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LOR™ Lift-Off Resists

LOR RESISTS OFFER

- Submicron linewidth control
- Finely tuned undercuts
- Does not intermix with imaging resists (no scum)
- Excellent adhesion to Si, NiFe, GaAs, InP and many other III-V and II-VI materials
- Simple bi-layer processing without extra flood exposure, develop, amine treatment or toxic chemical soak steps
- Formulations for deposition processes up to 5 µm

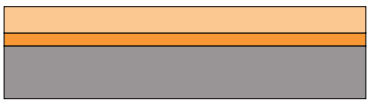
TYPES OF RESISTS

The LOR line of resists include two series:

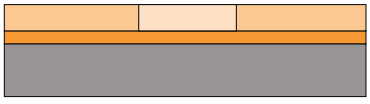
- LOR A series have relatively low dissolution rates and offer superb undercut control. They are ideally suited for thin-film processes with .26N metal-ion-free developers such as Shipley's CD-26 and TOK's NMD-3.
- LOR B series have relatively high dissolution rates, which makes them ideally suited for thick-film processes. They are optimized for metal-ion-bearing developers such as AZ 400K 1:4, as well as low normality metal-ion-free developers such as Shipley's MF-319.

MicroChem's line of LOR lift-off resists are based on the PMGI (polydimethylglutarimide) platform and are well suited for a variety of critical and non-critical level lift-off processes. Used in combination with conventional positive resists, LORs are available in a wide range of film thicknesses and undercut rates. LORs address the process requirements for GMR and MR heads, wireless devices, opto-electronics such as semiconductor lasers and detectors, MEMS and many other microelectronic applications requiring easy process tuning, high yields and superb deposition linewidth control.

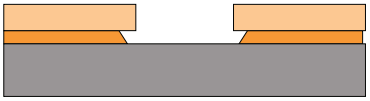
1. Coat and prebake LOR



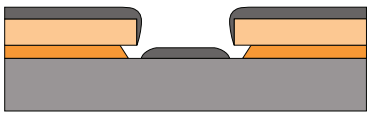
2. Coat and prebake imaging resist



3. Expose imaging resist



4. Develop resist and LOR. LOR develops isotropically, creating a bi-layer reentrant sidewall profile



5. Deposit film. The re-entrant profile ensures discontinuous film deposition.

6. Lift-off bi-layer resist stack, leaving only desired film.

HOW TO USE LOR RESISTS

Substrate preparation

To obtain maximum process reliability, substrates should be clean and dry prior to applying the LOR 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. LOR 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 LOR.

Coating process

LOR 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 and 2 provide the information required to select the appropriate LOR resist and spin conditions, based upon the desired film thickness. For clean lift-off processing, the LOR film should be thicker than the metal deposition thickness, typically 1.2 to 1.3 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. Table 1 offers a recommended baseline process for a metal-ion-free developer process. For suggested baseline processes for other LOR A products and LOR B resists, please visit our website:

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Spin speed vs film thickness for LOR A series resists.
Other film thicknesses available upon request.

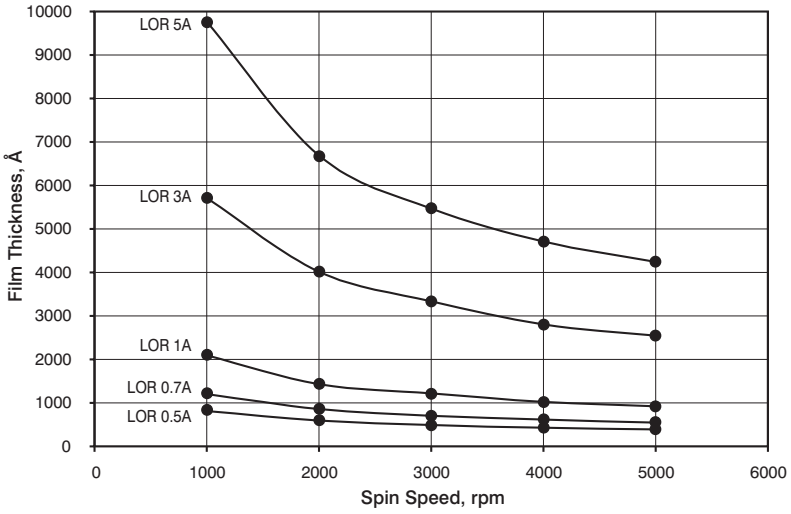

Figure 1

Spin speed vs thickness for LOR B series resists.
Other film thicknesses available upon request.

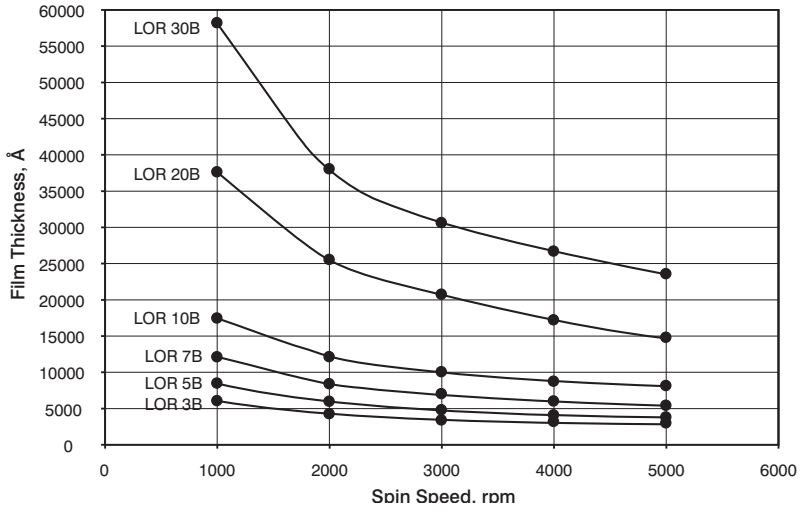

Figure 2

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

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

NOTE: MicroChem's EBR PG is a safer solvent system that is compatible with LOR as well as PGMEA- and ethyl lactate-based imaging resists. EBR PG will not cause LOR to precipitate and is recommended when LOR and imaging resists are run on the same coating tool.

Dispersion curve for LOR A and B resists.

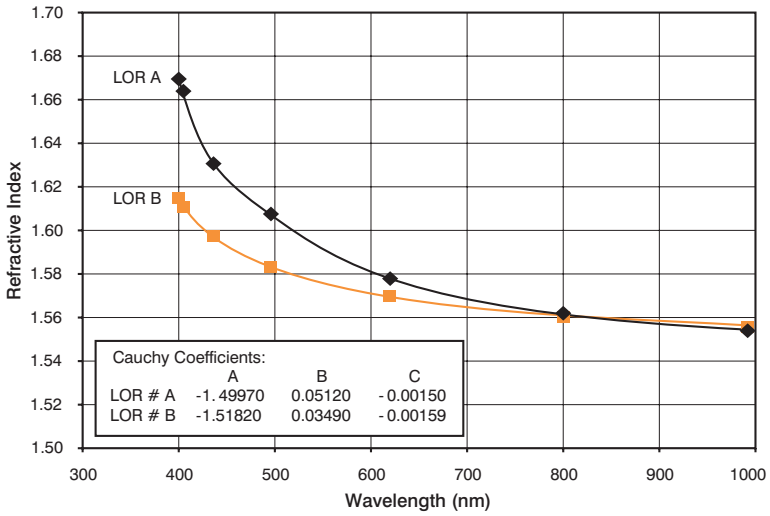

Figure 3

Edge bead removal

MicroChem's EBR PG effectively removes both edge beads and whiskers, and is designed specifically for LOR 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 LOR. See EBR PG data sheet for more details.

Edge Bead Removal - Continued

The primary functions of the prebake process are to dry the LOR 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, and develop time are also influential.

Hot plates are typically used for prebake, although LOR resists are compatible with convection oven processes. The recommended temperature range is between 150°C and 190°C. The relative undercut rate versus prebake temperature and time plots displayed in Figure 4 and Figure 5 provide the information required to select a baseline prebake process. Running a simple matrix varying prebake temperature and time is recommended for fine-tuning the process.

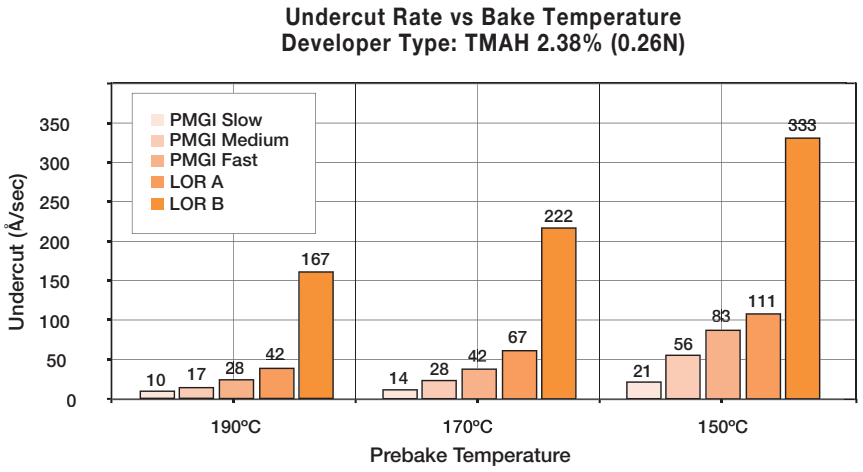

Figure 4

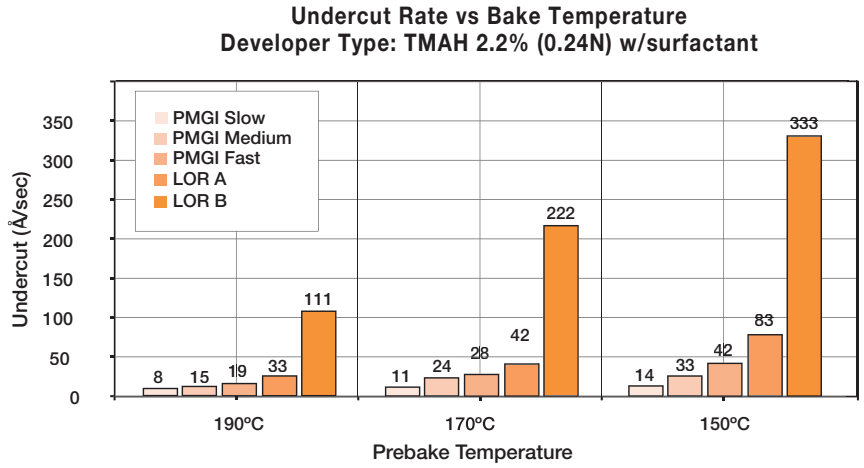

Figure 5

The data contained in the charts above was generated with immersion development processes under the conditions listed below. The data referenced in figure 4 was generated with Shipley's CD-26 developer, while the data referenced in figure 5 was generated with Shipley's MF-319 developer.

Bi-layer prebake process

PMGI/LOR film thickness: 1 µm
Bake mode: contact hotplate
Bake time: 5 minutes
Bake temperature: see above

Photoresist Type: Shipley S1811
S1811 film thickness: 1.1µm
Bake mode: contact hotplate
Bake: 115ºC for 60 seconds

APPLY AND PROCESS THE TOP LAYER IMAGING RESIST

Refer to the imaging resist manufacturer's processing recommendations for specific processing parameters. LOR resists are compatible with ethyl lactate and PGMEA-based g-line, i-line, broadband, and DUV imaging resists. No intermixing occurs, permitting the imaging resist to be applied and prebaked directly on top of the LOR resist, without the need for barrier layers or plasma descum steps. LOR resists do not require an additional exposure step to produce the desired develop selectivity and undercut profile.

POST-EXPOSURE BAKE PROCESS

Refer to the imaging resist manufacturer's technical data sheet for post-exposure bake recommendations. Post-exposure bake processing does not influence the performance characteristics of LOR resists.

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DEVELOPMENT PROCESS

LOR resists are optimized for metal-ion-free and metal-ion-bearing developers. LOR A products are ideal for .26N TMAH metal-ion-free developers, such as NMD-3 and CD-26. The LOR B products are more sensitive and designed to provide superb undercut process control for lower normality metal-ion-bearing/metal-ion-free developers such as AZ400K 1:4 and Shipley's MF-319.

METAL DEPOSITION PROCESS

The step coverage achieved in the deposition process will influence the dimension fidelity.

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 60°C for 30 minutes in the first tank and at 60°C for 30 minutes in the second tank. Ultrasonic action will improve the strip efficiency. Actual processing times may need to be adjusted depending upon prebake, step coverage, and profile used. See EBR PG data sheet for more details.

HANDLING LOR

Use precautions for handling 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 MATERIAL AND EQUIPMENT COMPATIBILITY

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

PROCESSING ENVIRONMENT FOR LOR

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

20-25° ± 1°C (68-77° ± 2°F)

35-45% ± 2% relative humidity

LOR 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 LOR

Each locality, state, and country has unique regulations regarding the disposal of organic solvents such as LOR resists. It is the user's responsibility to dispose of LOR in compliance with all applicable codes and regulations. In most cases, LOR may be included with other organic solvents for destruction or reclaim.

Ensure that acetone and resist waste is kept separate from LOR waste streams. LOR 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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