ELECTRONIC MATERIALS
MICROELECTRONIC TECHNOLOGIES

MEGAPOSIT™ SPR™3000 SERIES PHOTORESIST

For Microlithography Applications

DESCRIPTION

Megaposit SPR3000 Series Photoresist is a positive photoresist engineered for i-Line, g-Line and broadband applications with high throughput and excellent process latitudes. The resist is optimized to provide maximum performance with robust process latitudes over a wide range of exposure wavelengths. This versatility makes it ideally suited for a number of applications, especially mix and match lithography.

ADVANTAGES

Coating Properties

- Glycol ether- and xylene-free solvent system
- Excellent adhesion
- Superior coating uniformity

Exposure Properties

- Sensitive to i-Line, g-Line and broadband exposure
- Dyed versions optimized for linewidth control over reflective topography

Develop Properties

- Extremely versatile to provide robust process latitudes in a wide variety of developer families
- Microposit™ MF™-319 Developer or Megaposit MF-701 Developer is recommended for a high-resolution process
- Microposit MF-320 Developer is recommended for a high throughput process

Removal Properties

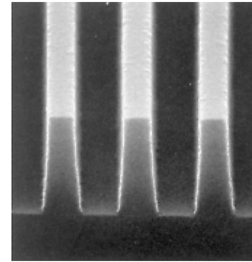
- Residue-free photoresist removal using standard Microposit Removers

Table 1. Process Conditions (Refer to Figure 1)

Substrate	100 mm Silicon
Photoresist	SPR3012
Thickness	As Indicated
Softbake	95°C/60 sec. Contact Hotplate
Exposure	As Indicated
PEB	115°C/60 sec. Contact Hotplate
Develop	As indicated/60 sec. Single Spray Puddle @ 21°C

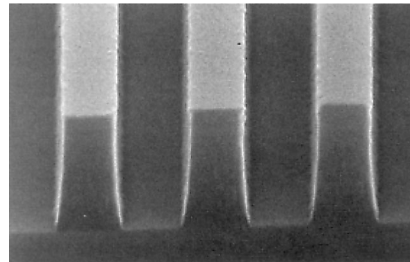
Figure 1. Masking Linearity SEMs

i-Line



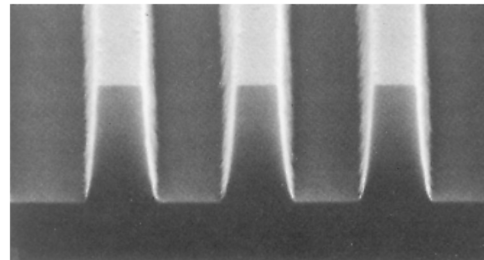
0.350 µm Lines/Spaces
Thickness: 9,675 Å ($E_{0\ max}$)
Exposure: GCA XLS 7200 (0.55 NA), 140 mJ/cm²
Developer: MF-701

g-Line



0.600 µm Lines/Spaces
Thickness: 11,700 Å ($E_{0\ max}$)
Exposure: GCA AutoStep 200 (0.42 NA), 182 mJ/cm²
Developer: MF-319

Ultratech (390–450 nm)



0.650 µm Lines/Spaces
Thickness: 11,675 Å ($E_{0\ max}$)
Exposure: Ultratech 1000 (0.34 NA), 171 mJ/cm²
Developer: MF-319

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SUBSTRATE PREPARATION

Megaposit SPR3000 Photoresist works well with hexamethyldisilazane (HMDS)-based Microposit primers. Concentrated primer is recommended when vacuum vapor priming, and diluted primer is recommended for liquid phase applications.

COAT

Megaposit SPR3000 Photoresist provides uniform, defect-free coatings. *Figure 2* illustrates the relationship between film thickness and spin speed. Optimal coating uniformity is typically achieved between 3,500 rpm and 5,500 rpm when using substrate sizes of 150 mm or less and between 2,000 rpm and 3,500 rpm when using 200 mm substrates. Nominal film thickness and uniformity may differ slightly due to process, equipment and ambient variables. A baseline coating process is outlined in *Table 3*.

Figure 2. Spin Speed vs. Thickness

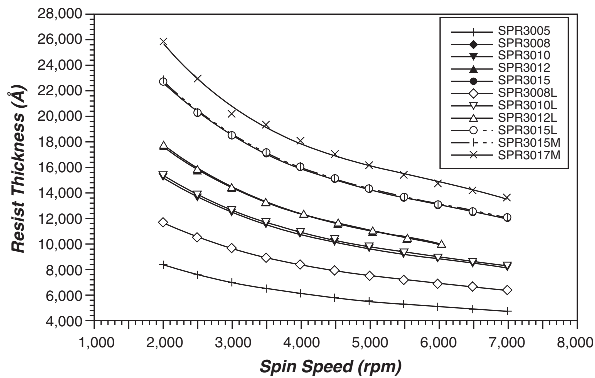

Table 2. Process Conditions (Refer to Figure 2)	
Substrate	100 mm Silicon
Softbake	95°C for 60 sec. Contact Hotplate
Thickness Tool	Nanometrics Nanospec 210

Table 3. Baseline Coating Parameters	
Operation	**Process Parameters**
Photoresist Volume	1 ml/inch of wafer diameter
Dispense Mode	Dynamic 3–5 seconds
Dispense Spin Speed	700–1,000 rpm
Acceleration Rate	10 Krpm/seconds
Final Spin Speed	3,500–5,500 rpm (≤150 mm wafers) 2,000–3,500 rpm (200 mm wafers)
Spin Time	30 seconds
Edge Bead Removal	Micrposit EDGE BEAD REMOVER EBR-10A

FILM THICKNESS MEASUREMENT

A refractive index of 1.64 is recommended with SPR3000 photoresist for film thickness tools requiring a fixed refractive index. The dispersion curves and the Cauchy equation displayed in *Figure 3* describe the relationship of the photoresists' refractive indices and the wavelength of light upon the film. *Table 4* summarizes specific Cauchy coefficients with a Prometrix Spectra Map SM300.

Table 4. Prometrix SM300 Cauchy Coefficients

Photoresist	n_1	n_2	n_3
SPR3012	1.6041	1.639e+06	-3.285e+09
SPR3012L	1.6070	1.816e+06	1.107e+10
SPR3012M	0.5983	1.601e+06	-1.173e+10

Figure 3. Dispersion Curve

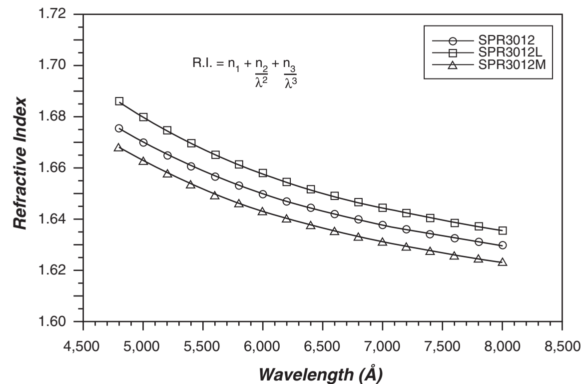

Table 5. Process Conditions (Refer to Figure 3)	
Substrate	100 mm Silicon
Prime	YES Vapor Prime Oven
Coat	GCA 1006 Microtrack
Thickness	SPR3012 (12,359Å) SPR3012L (12,427Å) SPR3015M (15,640Å)
Softbake	95°C/60 sec. Contact Hotplate
Measure	Prometrix SM 300

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SOFTBAKE

The main purpose of softbake is to reduce casting solvent and promote adhesion. Softbake temperatures and time can be application specific. Process optimization is recommended to enhance the lithographic performance of all resist systems. The following conditions are recommended for baseline processing with SPR3000 photoresist.

Table 6. Softbake Temperature and Time

Temperature	95°C
Time	60 sec. Contact Hotplate 90 sec. Proximity Hotplate

EXPOSE

Megaposit SPR3000 Series Photoresist can be exposed with light sources in the spectral range of 300 nm to 440 nm. The exposure properties have been optimized to maintain maximum performance for broadband, g-Line or i-Line applications. *Figures 4–6* display the absorbance spectra for SPR3000 Photoresists. *Table 7* summarizes the Dill parameters for SPR3000. Dill parameters are used in optical models, such as SAMPLE and PROLITH.

Figure 4. SPR3012 Absorbance Spectrum

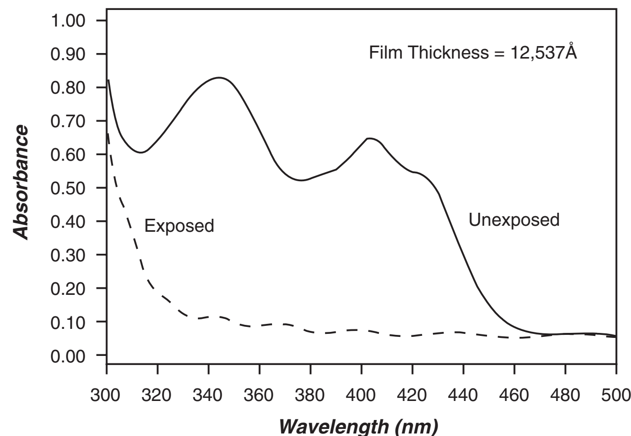

Figure 5. SPR3012L Absorbance Spectrum

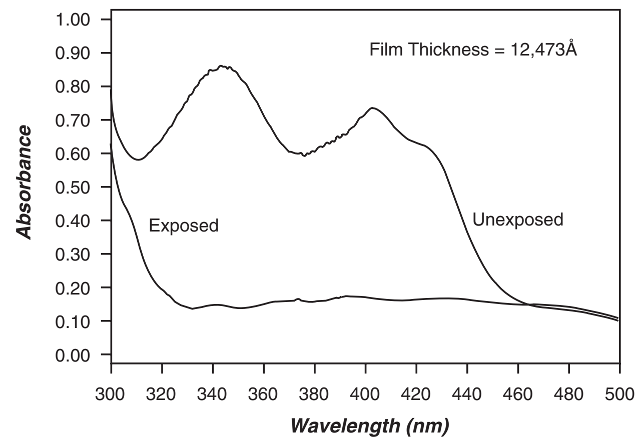

Figure 6. SPR3015M Absorbance Spectrum

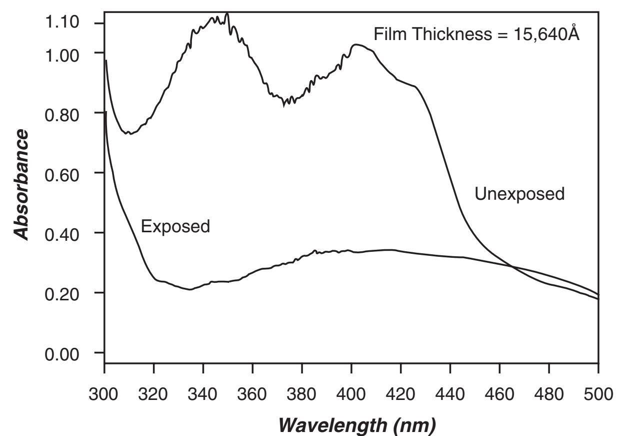

Table 8. Process Conditions (Refer to Figures 4–6)

Substrate	Glass
Photoresist	As Indicated
Thickness	As Indicated
Softbake	95°C/60 sec. Contact Hotplate
Exposure	Oriel Broadband Scanning Wedge
Measure	Hewlett Packard 8450A Spectrometer

Table 7. Dill Parameters

Wavelength	365 nm		405 nm		436 nm	
Dill Parameter	**A (µm)-1**	**B (µm)-1**	**A (µm)-1**	**B (µm)-1**	**A (µm)-1**	**B (µm)-1**
SPR3012	0.948	0.061	1.090	0.028	0.597	0.019
SPR3012L	0.925	0.195	1.047	0.235	0.535	0.242
SPR3015M	0.900	0.376	1.009	0.443	0.519	0.424

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Proper thickness selection is essential in reducing photospeed and critical dimension variability across topography. The interference curves displayed in *Figures 7 and 8* illustrate the Bulk E_0 photospeed variability across varying film thicknesses for the 365 nm (i-Line) wavelength. *Figures 9 and 10* illustrate the Bulk E_0 photospeed variability across varying film thicknesses for the 436 nm (g-Line) wavelength. Dyed versions of SPR3000 photoresists reduce reflective notching, which is more prominent on highly reflective substrates. The process parameters used for *Figures 7–10* are displayed on the next page.

Table 9. Process Conditions (Refer to Figure 7 & 8)	
Substrate	100 mm Silicon
Prime	YES Vapor Prime Oven
Coat Track	GCA 1006 Microtrack
Softbake	95°C/60 sec. Contact Hotplate
Exposure	GCA XLS 7200 i-Line (0.55 NA)
PEB	115°C/60 sec. Contact Hotplate
Developer	MF-319/60 SSP @ 21°C (TC U)

Figure 7. SPR3012/SPR3012L i-Line Interference Curves

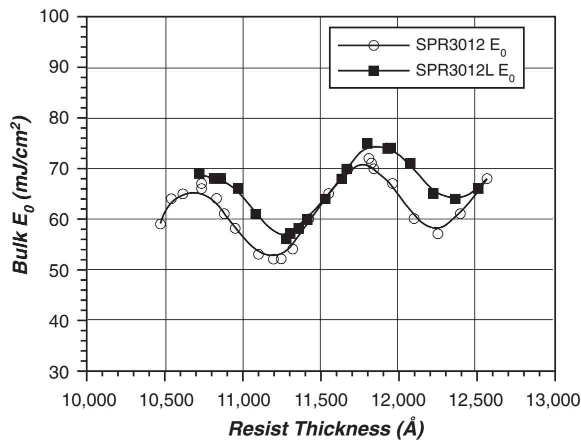

Figure 9. SPR3012/SPR3012L g-Line Interference Curves

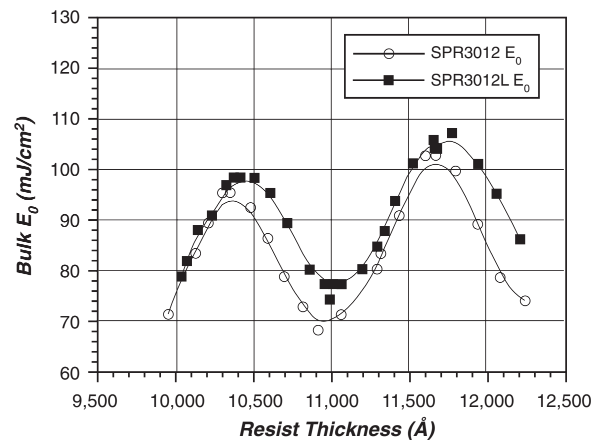

Figure 8. SPR3017M i-Line Interference Curves

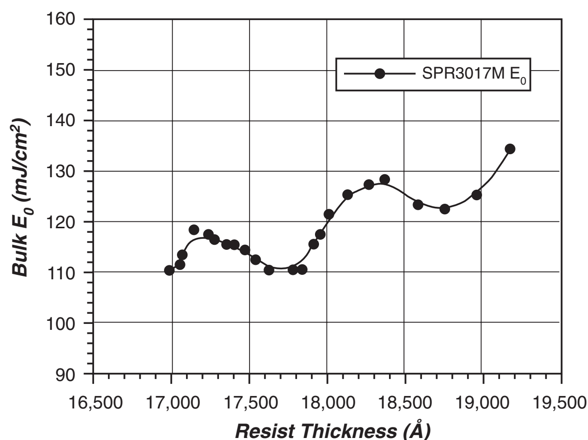

Figure 10. SPR3015M g-Line Interference Curves

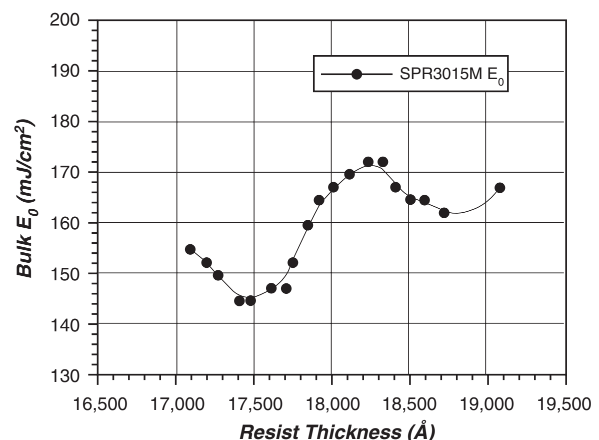

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Table 10. Process Conditions (Refer to Figure 9 & 10)	
Substrate	100 mm Silicon
Prime	YES Vapor Prime Oven
Coat Track	GCA 1006 Microtrack
Softbake	95°C/60 sec. Contact Hotplate
Exposure	GCA ALS 200 g-Line (0.42 NA)
PEB	115°C/60 sec. Contact Hotplate
Developer	MF-319/60 SSP @ 21°C (TC U)

POST-EXPOSURE BAKE

The post-exposure bake will reduce standing-wave interference effects, especially for monochromatic light sources. A post-exposure bake typically increases resolution and extends process latitudes. Post-exposure bake temperatures and times can be application specific, and process optimization is recommended. The following process conditions are baseline post-exposure bake recommendations for SPR3000 photoresist.

Table 11. Post-exposure Bake Temperature and Time	
Temperature	115°C
Time	60 sec. Contact Hotplate 90 sec. Proximity Hotplate

DEVELOP

Megaposit SPR3000 Photoresist has been optimized for use with the Microposit MF-319 Developer family. Immersion, spray or spray/puddle develop processes can be used. While Microposit MF-319 Developer or Megaposit MF-701 Developer is recommended for a high-resolution process and Microposit MF-320 Developer is recommended for a high-throughput process, SPR3000 photoresists perform well with a variety of developer families and over a wide range of wavelengths, showing the versatility of this process. A single spray/puddle develop process is recommended for a baseline process, and is outlined in *Table 12*.

Table 14 (next page) illustrates the lithographic capability of the Megaposit SPR3000 Series Photoresists in MF-319, MF-320, MF CD-26, MF-503 and MF-701 developers for g-Line and broadband applications. Application Engineering documents containing plots and SEMs are available for each process listed in *Table 14*. Contact your Rohm and Haas Electronic Materials Technical Sales Representative for specific literature packages.

Table 12. Baseline Single Spray/Puddle Develop Process

Step	Operation	Process Speed/Time
1	Develop Spray (Puddle Build)	50 rpm for 5 sec.
2	Static Puddle Dwell	0 rpm for 60 sec.
3	D.I. Rinse	500 rpm for 15 sec.
4	D.I. Rinse	800 rpm for 5 sec.
5	Spin Dry	4,500 rpm for 15 sec.

Table 13. Process Parameters (Refer to Table 14)

	SPR3000	SPR3000L	SPR3000M
Substrate	100 mm Silicon	100 mm Silicon	100 mm Silicon
Prime	HMDS (VVP)	HMDS (VVP)	HMDS (VVP)
Resist	SPR3012	SPR3012L	SPR3012M
Softbake	95°C/60 sec. Contact Hotplate	95°C/60 sec. Contact Hotplate	95°C/60 sec. Contact Hotplate
Thickness i-Line g-Line Ultratech*	 9,675Å (E_0 max) 11,700Å (E_0 max) 11,675Å (E_0 max)	 9,675Å (E_0 max) 11,700Å (E_0 max) 11,675Å (E_0 max)	 18,300Å (E_0 max) 18,300Å (E_0 max) 18,300Å (E_0 max)
Exposure i-Line g-Line Ultratech	 GCA XLS 7200 (0.55 NA) GCA ALS 200 (0.42 NA) Ultratech 1000 (0.34 NA)	 GCA XLS 7200 (0.55 NA) GCA ALS 200 (0.42 NA) Ultratech 1000 (0.34 NA)	 GCA XLS 7200 (0.55 NA) GCA ALS 200 (0.42 NA) Ultratech 1000 (0.34 NA)
PEB	115°C/60 sec. Contact Hotplate	115°C/60 sec. Contact Hotplate	115°C/60 sec. Contact Hotplate
Developer	As Indicated	As Indicated	As Indicated
Develop Process	60 sec. SSP @ 21°C	60 sec. SSP @ 21°C	60 sec. SSP @ 21°C

*390–436 nm

Table 14. Lithographic Capability Summary

	Nominal CD (μm)	Sizing Engergy (mJ/cm²)	E_s/E_0 Ratio	Masking Linearity (μm)*	Focus Latitude (μm)**	Exposure Latitude (μm)***
SPR3012 i-Line						
MF-319	0.500	114	1.84	0.375	1.50	35.1
MF-320	0.500	84	1.65	0.375	1.50	29.4
MF CD-26	0.500	90	1.80	0.375	1.50–1.65	37.8
MF-503	0.500	128	2.10	0.350	1.50	41.4
MF-701	0.500	136	2.03	0.350	≥1.50	30.9
	0.400	135	2.01	0.350	1.20	25.9
	0.375	137	2.04	0.350	1.00	16.8
g-Line						
MF-319	0.800	182	1.72	0.600	≥3.2	37.2
	0.700	179	1.69	0.600	3.00	27.4
	0.650	179	1.69	0.600	2.20	17.3
MF-320	0.800	160	1.88	0.600	≥3.20	31.3
	0.700	160	1.88	0.600	≥2.80	25.6
	0.650	160	1.88	0.600	2.20	20.0
MF CD-26	0.800	135	1.55	0.650	≥3.20	≥29.6
	0.700	135	1.55	0.650	2.40	22.2
MF-503	0.800	195	1.81	0.600	≥4.50	36.9
	0.700	196	1.81	0.600	3.30	32.7
	0.650	196	1.81	0.600	3.00	23.5
Ultratech						
MF-319	0.800	166	1.60	0.650	≥4.00	32.7
	0.700	164	1.58	0.650	3.00	25.6
MF-320	0.800	123	1.58	0.650	2.50	30.9
	0.700	124	1.59	0.650	2.00	18.5
SPR3012L i-Line						
MF-319	0.500	117	1.95	0.375	0.150	38.5
g-Line						
MF-319	0.800	227	2.00	0.550	≥3.20	37.4
	0.700	224	1.98	0.550	≥3.20	31.3
	0.650	221	1.96	0.550	≥3.20	24.8
SPR3017M i-Line						
MF-319	0.800	259	1.79	0.500	1.50	33.2
MF-319	1.000	357	1.79	0.700	3.30	31.6
	0.900	358	1.79	0.700	3.00	29.2
	0.800	356	1.79	0.700	2.70	22.8

*Masking Linearity: Reported at best focus and noted sizing energy. Reported value is the smallest resolved feature with a linear fit that remains within ±10% of the nominal CD.
**Focus Latitude: Maximum focal range where full film thickness is maintained, and CDs are within ±10% of the target CD.
***Exposure Latitude: CD vs. exposure dose is plotted and a curve fit is applied. Exposure latitude is calculated at ±10% of the target Cd.

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HARDBAKE/DUV CURE

Performing a hardbake and/or a DUV cure after develop improves stability and adhesion during etch, plating and ion implant. *Figure 11* demonstrates the thermal flow characteristics of 1.00 µm lines/spaces and a 100 µm bulk pad area. *Figure 12* shows the DUV cure characteristics for 1.00 µm lines/spaces and 15 µm bulk pads. Complete DUV cure process conditions can be obtained through a Rohm and Haas Electronic Materials technical sales representative.

PHOTORESIST REMOVAL

Megaposit SPR3000 Series Photoresist can be removed using Microposit Remover 1165 or Microposit Remover 1112A with or without an oxygen plasma strip. A two-bath removal system is recommended—the first to remove the bulk of the photoresist and the second to remove any remaining traces of photoresist. Consult specific remover data sheets for additional process information.

Table 15. Process Parameters (Refer to Figure 11)

Parameter	Value
Substrate	100 mm Silicon
Prime	HMDS (VVP)
Thickness	11,700Å
Softbake	95°C/60 sec. Contact Hotplate
Exposure	GCA ALS 200 (0.42 NA)
PEB	115°C/60 sec. Contact Hotplate
Develop	MF-319/60 sec. SSP @ 21°C
Hardbake Temp.	As Indicated
Hardbake Time	60 sec. Contact Hotplate

Table 16. Process Parameters (Refer to Figure 12)

Parameter	Value
Substrate	100 mm Silicon
Prime	HMDS (VVP)
Thickness	11,700Å
Softbake	95°C/60 sec. Contact Hotplate
Exposure	GCA ALS 200 (0.42 NA)
PEB	115°C/60 sec. Contact Hotplate
Develop	MF-319/60 sec. SSP @ 21°C
DUV Equipment	Fusion 200 PCV
DUV Cure Temp.	As Indicated

Figure 11. Hardbake Thermal Characteristics

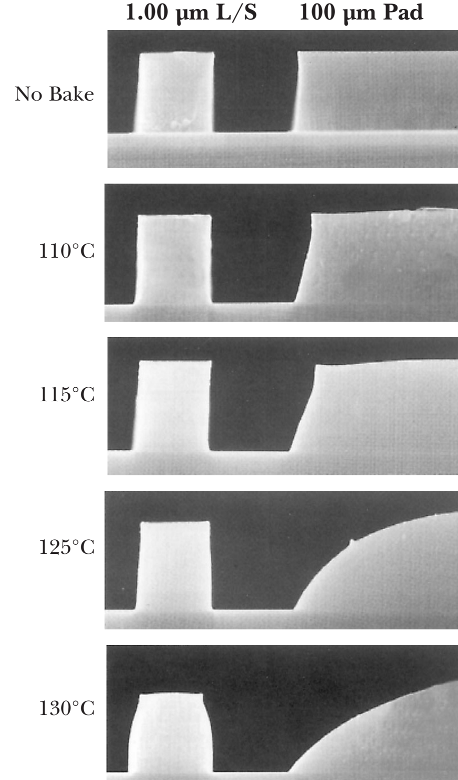
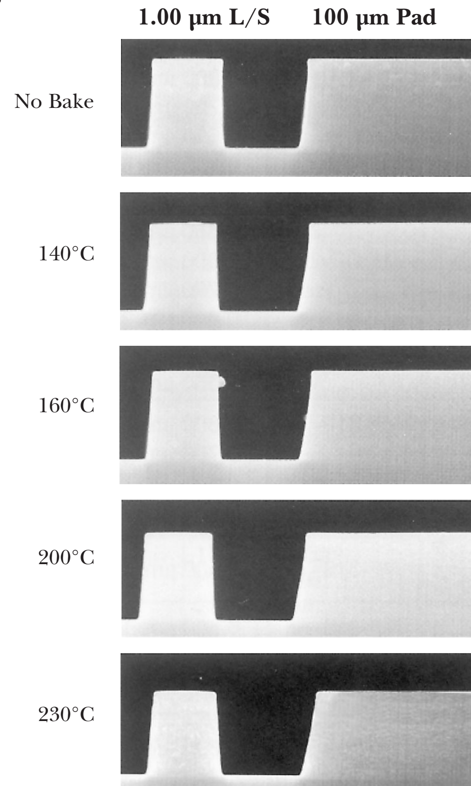


Figure 12. DUV Cure Thermal Characteristics



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EQUIPMENT

MEGAPOSIT SPR3000 Series Photoresist is compatible with most commercially available photoresist processing equipment. Compatible materials include stainless steel, glass, ceramic, unfilled polypropylene, high-density polyethylene, polytetraflouroethylene or equivalent materials.

HANDLING PRECAUTIONS

Before using this product, consult the Material Safety Data Sheet (MSDS)/Safety Data Sheet (SDS) for details on product hazards, recommended handling precautions and product storage.

CAUTION! Keep combustible and/or flammable products and their vapors away from heat, sparks, flames and other sources of ignition including static discharge. Processing or operating at temperatures near or above product flashpoint may pose a fire hazard. Use appropriate grounding and bonding techniques to manage static discharge hazards.

CAUTION! Failure to maintain proper volume level when using immersion heaters can expose tank and solution to excessive heat resulting in a possible combustion hazard, particularly when plastic tanks are used.

STORAGE

Store products in tightly closed original containers at temperatures recommended on the product label.

DISPOSAL CONSIDERATIONS

Dispose in accordance with all local, state (provincial) and federal regulations. Empty containers may contain hazardous residues. This material and its container must be disposed in a safe and legal manner.

It is the user's responsibility to verify that treatment and disposal procedures comply with local, state (provincial) and federal regulations. Contact your Rohm and Haas Electronic Materials Technical Representative for more information.

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