SHIPLEY

UVIII™ POSITIVE DUV PHOTO RESISTS

UVIII™ POSITIVE DUV PHOTO RESIST is optimized to provide wide process latitude for <0.250 µm lines/spaces and contact hole applications. The post-exposure delay stability and extended shelf life of UVIII are derived from the high activation energy chemical platform employed. UVIII is compatible with 0.26N developer systems and a wide range of substrates, including silicon, polysilicon, BPSG, and TEOS.

UVIII™ POSITIVE DUV PHOTO RESIST

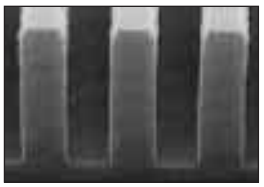
Features:

- Sizing Energy
  - 15.0–20.0 mJ/cm^2 for Lines/Spaces
  - <40.0 mJ/cm^2 for Contact Holes
- Depth of Focus
  - 1.00 µm DOF for 0.250 µm Lines/Spaces and Contact Holes
- Resolution
  - ≤0.220 µm Lines/Spaces and Contact Holes
- >7-hour Post-exposure Bake Stability
- >6-month Shelf Life
- <5 nm/°C Post-exposure Bake Sensitivity
- 150°C/3 min. Thermal Stability

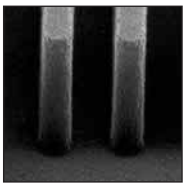
Substrate

UVIII POSITIVE DUV PHOTO RESIST works well with a wide range of substrates, including silicon, polysilicon, BPSG and TEOS. See SEM photos in *Figure 2 (next page)*. A hexamethyldisilazane (HMDS) based MICROPOSIT® primer may be used to promote adhesion with substrates that require such treatment. Vacuum vapor priming at 120°C for 30 seconds with concentrated HMDS is recommended.

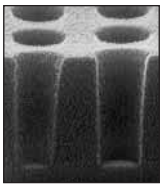
Figure 1. Lithographic Performance



0.250 µm Lines/Spaces on Silicon



0.250 µm Lines/Spaces on CD-11

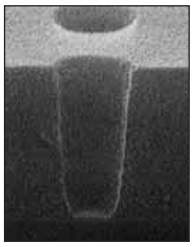


0.270 µm Contact Holes on Silicon

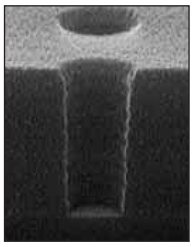
Table 1. Recommended Process Conditions

Lines/Spaces	
Thickness:	6,000–8,720Å
Softbake:	130°C/60 sec. Proximity Hotplate
PEB:	130°C/90 sec. Proximity Hotplate (for non-reflective substrates)
	140°C/90 sec. Proximity Hotplate (for reflective substrates)
Developer:	MEGAPOSIT® MF® CD-26 @ 21°C, 20/20 sec. Double Puddle
Contact Holes	
Thickness:	6,000–8,720Å
Softbake:	140°C/60 sec. Proximity Hotplate
PEB:	150°C/90 sec. Proximity Hotplate
Developer:	MEGAPOSIT® MF® CD-26 @ 21°C, 20/20 sec. Double Puddle

Figure 2. Contact Performance on Various Substrates



0.250 µm
Contact Hole on BPSG



0.250 µm
Contact Hole on TEOS

Figure 3. UVIIHS/UVIII Coat Quality

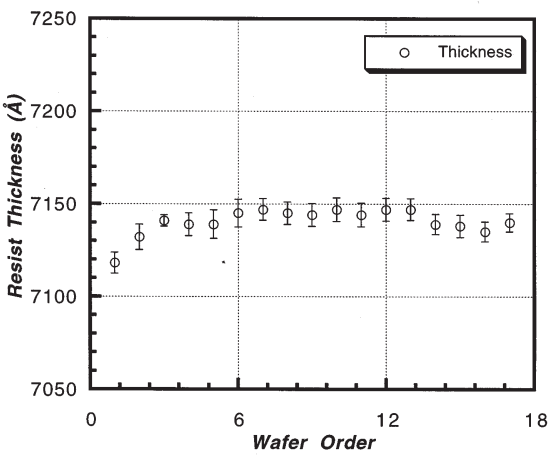
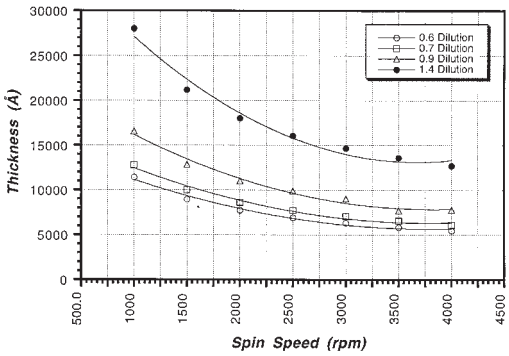


Table 2.
Lithographic Summary

	Silicon 0.250 µm L/S	CD-11 0.250 µm L/S
Sizing Energy (E_S):	17.3 mJ/cm²	21.0 mJ/cm²
Resolution @ E_S:	0.220 µm	0.220 µm
Masking Linearity:	0.220 µm	0.240 µm
Exposure Latitude:	18.50%	26.70%
Focus Latitude @ E_S:	1.00 µm	0.80 µm
Iso/Dense Bias @ E_S:	0 nm	-23 nm
	Silicon 0.250 µm CH	
Sizing Energy (E_S):	23.0 mJ/cm²	
Exposure Latitude:	15%	
Focus Latitude @ E_S:	0.80 µm	

Figure 4. UVIIHS/UVIII Spin Speed Curve on 8" Silicon Substrate



Coat

UVIII POSITIVE DUV PHOTO RESIST provides a uniform coating on 8-inch substrates. As seen in *Figure 3*, the within-wafer uniformity is less than 6 Å (1σ) and the within-lot uniformity is 7.3 Å (1σ). *Figure 4* shows the relation between spin speed and resist thickness for 8-inch substrates. Nominal film thickness may vary slightly due to process, equipment, and ambient variables.

Softbake

Aside from its primary function to reduce the solvent volume and alleviate stress, the softbake step plays an important role in optimizing lithographic performance and feature profiles for chemically amplified resists. A ten-degree temperature differential (softbake lower than PEB) is used to reduce standing waves. At the same time, the softbake temperature is optimized so that it increases the density of the resist film and eliminates excessive acid diffusion. The recommended softbake process for lines/spaces and contact holes is listed in *Table 3* for both silicon and anti-reflective coatings.

Table 3.
Softbake Process Conditions

Lines/Spaces	
Temperature:	130°C
Time:	60 seconds Proximity Hotplate
Contact Holes	
Temperature:	140°C
Time:	60 seconds Proximity Hotplate

Film Thickness Measurement

Figure 5 shows the refractive index of UVIII POSITIVE DUV PHOTO RESIST as a function of wavelength. The curve fit equation is used to calculate the cauchy coefficients needed for film thickness metrology. The cauchy coefficients are listed in *Table 4*.

Resist thickness control is essential to reducing variability of bulk E_0 photospeed and critical dimensions. Resist thickness should be selected by considering etch and/or implant requirements, topography and total absorbance. Resist thicknesses of 6,000–8,720Å have been used in characterizing UVIII. *Figures 6 and 7* display the E_0 and CD interference curves for silicon and CD-11 ARC.

Figure 5. Dispersion Curve

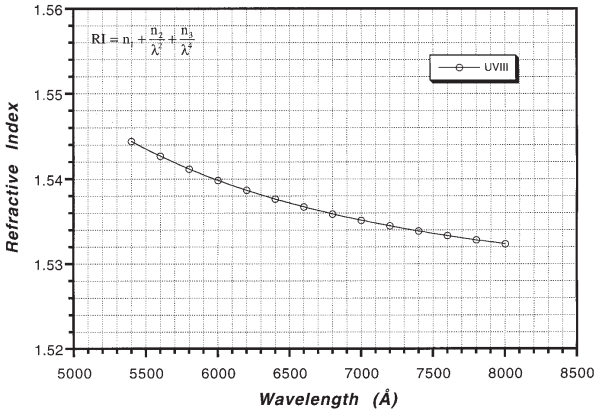


Table 4.
Cauchy Coefficients

n_1	1.5247
n_2	4.17e+05
n_3	4.61e+12

Figure 6. Interference Curve Silicon

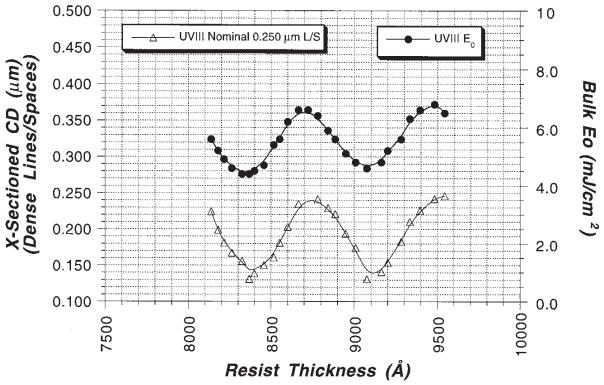
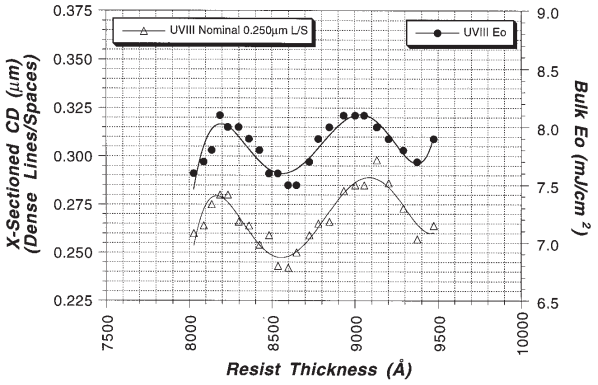


Figure 7. Interference Curve CD-11



Expose

UVIII POSITIVE DUV PHOTO RESIST is designed for lines/spaces and contact hole applications using an excimer laser exposure tool. *Figure 8* displays the absorbance curve, which shows only a small amount of bleaching after exposure. *Table 5* lists the Dill parameters and other parameters needed for the proper modeling of chemically-amplified resists.

Figure 3. Absorbance Curve

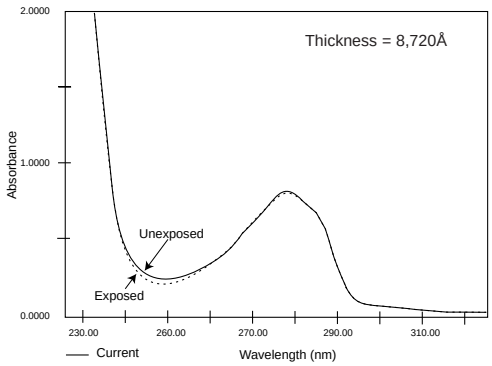


Table 5.
Prolith Parameters

Dill A Value:	0.0857
Dill B Value:	0.4186
Dill C Value:	8.565*10-4 cm^2/mJ
R_{min}:	0.85 Å/sec.
R_{max}:	24,193 Å/sec.
n:	15.23
Acid Generation Coefficient:	0.063 cm^2/mJ

RI @ 248nm = 1.74

*Chemically-amplified resist requires additional modelling parameters which are currently being determined. Please see your TSR for an updated copy of modelling parameters.

Post-exposure Bake

The post-exposure bake is used for driving the photochemical reaction and reducing standing wave interference effects. The recommended processing conditions for silicon and ARC substrates are listed in *Table 6*. Chemically-amplified resists exhibit pseudo-Arrenihus behavior. Depending on the PEB temperature the deprotection reaction rate can be either diffusion controlled or reaction controlled. The pseudo-arrenihus plot for UVIII POSITIVE DUV PHOTO RESIST on silicon shows two distinct regions and is pictured in *Figure 9*. The plot shows an inflection point at a PEB temperature of 137°C; operating above this temperature reduces the amount of standing waves on silicon. *Figure 10* shows the CD sensitivity to changes in PEB.

Table 6. Post-Exposure Bake Process Conditions

Lines/Spaces	
Silicon	
Temperature:	140°C
Time:	90 sec. Proximity Hotplate
Anti-Reflectant Substrates	
Temperature:	130°C
Time:	90 sec. Proximity Hotplate
Contact Holes	
Temperature:	150°C
Time:	90 sec. Proximity Hotplate

Figure 9. Pseudo-Arrenihus Plot

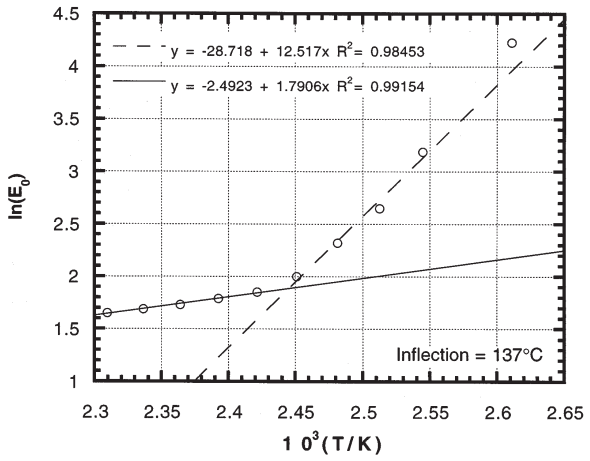
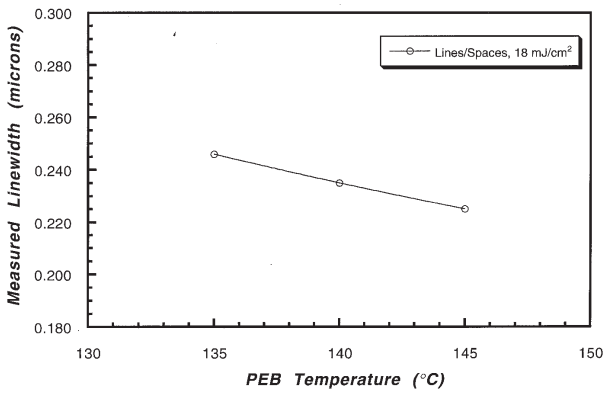


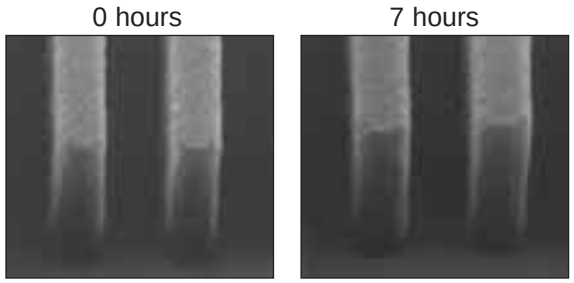
Figure 10. PEB Sensitivity



Post-Exposure Delay Stability

The post-exposure delay stability is a critical parameter since during the post-exposure delay basic contaminants can be absorbed at the resist surface and interfere with the generated acid and result in T-topping or CD growth. The delay stability for UVIII POSITIVE DUV PHOTO RESIST, as seen in *Figure 11*, is greater than 7 hours in a non-filtered environment.

Figure 11. Post-exposure Bake Delay Stability

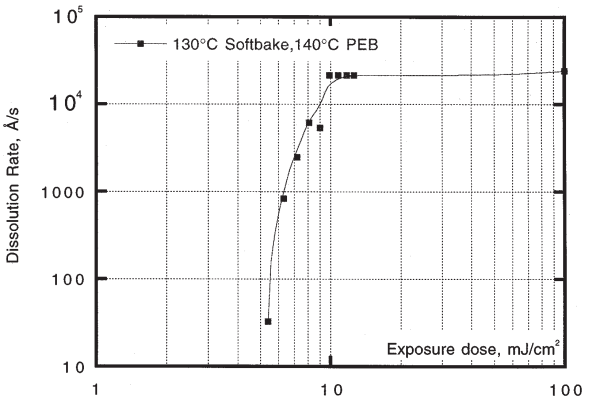


0.250 µm lines/spaces pairs in a non-filtered environment

Develop

UVIII POSITIVE DUV PHOTO RESIST is compatible with 0.26N developers, particularly with MEGAPOSIT® MF CD-26 DEVELOPER and MEGAPOSIT® LDD-26W DEVELOPER. A 20/20 second double spray puddle with no pre-wet is recommended for most applications, including lines/spaces and contact holes. UVIII is a high contrast resist, with excellent resolution and sidewall profiles. The R_{max}, R_{min}, and n are listed in *Table 5*. *Figure 12* (next page) shows the dissolution rate as a function of exposure dose.

Figure 12. Dissolution Curve



Photoresist Removal

UVIII POSITIVE DUV PHOTO RESIST can be removed with MICROPOSIT® REMOVER 1165®. A two bath process is recommended with each bath at a temperature of 80°C. The first bath is used to remove the bulk of the photoresist and the second bath to remove residual traces of photoresist. Consult specific remover datasheets for additional process information.

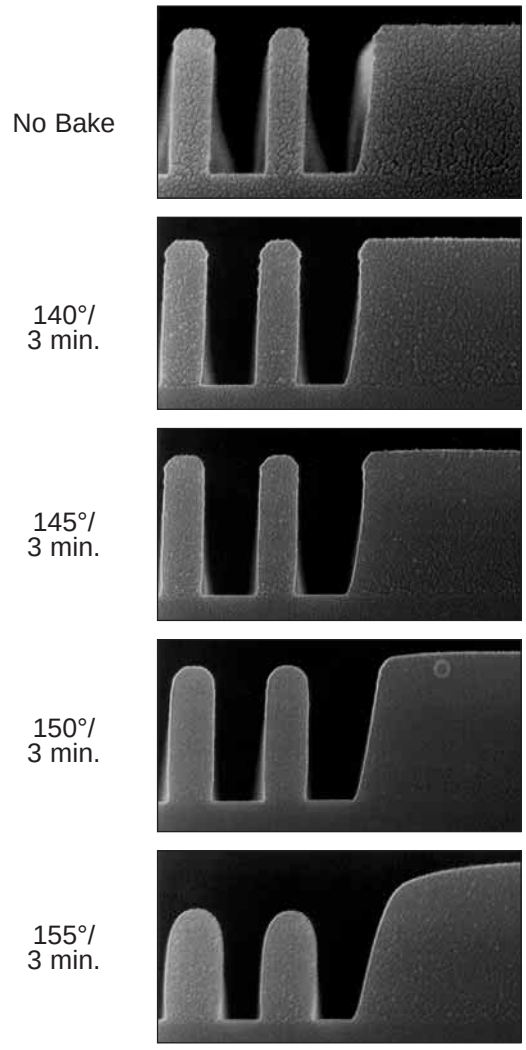
Hardbake

An additional bake after develop removes residual solvents and, therefore, can improve stability and adhesion during etch. *Figure 13* (next page) displays the thermal flow characteristics of UVIII POSITIVE DUV PHOTO RESIST for 0.250 µm lines/spaces and a 10 µm PAD.

Etch Resistance

Table 7 lists the bulk etch selectivity for an ARC etch (CD-11), a poly etch, and a metal etch (TiN). The selectivity is a ratio of the substrate etch rate to the rate of resist loss, e.g. substrate: resist.

Figure 13. Thermal Characteristics



Handling Precautions

UVIII POSITIVE DUV PHOTO RESIST is a combustible liquid and vapor; keep away from heat, sparks, and open flame. Causes irritation to eyes, nose, and respiratory track. Repeated skin contact may produce dermatitis. Use with adequate ventilation and avoid breathing vapors and mists. Wash thoroughly after handling and always wear chemical goggles, gloves, and suitable protective clothing. Keep container closed when not in use.

Storage

Store UVIII POSITIVE DUV PHOTO RESIST in an upright, sealed original container in a dry area at 30-50°F away from heat and sunlight. Keep away from alkaline materials, acids, and oxidizers.

Waste Treatment

UVIII POSITIVE DUV PHOTO RESIST contains ethyl lactate. It may be included with other wastes containing similar organic solvents to be discarded for destruction or reclaim in accordance with local, state, and federal regulations.

Table 7.
Bulk Etch Selectivity

ARC Etch (CD-11)		**Poly Etch**		**Metal Etch (TiN)**	
Etcher:	Applied 5000	Etcher:	Lam 4420	Etcher:	Lam 4600
RF:	600 watts	RF:	375 watts	RF:	510 watts
Pressure:	25 mtorr	Pressure:	375 mtorr	Pressure:	230 mtorr
CHF_3:	33 sccm	HBR:	125 sccm	BCl_3:	55 sccm
O_2:	7 sccm	He:	180 sccm	N_2:	55 sccm
AR:	80 sccm	Cl_2:	280 sccm	Cl_2:	65 sccm
		Gap:	0.75 cm	Gap:	5.0 cm
TIME:		TIME:		TIME:	
Full:	65 sec.	Full:	75 sec.	Full:	60 sec.
Partial:	30 sec.	Partial:	30 sec.	Partial:	30 sec.
Bulk Etch Selectivity Substrate: Resist		**Bulk Etch Selectivity Substrate: Resist**		**Bulk Etch Selectivity Substrate: Resist**	
0.8 : 1.0		5.3 : 1.0		3.0 : 1.0	

Notes

USA Operations
Shipley Company, L.L.C.
455 Forest Street
Marlborough, MA 01752-3001
TEL: (508) 481-7950
(800) 832-6200
FAX: (508) 485-9113

European Operations
Shipley Europe Ltd.
Herald Way
Coventry CV3 2RQ
England
TEL: 44 203 457 203
FAX: 44 203 440 331

Far East Operations
Shipley Far East Ltd.
Nishidai-NC Bldg.
1-83-1, Takashimadaira
Itabashi-ku, Tokyo 175 Japan
TEL: 81 35 920 5300
FAX: 81 35 920 5471

Domestic Regional Offices

1458 MacArthur Road
Whitehall, PA 18052-5711
TEL: (610) 820-9777
(800) 345-3100
FAX: (610) 820-4045

Plaza North
2880 LBJ Freeway
Suite 107
Dallas, TX 75234
TEL: (214) 446-2400
(800) 527-3730
FAX: (214) 245-0796

1575 West University Drive
Suite 107
Tempe, AZ 85281-3283
TEL: (602) 894-5499
(800) 262-6377
FAX: (602) 894-8379

3945 Freedom Circle
Suite 370
Santa Clara, CA 95134
TEL: (408) 988-3600
(800) 423-9937
FAX: (408) 988-3698

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