- High transparency at 193nm and 157nm

PDM-5040 photoresist is based on poly(cyclic olefin) technology. With proprietary techniques to polymerize COP, our alicyclic backbone is inherently resistant to the tortures of dry-etch conditions without the need to modify pendant functionality. This etch resistance coupled with our ability to control end group functionalities leads to a photoresist with a natural improvement to line-edge roughness (LER).



PDM-5043

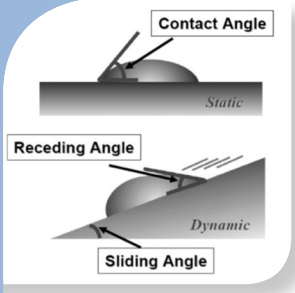
- Alignment Layer
- Photo, not rubbed
- Low pre-tilt angle

Liquid crystal (LC) displays consist of several layers. The function of the layers adjacent to the LC is to anchor and orient the LC. Traditional methods to create this polymer alignment layer utilize mechanical rubbing to produce micro-scratches and induce LC alignment. After exposing our photosensitive PDM-5043 material through a polarized filter, it is capable of anchoring and aligning LC with a low pre-tilt angle useful for IPS/FFS next generation displays.

PDM-5046

- High Transparency
- Low Birefringence
- High T_g
- Film Capable

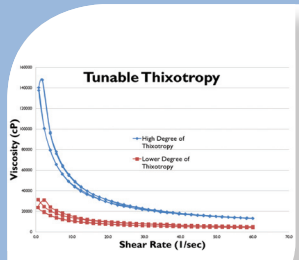
Traditional Cyclic Olefin Polymers (COP) have exceptional glass-like transparency. Likewise, polyimides are known for their high T_g and good mechanical properties. PDM-5046 combines glass-like transparency, zero birefringence, high thermal stability, and high T_g (200-300˚C). The available polymer is soluble in traditional organic solvents (e.g., hexanes, toluene, etc.) and is capable of being converted into film.



PDM-5049

- Top Coat
- Immersion Lithography
- Hydrophobic
- TMAH-soluble

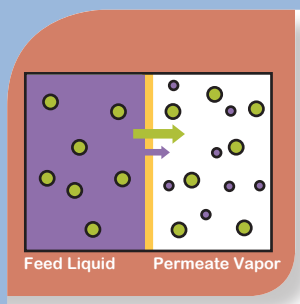
For years, the resolution of photoresists was limited by Rayleigh's equation dictated by the wavelength of light and numerical aperture of the lens. More recently, resolution was increased by putting high refractive index fluids (e.g., H_2O) in contact with the lens. To eliminate lens damage and defects caused by water, we developed an exceptionally high purity Top Coat that segregates the resist from the lens. In addition, PDM-5049 balances contact angles and TMAH-dissolution.



PDM-5055

- Shear Thinning
- Thixotropic
- Tunable Viscosity
- Low Cure Temperature

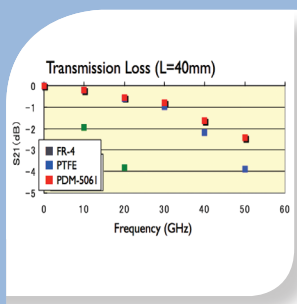
Typical polymer solutions are Newtonian fluids meaning that viscosity is linearly proportional to shear rate. In the case of PDM-5055, when the shear stress is removed, viscosity increases dramatically. This behavior is known as thixotropy. Most commonly, thixotropy can be observed in a stubborn bottle of ketchup. However, this behavior can be practically utilized in thread adhesives, paint, and solder pastes. In all cases, when the shear forces are removed, the material has a tendency to 'stay put'.



PDM-5058

- Biofuels
- Pervaporation Membrane
- Molecular Porosity

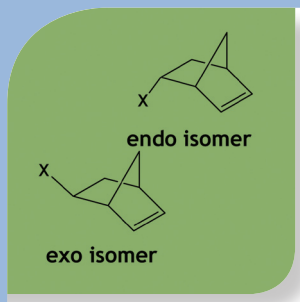
Pervaporation is a process which separates molecules through a membrane under the aid of a vacuum with minimal thermal energy. This process requires less energy than traditional distillation, and is avidly being sought in the industry of biofuel separation for green sources of energy. PDM-5058 is based on cyclic olefin polymers (COP). Their molecular cage structure inherently allows for separation at the molecular level while maintaining high flux across the membrane.



PDM-5061

- Low Loss at High Frequency
- Tan δ = 0.0004 at 50 GHz
- K of 2.28
- Flame-Resistant

This system is designed to be 100% reactive with no need for solvent. Our proprietary blend is <30 cP, but can also be tailored to a variety of viscosities for several dispense techniques including ink-jetting and traditional jet-dispensing. After a brief thermal cure, it polymerizes and solidifies to a thermoset in place. On its own, the polymer is capable of UL-94 V-0 rating. Its dielectric constant and low loss are comparable to PTFE, but its low viscosity may provide processing advantages.



PDM-5064

- Norbornene Monomer
- Specialty X-Group Functionalization
- Controllable Endo and Exo-Stereospecificity

Our breakthrough catalyst technology enables us to polymerize functionalized norbornene monomers to make polynorbornenes (PNB) or cyclic olefin polymers (COP). To facilitate the demand for polymers and their applications, a broad array of functionalized norbornene monomers are available (e.g., acetate, ester, alcohol, ether, amine, alkyl, ketone, anhydride, silyl ether, epoxide, phenyl, vinyl). Please inquire of PDM-5064 if you have a high value application requiring functionalized norbornene synthesis.

PDM-5067

- Polymer Architecture
- Block Copolymers
- Telechelic Polymers

PDM-5067 stems from the growing base of our core catalyst technology. Functionalized norbornene monomers are subjected to addition polymerization. This mechanism allows us to produce living-like polymers oftentimes demonstrating polydispersities less than 1.1, thus enabling controlled addition for formation of A-B block copolymers, A-B-A triblock copolymers, as well as hyper-branched or telechelic functionalized polymers.

PDM-5070

- Moldable
- Low Melt Viscosity
- High Melt Flow Rate

Molding of polymers is a long-standing technology which involves heating a polymer above its crystallization temperature while applying pressure in a cavity mold. PDM-5070 is an amorphous material, but its architecture can be modified to increase the melt flow rate (from 1 → 40 grams/10 min) and decrease the melt viscosity (from 160 → 40 cP at 200˚ C). A molded part can be obtained which maintains glass-like transparency with a T_g exceeding 200˚ C.

SUMITOMO BAKELITE CO., LTD.

The Semiconductor Materials business group provides epoxy resin molding compounds for encapsulation of semiconductor devices, photosensitive coating resins for semiconductor wafers, pastes for die bonding and semiconductor substrate materials.

The High Performance Plastics business group provides phenolic molding compounds, phenolic resins for industrial use, molded parts and dies, synthetic resin adhesive, copper-clad laminates, and aerospace interior components.

The Quality of Life business group provides medical devices, decorative laminates and sheets, multilayered films, freshness preserving films, resin plates, and biotechnology related products.

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