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NANO™ PMGI Resists

MicroChem's line of PMGI resists consist of polydimethylglutarimide polymer with proprietary solvent blends. These resists have unique properties that make them well suited for lift-off processing as well as many other lithographic applications. PMGI is virtually insoluble in typical photoresist solvents; therefore i-line, deep UV and e-beam resists can be placed on top of PMGI without intermixing. PMGI resists are also readily soluble in most standard alkaline photoresist developers and have highly controllable dissolution properties. These attributes make PMGI resists uniquely suited for many critical and non-critical bi-layer lift-off processes. Mainstream applications include GMR & MR heads, wireless devices, opto-electronics, MEMs, packaging and other microelectronic applications requiring very high resolution imaging, easy process tuning, high yields and superior deposition linewidth control.

In addition to having superb lift-off properties, PMGI has high thermal stability (Tg ~190ºC), which makes it compatible with high temperature processes. PMGI has superior planarizing properties, making it suitable as a planarizing layer over severe topography. PMGI is also optically transparent in the visible and near IR, has excellent reflow properties and is used in the fabrication of microlenses.

PMGI RESISTS OFFER

- Sub 0.25µm lift-off processing
- Film thicknesses from <200Å - >5µm
- Choice of resin blends for optimal undercut control
- High thermal stability
- Superior adhesion to Si, NiFe, GaAs, InP and many other III-V materials
- Excellent planarizing properties
- Optically transparent for microlens fabrication

RANGE OF PRODUCTS

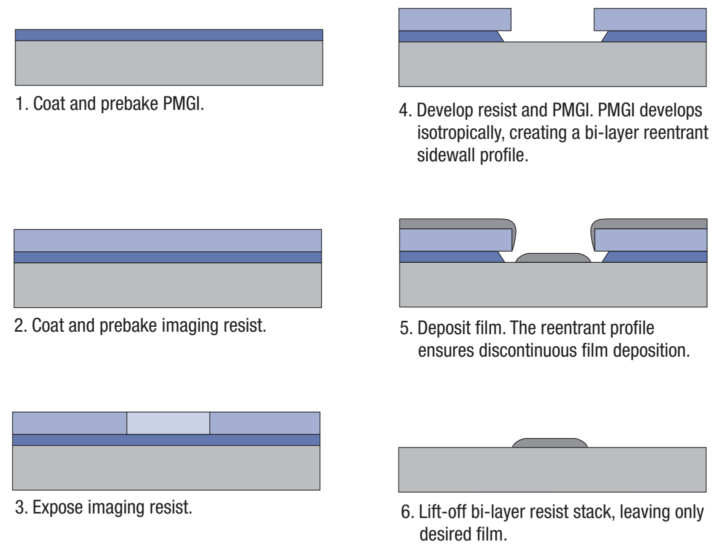
The PMGI line of resists consists of three resin blends with slow, medium and fast dissolution (undercut) rates. For lift-off applications requiring faster dissolution rates, please refer to our LOR lift off resist technical data sheet. PMGI and LOR resists are available in dilutions for film thicknesses from <200Å - >5µm.

Simple Bilayer Lift-Off Process

This process requires the fewest process steps and is recommended for most lift-off applications. In this simplified process the PMGI layer develops nearly isotropically* to produce bi-layer reentrant resist profiles. The amount of undercut is precisely controlled by the PMGI prebake conditions as well as through the choice of developer, develop time and develop mode. PMGI does not require additional exposure or development steps, making it simple to use, while increasing throughput.

*The slope of the PMGI resist sidewall may be reduced and in some instances becomes nearly anisotropic, through process optimization. Developer type, develop mode and time as well as prebake conditions influence the PMGI sidewall profile.

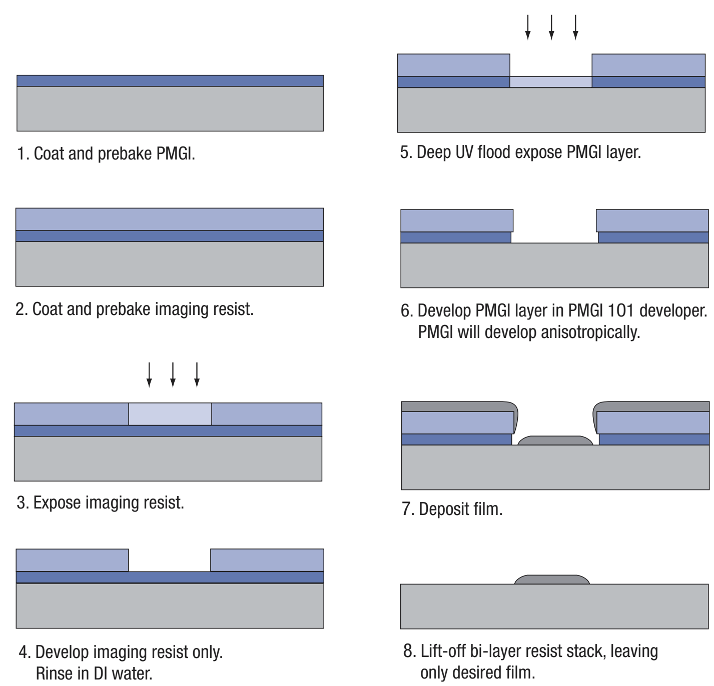
Simple Bilayer Lift-Off Process



Cap-On Bilayer Lift-Off Process

This process is recommended for applications where the desired amount of undercut is less than the thickness of the PMGI film, requiring near anisotropic development of the PMGI layer. In this process the top layer resist is imaged and becomes a mask for the exposure of the PMGI film. The wafer is subsequently DUV flood exposed to facilitate chain scission of the exposed portions of the PMGI layer, which enhances the develop rate and reduces the amount of undercut in the unexposed portions of the film. In addition to the deep UV (240-290nm) flood exposure step the cap-on process also requires a second develop step. The PMGI layer is selectively developed with PMGI 101 developer (TEAH), which will not further develop the imaging resist layer.

Cap-On Bilayer Lift-Off Process



HOW TO USE PMGI RESISTS

Substrate Preparation

To obtain maximum process reliability, substrates should be clean and dry prior to applying the PMGI resist. Start with a solvent cleaning, or a rinse with dilute acid, followed by a DI water rinse. To dehydrate the surface, bake at 200°C for 5 minutes on a contact hot plate or 30 minutes in a convection oven. PMGI resists have excellent adhesion to most semiconductor, GaAs, and thin-film head substrates. Primers such as HMDS (hexamethyldisilazane) are typically NOT required to promote adhesion with PMGI.

Coating Process

PMGI resists are designed to produce low defect coatings over a broad range of film thicknesses using a variety of spin coat conditions. The film thickness versus spin speed plots displayed in Figures 1 through 3 provide the information required to select the appropriate PMGI resist and spin conditions to obtain the desired film thickness. For clean lift-off processing, the PMGI film should be thicker than the metal deposition thickness, typically 1.2 - 1.33 times the thickness of the metal film. Spin speeds between 2,500 and 4,500 rpm generate maximum coating uniformity. Use the higher speeds for smaller substrates and lower speeds for larger substrates. Specific coat conditions are application and equipment specific. Please refer to Table 1 for a base line spin coat process.

Coating equipment should be compatible with cyclopentanone, the primary casting solvent in PMGI resists. To minimize spin bowl exhaust variability and drain-line clogging associated with mixing conventional and PMGI resists, a dedicated coat bowl and drainage system is recommended. Alternatively, PMGI and conventional resists may be used in the same system provided MicroChem's EBR PG is used for edge bead removal and spin bowl clean up.

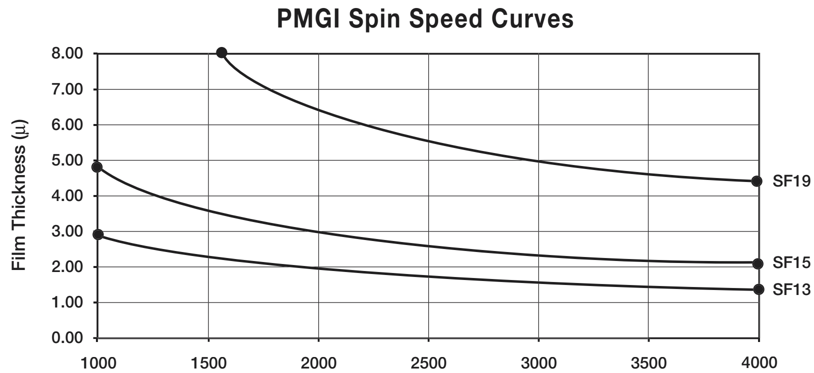


Figure 1

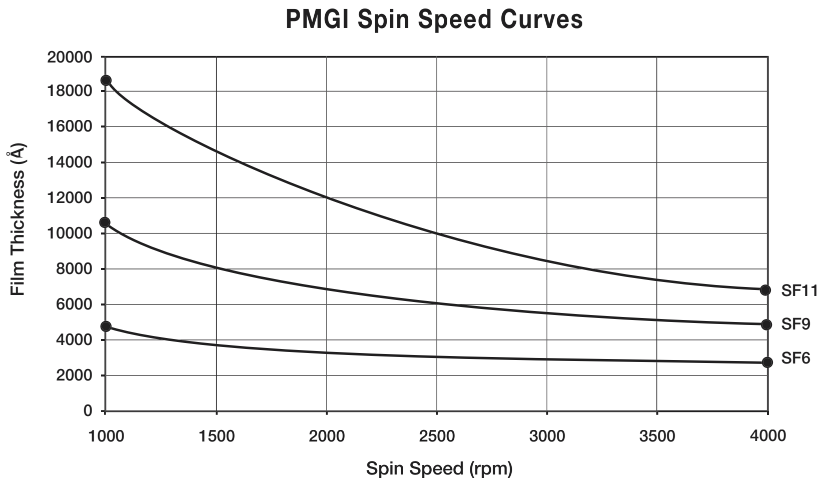


Figure 2

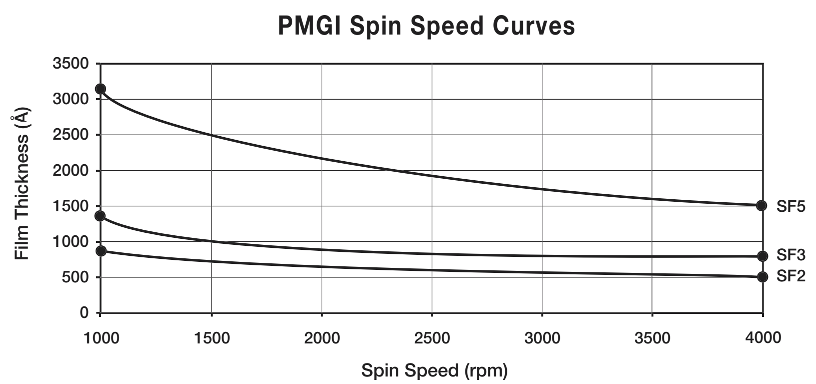


Figure 3

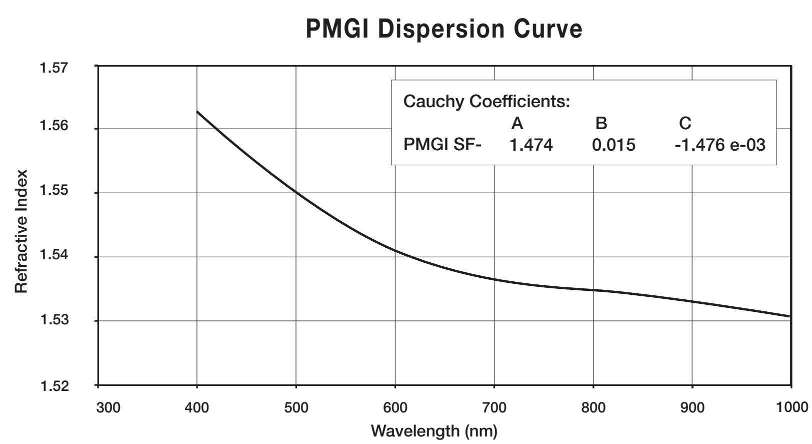


Figure 4

RECOMMENDED COATING PARAMETERS

PROCESS STEP	PROCESS PARAMETERS
Dispense volume	5 ml (150 mm Si wafer)
Dispense mode	Dynamic 3-5 seconds
Dispense spin speed	300-500 rpm
Acceleration	10,000 rpm/second
Terminal spin speed	3,000 rpm
Spin time	45 seconds
Edge bead remover	EBR PG

Table 1

Edge Bead Removal

MicroChem's EBR PG effectively removes both edge beads and whiskers, and is designed specifically for PMGI resist. EBR PG is compatible with most conventional positive resists and commercially available coating tracks. EBR PG is also an effective solvent for spin-bowl clean up and rework of unbaked wafers. Acetone and conventional resist edge-bead removers are not recommended with PMGI. See EBR PG data sheet for more details.

Prebake Process

The primary functions of the prebake process are to dry the PMGI film and to fix the development and undercut rate. Once the exposure and development processes have been defined, careful design of the prebake process enables precise control of undercut and maximum process windows. Prebake temperature is the parameter with the greatest influence on undercut rate, although prebake time, exposure dose of the imaging resist, choice of developer, develop mode and develop time are also influential.

Hot plates are typically used for prebake, although PMGI resists are compatible with convection oven processes. The recommended temperature range is between 150°C and 190°C, although PMGI may be baked up to 250°C. The relative undercut rate versus prebake temperature and time plots displayed in Figure 5 and Figure 6 provide the information required to select a baseline prebake process. A simple matrix varying prebake temperature and time is recommended for fine-tuning the process.

Undercut Rate vs Bake Temperature
Developer Type: TMAH 2.38% (0.26N)

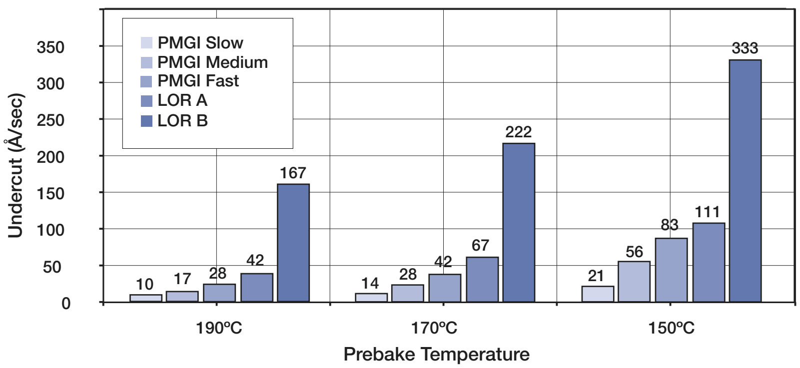


Figure 5

Undercut Rate vs Bake Temperature
Developer Type: TMAH 2.2% (0.24N) w/surfactant

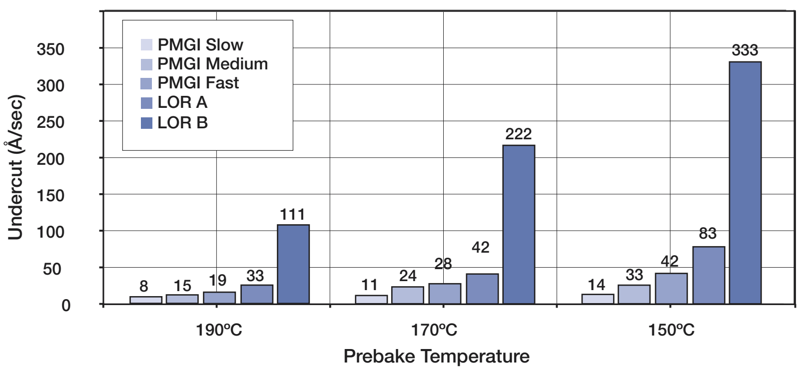


Figure 6

The data contained in the charts above was generated with immersion development processes under the conditions listed below. The data referenced in figure 5 was generated with Shipley's CD-26 developer, while the data referenced in figure 6 was generated with Shipley's MF-319 developer.

Bi-layer prebake process

PMGI film thickness: 1 µm	Photoresist Type: Shipley S1811
Bake mode: contact hotplate	S1811 film thickness: 1.1µm
Bake time: 5 minutes	Bake mode: contact hotplate
Bake temperature: see above	Bake: 115ºC for 60 seconds

APPLY AND PROCESS THE IMAGING RESIST LAYER

Refer to the imaging resist manufacturer's processing recommendations for specific processing parameters. PMGI resists are compatible with ethyl lactate and PGMEA-based g-line, I-line, broadband, deep UV and e-beam photoresists. No intermixing occurs, permitting the imaging resist to be applied and prebaked directly on top of the PMGI layer, without the need for barrier layers or plasma de-scum steps. PMGI does not require an exposure step when using the simple bi-layer lift-off process. When using the cap-on process, the PMGI layer must be deep UV (240-290nm) flood exposed. Actual exposure dose is dependent on PMGI film thickness and prebake conditions.

POST-EXPOSURE BAKE (PEB) PROCESS

PMGI does not require a post exposure bake step. Refer to the imaging resist manufacturer's process recommendations to determine whether a PEB step is required.

DEVELOPMENT PROCESS

PMGI resists are optimized for use with various metal ion free and metal ion containing developers. Factors such as developer type, normality, whether the developer contains a surfactant, develop mode, as well as other process factors involving prebake, PMGI and photoresist type and thickness all influence the develop process and subsequent resist sidewall profiles. Therefore careful consideration should be given to the resists/developer system. PMGI slow, medium and fast resists are well suited for use with TMAH 0.26N, (2.38%) developers such as NMD-3, NMD-W, Shipley's CD-26 and AZ 300MIF. PMGI fast resists are also compatible with less aggressive developers such as TMAH 0.237N, (2.2%) developers such as Shipley's MF-319, which offer enhanced process control by reducing the develop undercut rate. Refer to the undercut rate charts contained in figures 5 & 6 for recommended development times for selected developers. For more detailed information regarding your process needs, please contact your MicroChem technical sales representative or refer to the PMGI process notes, which are available on our website. www.microchem.com

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DEPOSITION PROCESS

PMGI has high thermal stability and is therefore compatible with both high temperature sputter and evaporative metal and dielectric deposition processes. The step coverage achieved in the deposition process will influence the dimensional stability.

LIFT-OFF PROCESS

Use MicroChem's Remover PG to lift-off the bi-layer resist stack. As a baseline process, use Remover PG in two tanks: at 60ºC for 30 minutes in the first tank and at 60ºC in the second tank. Ultrasonic action will improve the resist removal efficiency. Actual processing times will vary depending upon prebake conditions, step coverage and resist profiles. See our Remover PG technical data sheet for more information on this product.

PROPERTIES OF PMGI

Property	Value
Glass Transition Temperature (Tg)	190ºC
Planarization Temperature (after prebake)	250ºC - 300ºC
Degradation Temperature	335ºC

PMGI STORAGE

Store upright in original sealed containers in a dry area between 4 and 27°C (40-80°F). Keep away from sources of ignition, light, heat, oxidants, acids, and reducers. Do not use after expiration date (1 year from date of manufacture).

DISPOSING OF PMGI

Each locality, state and country has unique regulations regarding the disposal of organic solvents such as those contained in PMGI resists. It is the user's responsibility to dispose of PMGI in compliance with all applicable codes and regulations. In most cases PMGI may be included with other organic solvents for destruction or reclaim. Ensure that acetone is kept separate from PMGI waste streams, as PMGI will precipitate in the presence of acetone, which may form unwanted solids in the collection area.

PROCESSING ENVIRONMENT FOR PMGI

For optimum results, use PMGI resists in a controlled environment.

20-25° ± 1°C (68-77° ± 2°F)

35-45% ± 2% relative humidity

PMGI MATERIAL AND EQUIPMENT COMPATIBILITY

PMGI is compatible with glass, ceramic, unfilled polypropylene, high-density polyethylene, polytetrafluoroethylene (PTFE), stainless steel, and equivalent materials. PMGI resists are compatible with most commercial resist processing equipment.

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