LOR and PMGI Resists

DESCRIPTION

LOR and PMGI resists are based on polydimethylglutarimide. Its unique properties enable LOR and PMGI products to perform exceptionally well when used, either as a sacrificial layer, or as an undercut layer in bi-layer lift-off processing. LOR and PMGI resists are designed for applications requiring high resolution imaging, easy process tuning, high yields and superior deposition line width control. Mainstream applications utilizing LOR or PMGI resists include GMR & MR heads, wireless devices, opto-electronics, MEMs, and packaging.

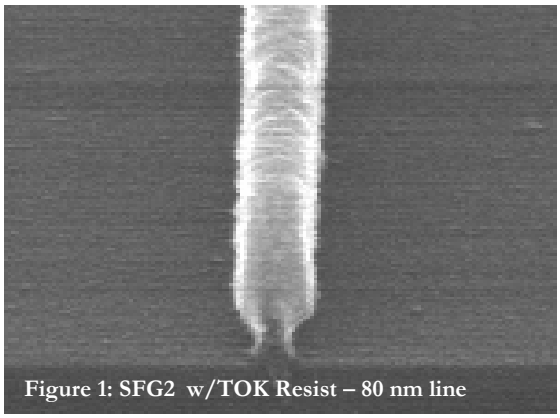


Figure 1: SFG2 w/TOK Resist – 80 nm line

BENEFITS

- **Sub 0.25µm lift-off processing.**
- **Film thicknesses for depositions from <20nm - >5µm.**
- **Dissolution Rate optimized for maximum undercut control.**
- **Simple bi-layer processing without extra flood exposure, develop, amine treatment or toxic chemical soak steps required.**
- **Superior adhesion to Si, NiFe, GaAs, InP and many other III-V materials.**
- **Compatible with g-, h-, i-line, DUV, 193nm and E-beam resists.**
- **Compatible with TMAH and metal-ion bearing developers.**
- **High thermal stability.**
- **Excellent conformal and/or planarizing formulation's available.**
- **Optically transparent formulations available.**

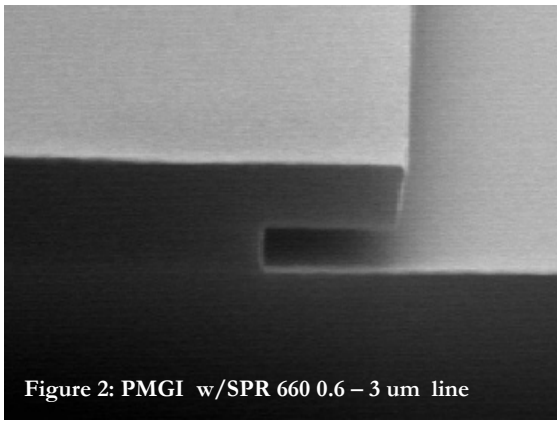


Figure 2: PMGI w/SPR 660 0.6 – 3 um line

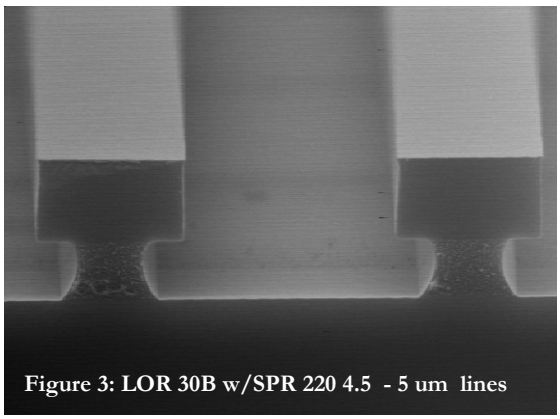
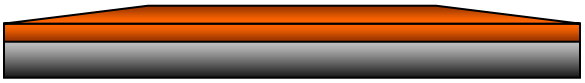
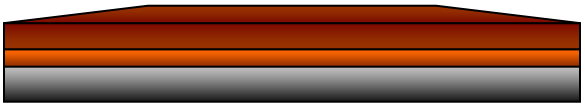


Figure 3: LOR 30B w/SPR 220 4.5 - 5 um lines

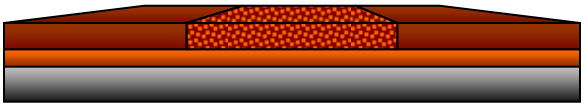
Figure 4:



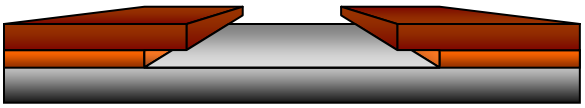
1. Coat and Soft-bake PMGI or LOR.



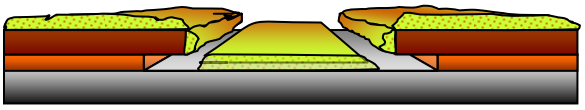
2. Coat and Soft-bake Imaging Resist.



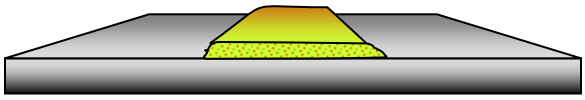
3. Expose Imaging Resist.



4. Develop resist and PMGI/LOR.



5. Deposit film.



6. Lift-off Bi-layer stack and residual deposition.

Substrate preparation

LOR/PMGI resists exhibit 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/LOR products when used as recommended.

To obtain maximum process reliability, substrates should be clean and dry prior to applying LOR resist. Start with solvent cleaning, or rinse with dilute acid, followed by 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.

Coating process

LOR and PMGI resists are designed to provide low defect level coatings over a broad film thickness range using a variety of spin-coat conditions. For clean lift-off processing, LOR/PMGI films should be thicker than the deposited metal film, typically by 25%.

Film thicknesses versus spin speed plots are included in the technical data section. Spin speeds between 2,500 and 4,500 rpm generate maximum coating uniformity. The Spin speed needs to be optimized for the substrate size and shape. Generally, higher speeds are used for smaller substrates and lower speeds for larger substrates. Substrates with deep topography or irregular shape will need to be spun slower for improved coverage.

Coating equipment should be compatible with cyclopentanone to minimize coater-bowl exhaust variability and drain-line clogging associated with mixing conventional and PMGI/LOR resists. A dedicated coat-bowl and drainage system is recommended but not mandatory.
When MicroChem EBR PG is used for clean up or edge bead removal, LOR/PMGI and conventional resists may be employed in the same system.

Edge Bead Removal

MicroChem EBR PG effectively removes both edge-beads and whiskers, and is designed specifically for LOR/PMGI resists. EBR PG is compatible with most conventional positive resists and commercially available coating tracks. Acetone and conventional resist edge-bead removers are NOT recommended with LOR/PMGI products. See the EBR PG data sheet for more details

Soft- bake/Prebake Process

The pre-bake process enables precise and reproducible control of undercut to provide maximum process windows. Pre-bake temperature shows the greatest influence on undercut rate, although pre-bake time, exposure dose for the patterning resist, choice of developer, develop mode and develop time are also influential. Refer to Figures 5a, 5b and 6.
Hot plates are the preferred tool for the pre-bake; however, LOR/PMGI resists are also compatible with convection oven processes. The recommended bake temperature range is 150°C - 200°C, although some PMGI products may be baked to 250°C. Ultimately, a matrix design varying pre-bake temperature and time is recommended for process fine-tuning.

Application and Processing the Patterning Resist Layer

Refer to the patterning resist manufacturer process recommendations for specific processing directions. LOR/PMGI products are compatible with typical g-line, i-line, broadband, deep UV, 193nm, and e-beam photoresists. The resist can be applied and pre-baked directly over PMGI without need for barrier layers or plasma de-scum steps. LOR or PMGI does not require an exposure step when using the simple bi-layer lift-off process. PMGI can also be used in a Cap-On process in which the PMGI layer must be deep-UV (240-290nm) flood exposed. The Cap-On process is typically used to obtain straighter sidewall profiles in the PMGI resist layer. For more detailed information regarding the Cap-On process, please contact your MicroChem Technical Sales Representative, or refer to the PMGI Process Notes, which are available on our website, www.microchem.com

Figure 5a:

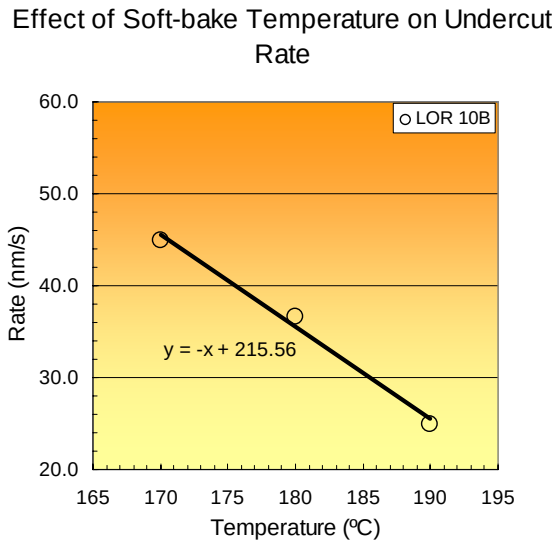


Figure 5b:

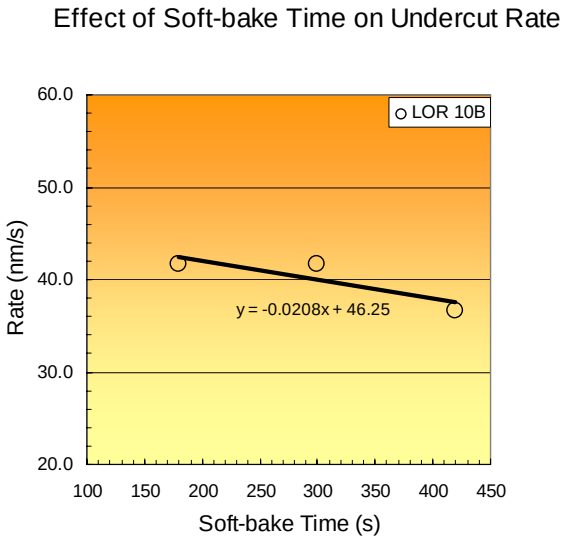
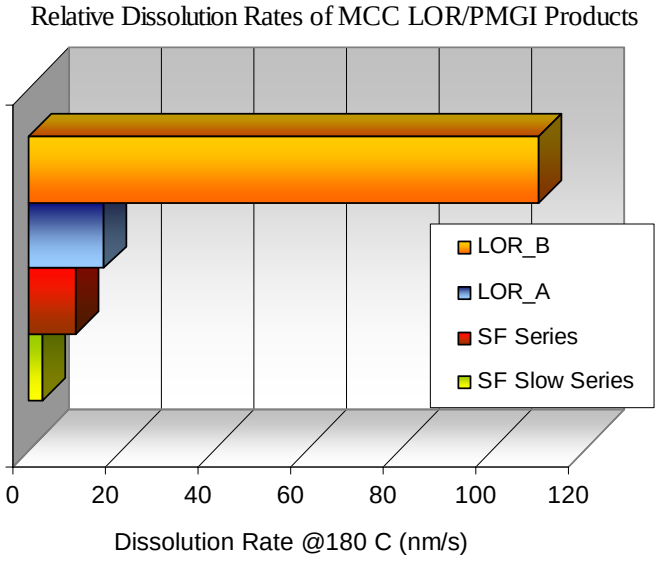


Figure 6:



Post - Exposure (PEB) Process

LOR/PMGI does not require post-exposure baking. Refer to patterning resist manufacturer process recommendations to determine whether a PEB step is required.

Development Process

LOR and PMGI resists are optimized for use with various metal ion free and metal ion containing developers. Thickness of both LOR/PMGI layer and patterning resist layer contribute ultimately to final develop time. Also, sidewall profile can be influenced by the development process. Straighter sidewalls with thick (>2 um) LOR/PMGI layers are obtained using spray development. Refer to the product selection guide to determine the best product to satisfy your application requirements. For more detailed information regarding processing needs, please contact a MicroChem Technical Sales Representative, or refer to the PMGI Process Notes, which are available on the website, www.microchem.com

Deposition Process

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

Lift-Off Process

Use MicroChem's Remover PG to remove the bi-layer resist stack. Removal rate of LOR/PMGI is dependent upon soft-bake temperature of the LOR/PMGI product and remover bath temperature. As a baseline process, use Remover PG in two tanks: at 60ºC for 30 minutes in the first tank and rinse at 60ºC in the second tank. Ultrasonic action will improve the resist removal efficiency. Actual processing times will vary depending upon pre-bake conditions, step coverage and resist profiles. Figure 9 demonstrates the effect of temperature on the removal process. Consult the Remover PG technical data sheet for more information on this product.

Figure 7:
The Effect of Developer Type on Dissolution Rate

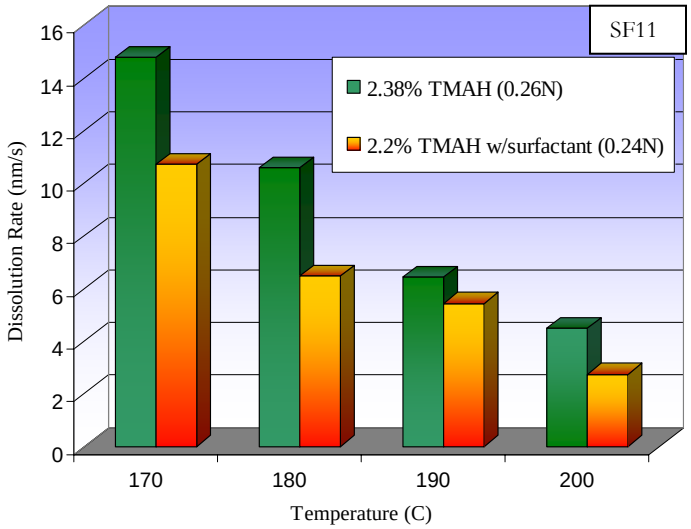
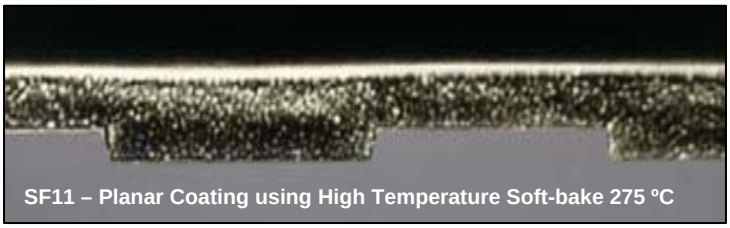


Figure 8:



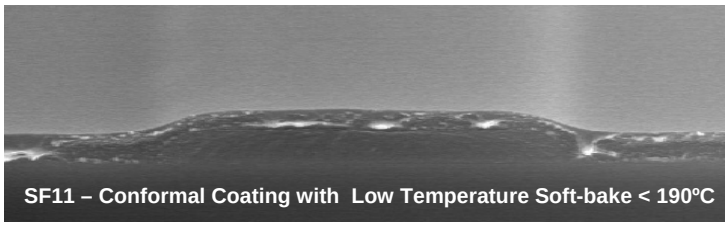
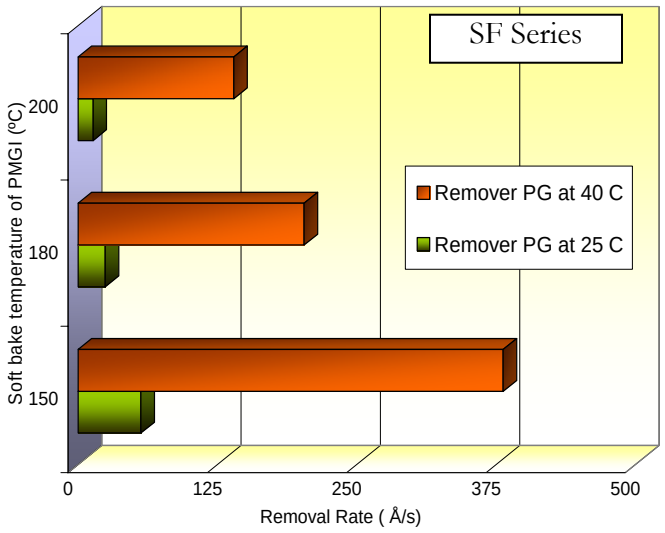


Figure 9:
Removal Rate of PMGI in Remover PG at 25 and 40 ºC



Technical Data

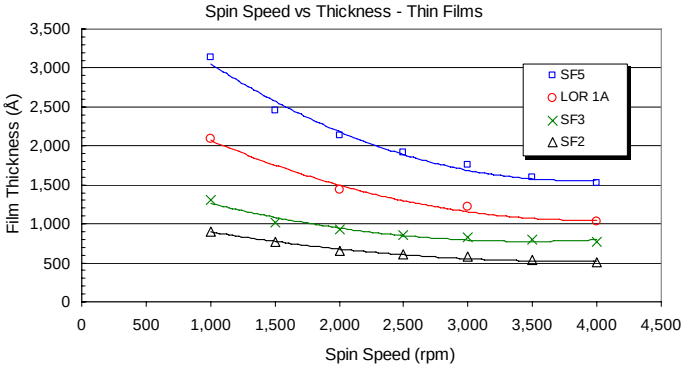


Table 1: Optical Constants for LOR/PMGI Products								
	436		365		248		193	
	n	k	n	k	n	k	n	k
SF	1.557	0.000	1.574	0.000	1.676	0.022	1.526	0.083
SF_S	1.553	0.000	1.570	0.000	1.669	0.020	1.560	0.104
LOR_A	1.588	0.008	1.581	0.058	1.675	0.041	1.578	0.138
LOR_B	1.595	0.000	1.640	0.027	1.711	0.044	1.519	0.184

- Products were soft-baked at 180 °C for 3 min

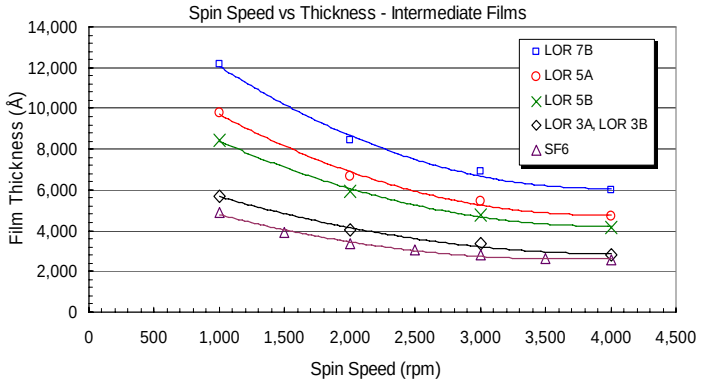
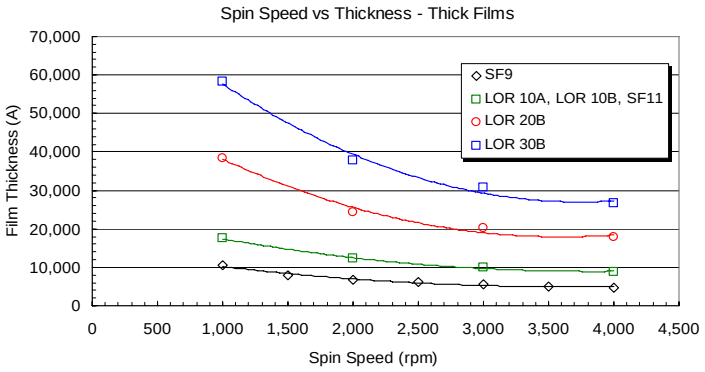
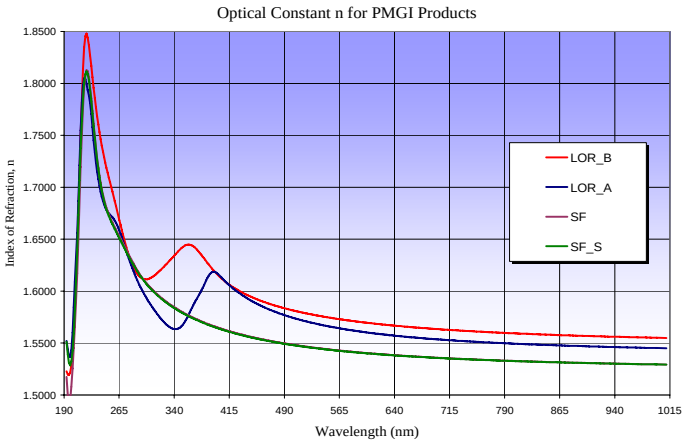


Table 2: Cauchy Parameters for LOR/PMGI in the Transparent Region				
Product	An	Bn	Cn	Wavelength Range (nm)
SF	1.524	5.176E-03	2.105E-04	300 - 1700
SF_S	1.522	5.052E-03	2.113E-04	300 - 1700
LOR_A	1.537	5.636E-03	7.984E-04	500 - 1700
LOR_B	1.547	5.912E-03	6.190E-04	430 - 1700





RECOMMENDED COATING 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 3: Viscosity and Density Data		
Product Film Thickness @ 3000 rpm	Approximate Viscosity, cSt	Approximate Density, g/ml
50 nm	2	0.96
100 nm	3	0.97
200 nm	7	0.97
300 nm	11	0.98
500 nm	25	0.98
1 um	115	0.99
2 um	450	1.00
3 um	750	1.00

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LOR/PMGI Product Selection Guide

Attributes		LOR A	LOR B	SF	SF Slow
Undercut Geometry	<0.35um			☆	★
	0.35 - 0.5um	★		★	
	0.5 - 1um	★	★		
	>1 um		★	☆ 3	☆ 3
Thickness Range	<100nm			★	★
	0.1um - 1um	★	★	★	★
	1 - 5 um	☆ 4	★	☆ 3	☆ 3
Temperature Range	<150 C				
	150 - 190 C	★	★	☆ 1,2	☆ 1,2
	>190 C			★	★
Developer Compatibility	0.26N MIF	★		★	★
	0.24N MIF	★	★	★	★
	MIB		★		
Resist Solvent Compatibility	Ethyl Lactate	★ 2	★ 2	★ 2	★ 2
	PGMEA	★	★	★	★
	2-Heptanone	★	★	★	★
	Cyclohexanone	★	★	★	★
Substrate Compatibility	Si	★	★	★	★
	Glass	★	★	★	★
	NiFe	★	★	★	★
	III-V Metals	★	★	★	★
	Au	★	★	★	★
Coating	Conformal	★	★	★	★
	Planar & Via-fill			☆ 5	☆ 5

1. Adhesion loss can occur with reworked substrates when soft-baking the PMGI with temperatures lower than 180 °C.
2. Intermixing can occur with Ethyl Lactate based resists at temperatures below 180 °C.
3. A Cap-On Process or an additional exposure of the PMGI layer can be used to achieve excellent results.
4. Compatible up to 3um in thickness.
5. High temperatures >250 °C needed for reflow.

Handling LOR/PMGI

Use precautions for combustible mixtures with cyclopentanone when handling LOR products. Avoid contact with eyes, skin, and clothing. Use with adequate ventilation and avoid breathing fumes. Wear chemical-resistant eye protection, chemical gloves, and protective clothing when handling LOR products.
LOR resists cause irritation in case of contact with eyes, skin, and mucous membranes. In case of eye contact, flush with water for 15 minutes and call a physician immediately. Review the current product Material Safety Data Sheet before using.

LOR/PMGI Material and Equipment Handling

LOR/PMGI is compatible with glass, ceramic, unfilled polypropylene, high-density polyethylene, polytetrafluoroethylene, stainless steel, and equivalent materials. LOR/PMGI products are compatible with most commercial resist processing equipment.

Processing Environment for LOR/PMGI

For optimum results, use LOR resists in a controlled environment.
20-25° ± 1°C (68-77° ± 2°F)
35-45% ± 2% relative humidity

LOR/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 the expiration date (1 year from date of manufacture).

Disposing of LOR/PMGI

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

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