



AZ BARLi II

Solvent Compatible Bottom Antireflective Coating for i-Line Process

Data Package

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AZ BARLi II Coating Material

Features, Process, and Performance

AZ's bottom antireflective coating material, AZ BARLi II coating, is tailor-made to yield near-optimum values for refractive indices (n and k) for **i-line** lithography, which ensures minimum reflectivity and maximum swing reduction for photoresist layers.

AZ BARLi II coating material is formulated in photoresist-compatible solvents to simplify edge bead removal process and to be both environmentally and user friendly.

Composed of highly absorptive polymer-bound dyes, this material provides excellent coating uniformity and step coverage. Other features include high etch selectivity and good thermal stability.

AZ BARLi II Coating Material

Features/Benefits

- ▶ Highly absorptive polymer-bound dye used as the bottom antireflective coating for **i-line** photoresists
- ▶ Near-optimal optical constants ($n/k=1.63/0.31$) for maximum swing reduction at the optimal film thicknesses (910Å and 1960 Å)
- ▶ Formulated with photoresist-compatible solvents to simplify EBR process and to be end-user friendly
- ▶ Excellent coating uniformity and step coverage profile
- ▶ High etch selectivity, comparable to AZ BARLi coating material
- ▶ High thermal stability up to 230°C
- ▶ No intermixing with photoresist layer after soft baking
- ▶ Two thickness grades, AZ BARLi II 90 and 200, provide the optimal film thickness for the first and the second swing minimum respectively

Optical Constants of AZ BARLi and AZ BARLi II Coatings

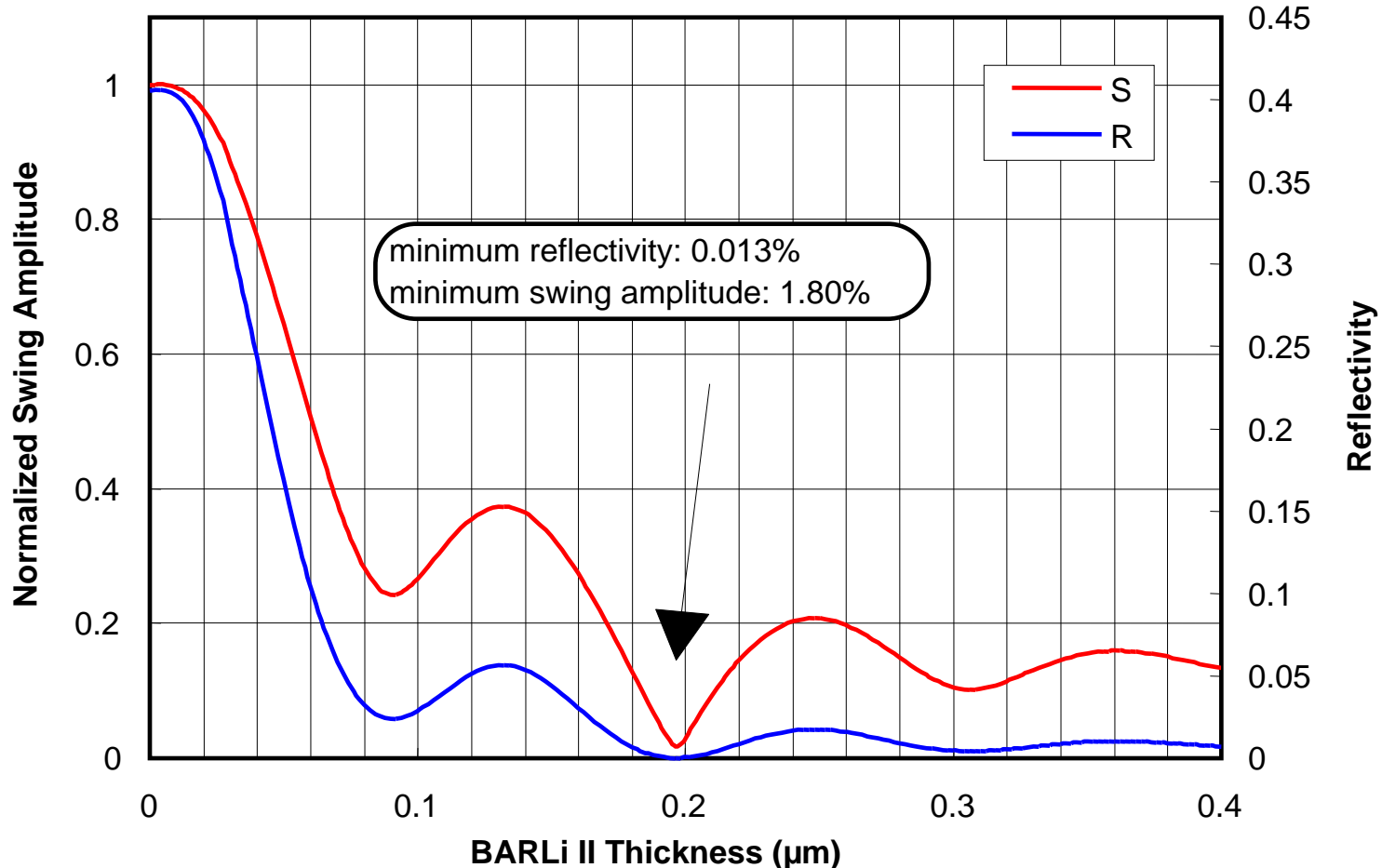
Near-optimal values of n and k at 365 nm, both AZ BARLi and AZ BARLi II coatings are highly absorptive materials for i-line process

Coating	Wavelength (nm)	n from spectr. ellipsometry	k from spectr. ellipsometry
BARLi	365	1.65	0.33
BARLi II	365	1.63	0.31

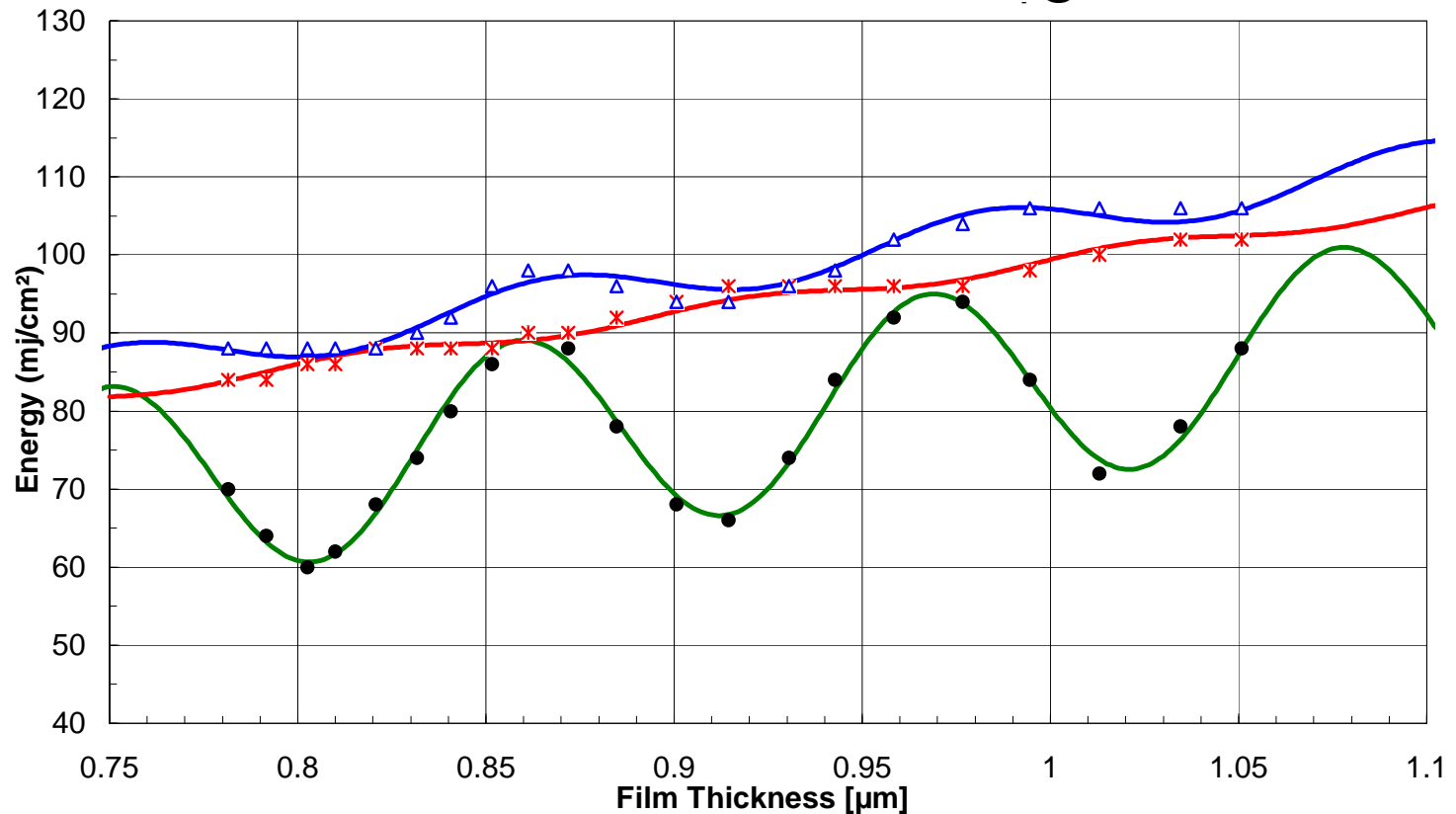
BARLi film baked at 150 °C, BARLi II film baked at 200°C

Simulated Swing Reduction of Photoresist by AZ BARLi II Coating

Resist ($n=1.704-0.024i$) on AZ BARLi II ($n=1.63-0.31i$) on Si ($n=6.55-2.07i$), 365nm



Swing Curves of AZ 7908 Photoresist on AZ BARLi II Coatings

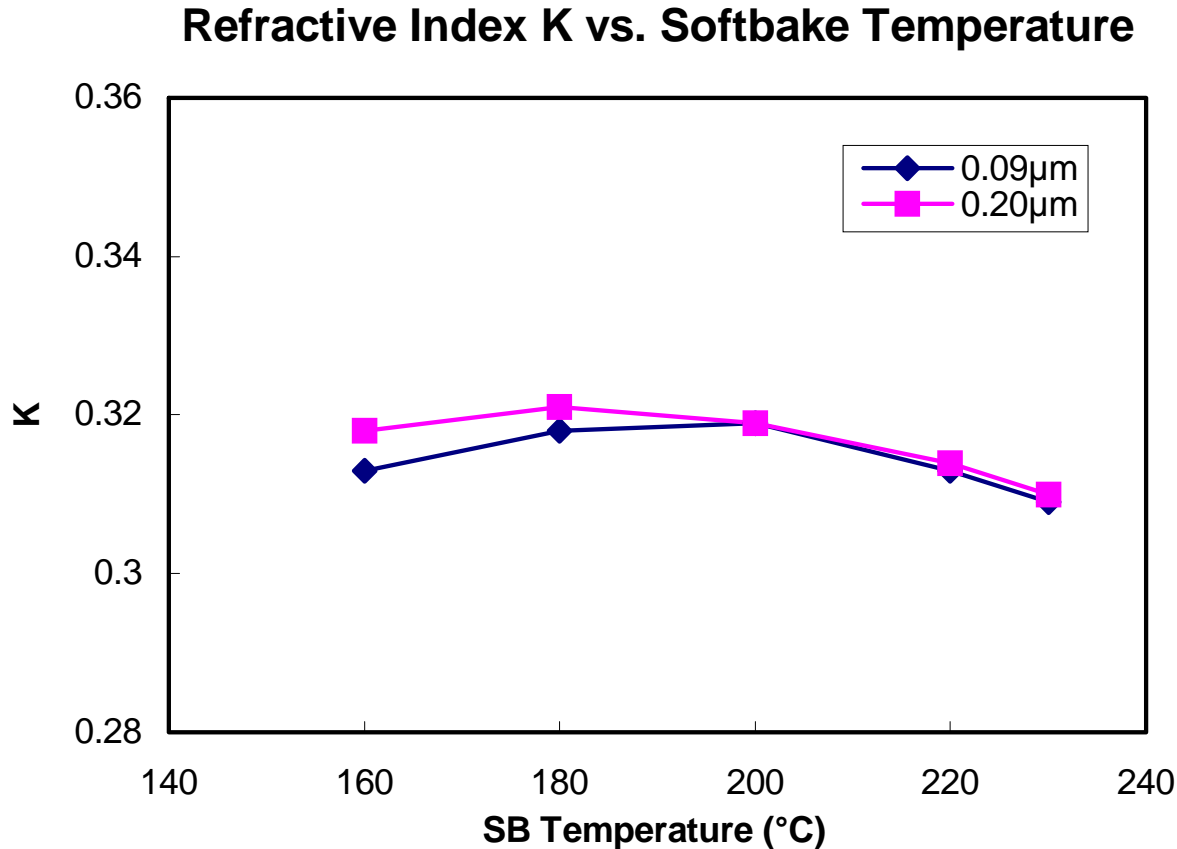


AZ BARLi II at 900Å (blue) and 1960Å (red)

SB 90°C/60sec, PEB 110°C/60sec, AZ 300MIF Developer, 70sec puddle @23°C

AZ BARLi II coatings reduced swing amplitude by 80% at 900Å film thickness and 94% at 1960Å

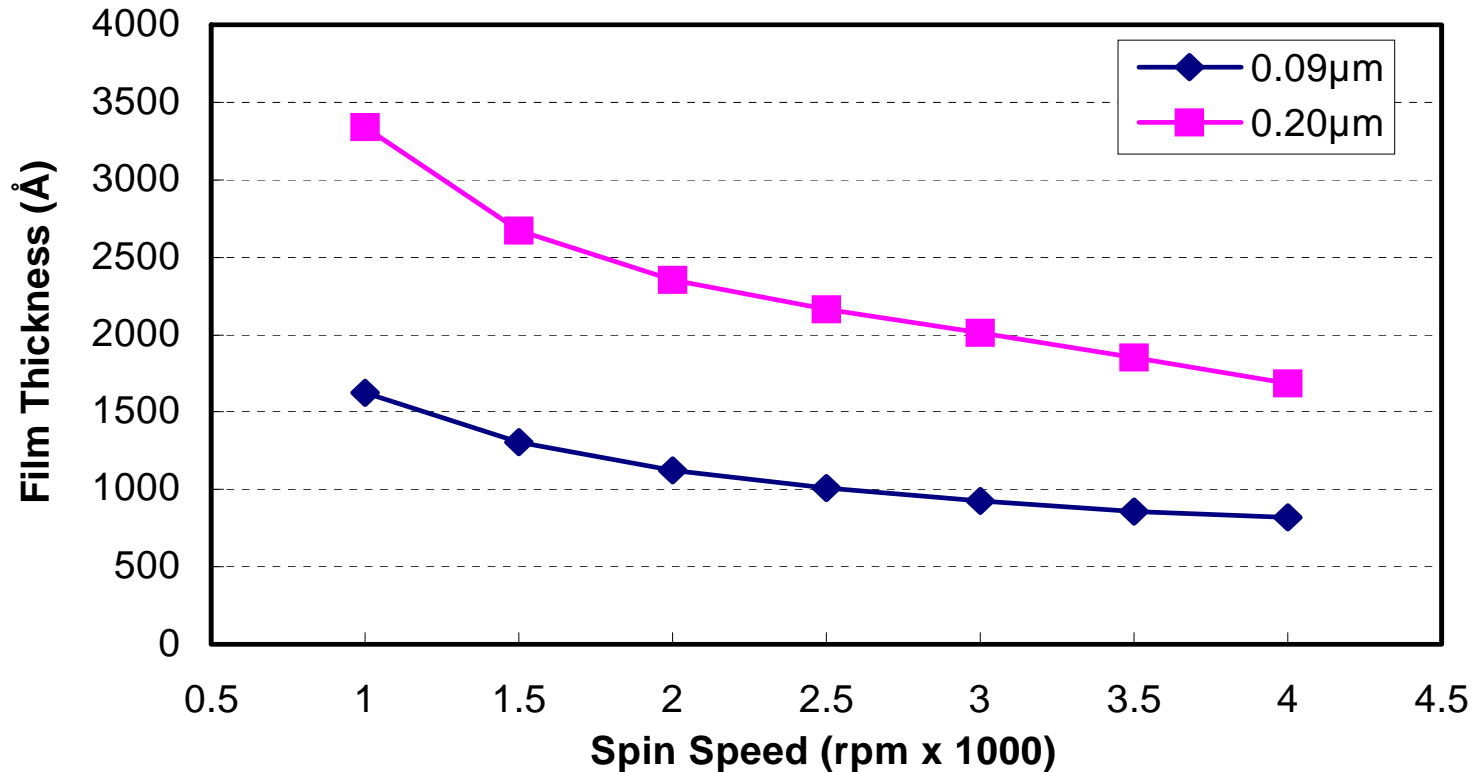
Thermal Stability of AZ BARLi II Coating



Refractive index k changed $< \pm 2\%$ at softbake temperature from 160°C to 230°C , providing wide process latitude.

Spin Curves of AZ BARLi II Coatings

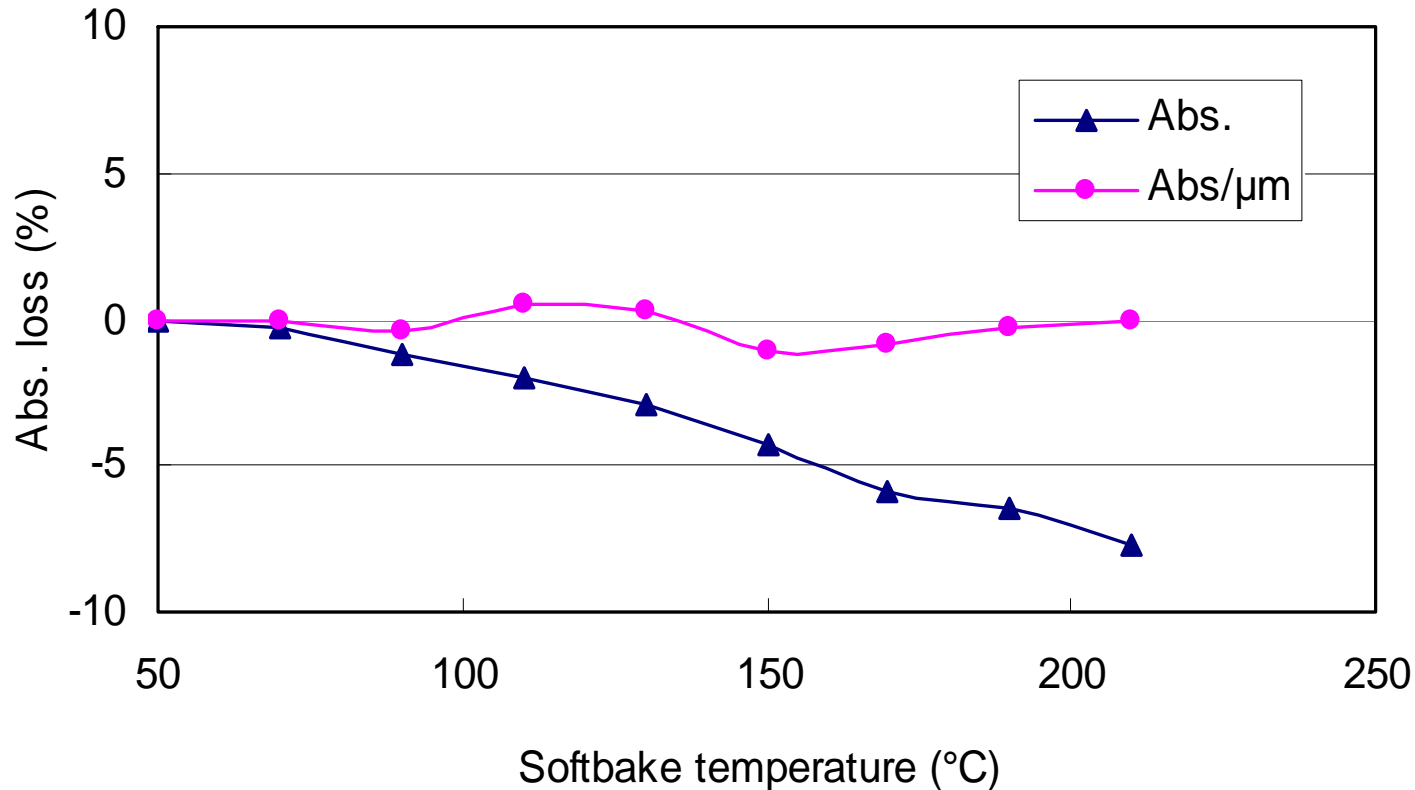
Spin Curve at 200°C Softbake



Two thickness grades of AZ BARLi II coatings provide 1st and 2nd optimal FT respectively at standard operating conditions (spin @ 3000rpm, SB @ 200°C/60sec.)

Thermal Stability of AZ BARLi II Coating

Absorbance loss vs. softbaking temperature

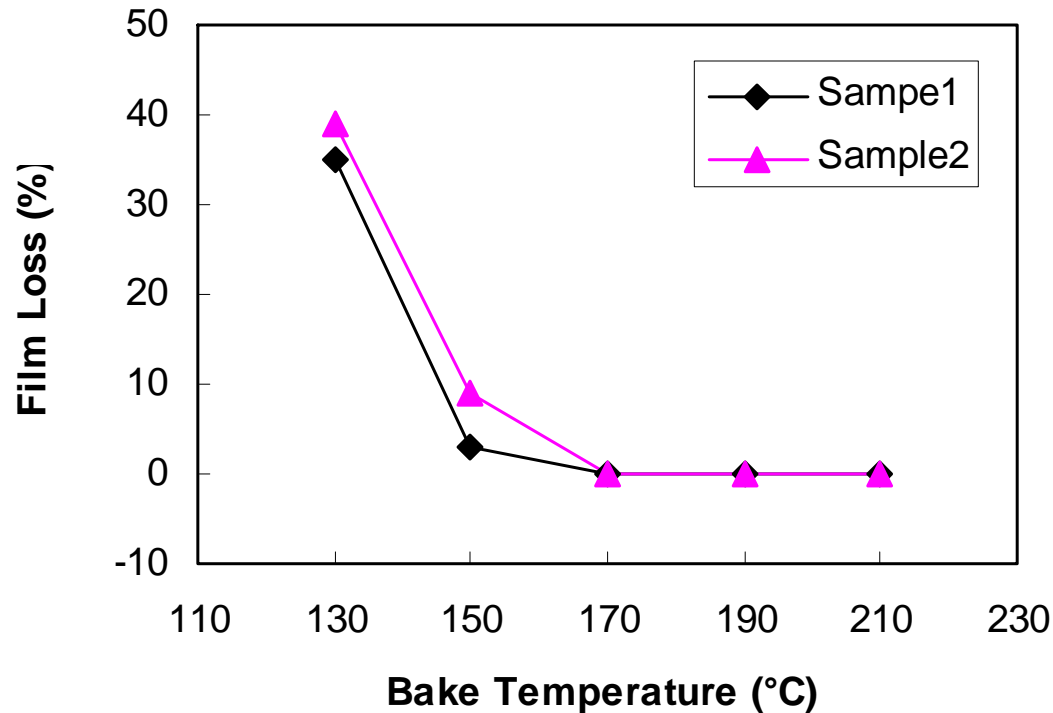


Optical density of AZ BARLi II film varied $< \pm 1.0$ % from 50°C to 210°C, indicating high thermal stability.

Thermal Stability of AZ BARLi II Coating

AZ BARLi II Film Loss vs. Soft Baking Temperature

AZ BARLi II films soft baked at 200°C for 60 sec., and then soaked in EL for 60 sec.

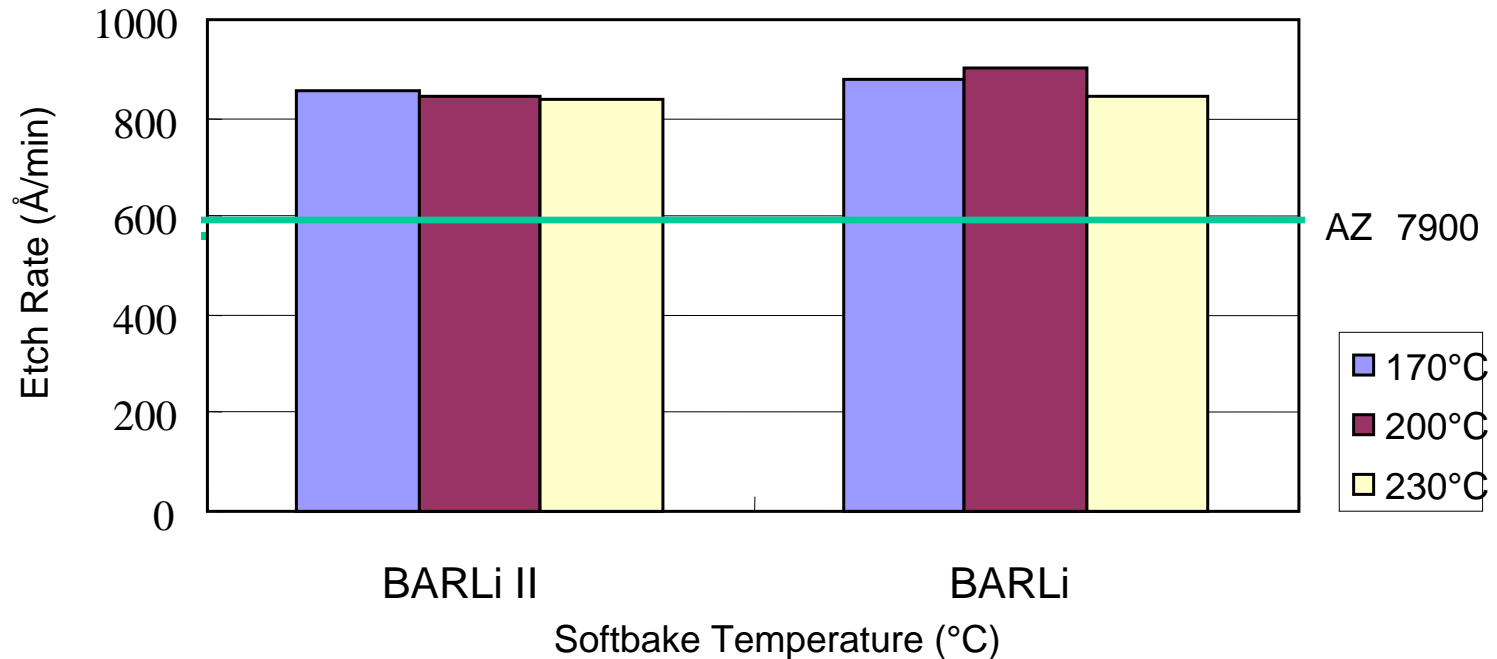


No intermixing with photoresist solvents observed after soft baking at 170°C or higher

Etch Test of AZ BARLi and AZ BARLi II Coatings

Both AZ BARLi and BARLi II coatings are highly etchable

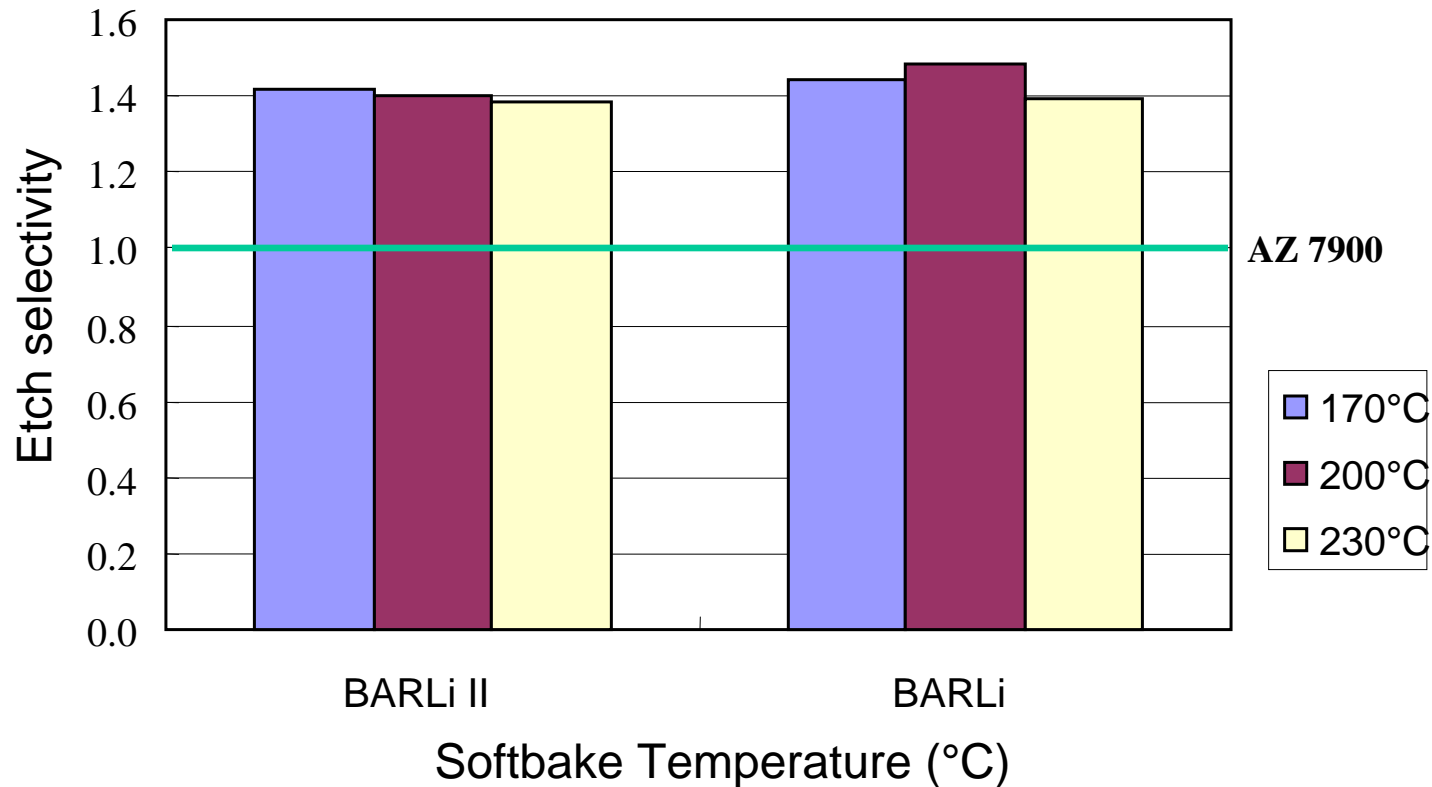
Etch Rate vs. Softbake Temperature



Etch conditions: Samco RIE-10N, CHF_3/O_2 in 40/10 sccm, 60w, 60 seconds.

Etch Selectivity of AZ BARLi and AZ BARLi II Coatings

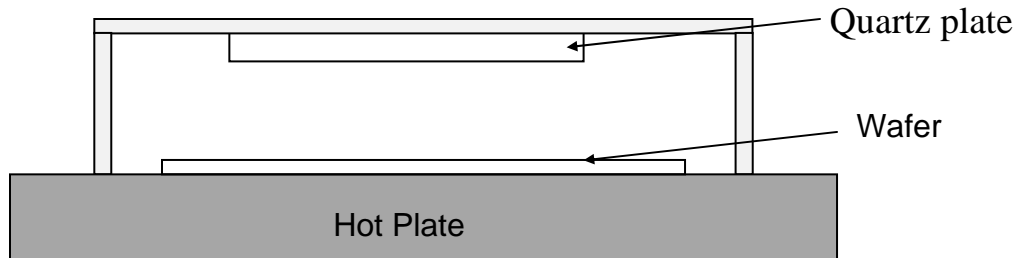
Both AZ BARLi and AZ BARLi II coatings showed etch selectivity of higher than 1.4 vs. Novolak-based photoresist



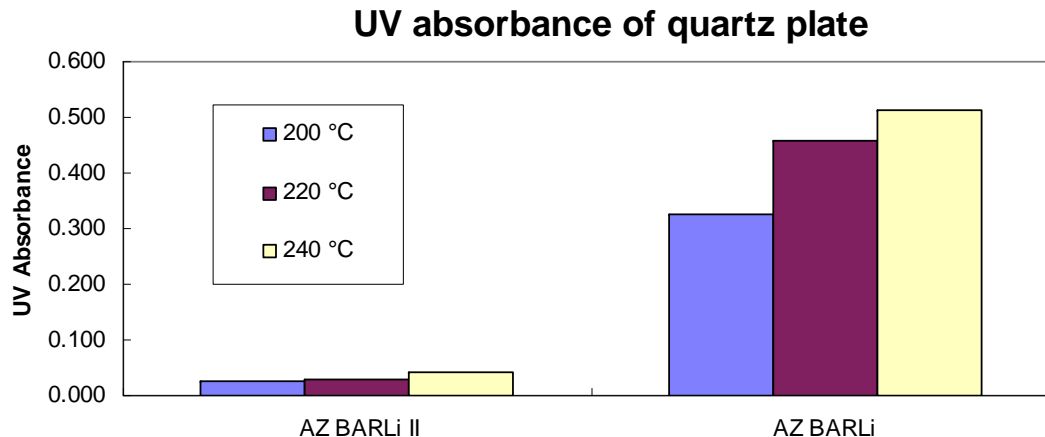
Etch conditions: Samco RIE-10N, CHF_3/O_2 in 40/10 sccm, 60w, 60 seconds.

Sublimation Test of AZ BARLi and BARLi II Coatings

AZ BARLi II coating showed high thermal stability and no sublimation of absorptive materials at up to 240°C

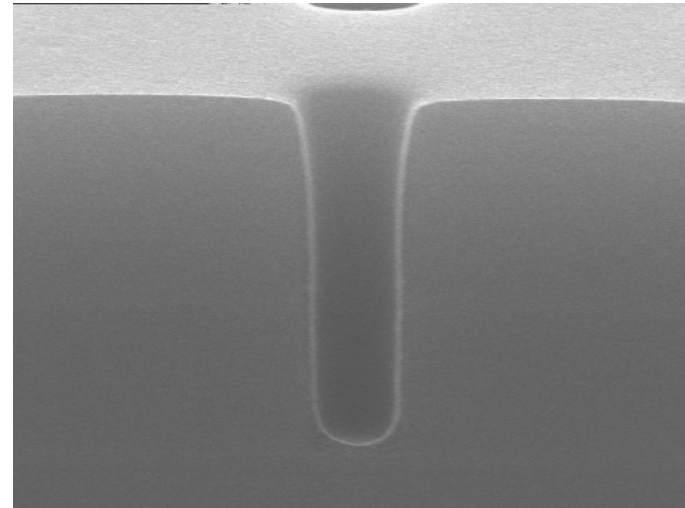
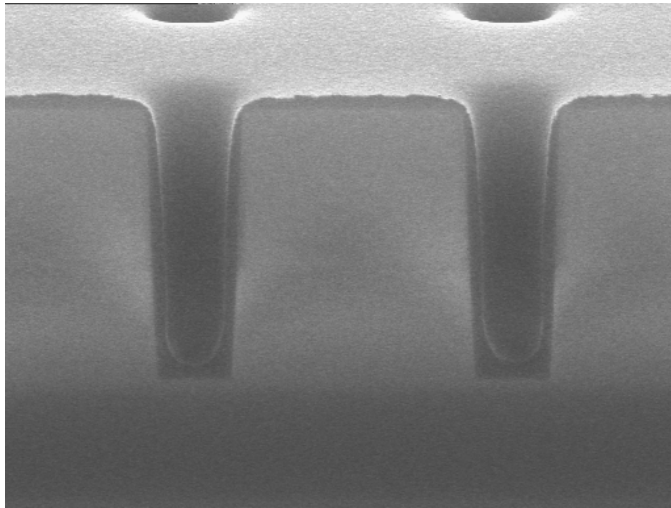


Sublimation test: AZ BARLi II coated @ 0.3 μm onto ten 4" Si-wafers and each baked for 120sec, quartz wafer measured for absorbance after 10 Si-wafers baked.



Topography Profiles of AZ BARLi II Coating

AZ BARLi II coating showed good conformity properties



AZ BARLi II material coated onto SiO_2 wafers with contact holes at ~ 1.7 μm deep and 0.4 μm open.

SEM Micrographs of AZ 7908 Resist on AZ BARLi II and AZ BARLi

Resolution better than 0.32 μ m, showed AZ BARLi II and AZ BARLi coatings are comparable

AZ BARLi II:

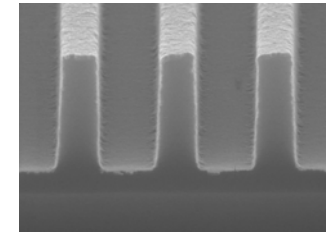
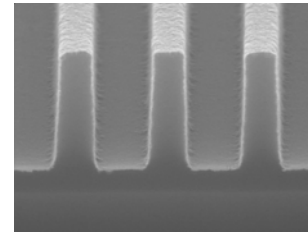
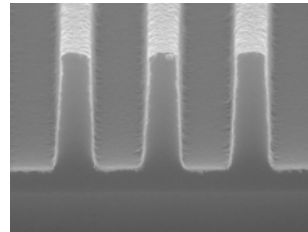
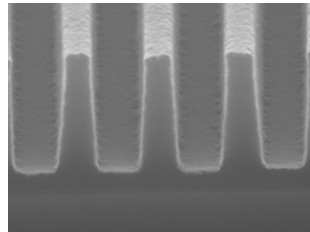
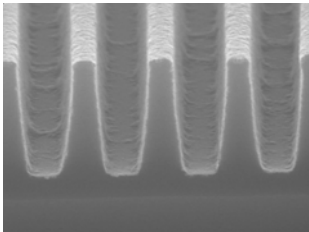
0.30 μ m

0.32 μ m

0.34 μ m

0.36 μ m

0.38 μ m



AZ BARLi:

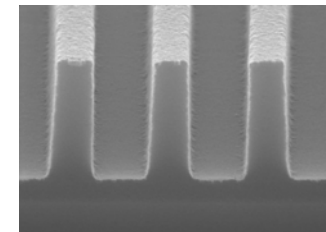
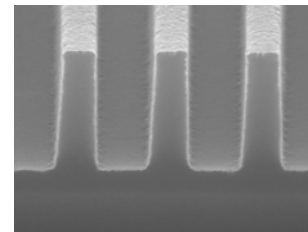
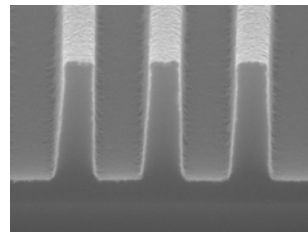
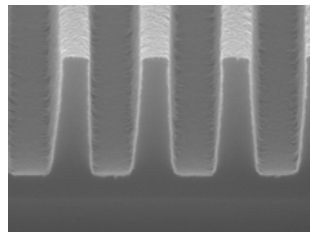
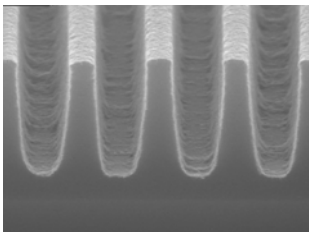
0.30 μ m

0.32 μ m

0.34 μ m

0.36 μ m

0.38 μ m



AZ BARLi II & AZ BARLi FT at 0.19 μ m, SB 200°C/60sec.,
AZ 7908 FT at 0.97 μ m, SB 90°C/60sec., PEB 110°C/60sec.,
Developer AZ 300MIF 23°C/70sec., Exposure Nikon 0.54NA **i-line**.

SEM Micrographs of AZ 7908 Resist on AZ BARLi II and BARLi

***DOF 1.2 μm (at 0.34 μm), comparable performance for both AZ BARLi II
and AZ BARLi coatings.***

AZ BARLi II

DOF: -0.8 μm

-0.6 μm

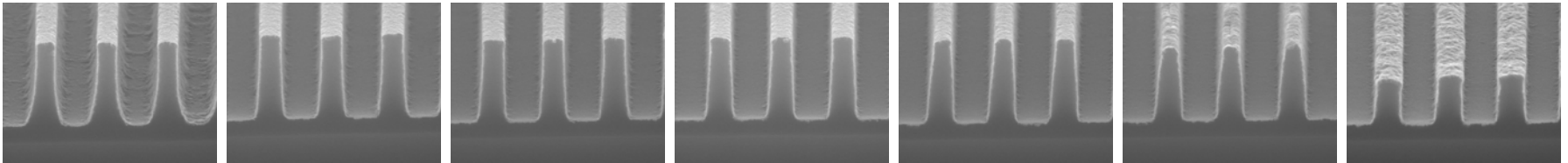
-0.4 μm

-0.2 μm

0.0 μm

+0.2 μm

+0.4 μm



AZ BARLi

DOF: -0.8 μm

-0.6 μm

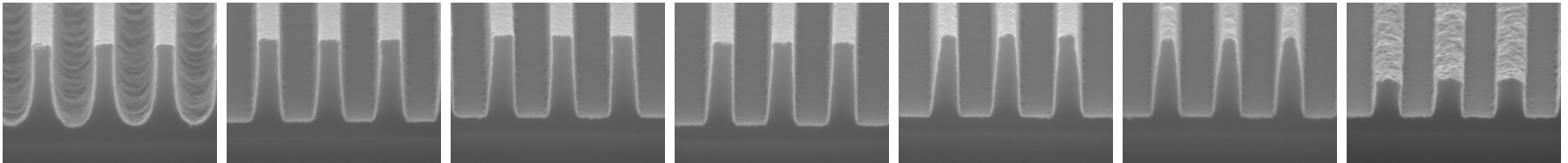
-0.4 μm

-0.2 μm

0.0 μm

+0.2 μm

+0.4 μm



AZ BARLi II & AZ BARLi FT at 0.19 μm , SB 200°C/60sec.,
AZ 7908 FT at 0.97 μm , SB 90°C/60sec., PEB 110°C/60sec.,
Developer AZ 300MIF 23°C/70sec., Exposure Nikon 0.54NA **i-line**.

Recommended Standard Process

- ▶ **Substrate Pre-Treatment**

HMDS not recommended.

- ▶ **Spin Process**

Target thickness: 910Å for AZ BARLi II 90

1960Å for AZ BARLi II 200

Spin and EBR process similar to photoresist process.

Apply static or dynamic dispense at 500-1000rpm.

Final spin speed approx. 3000rpm, actual setting depends on equipment, set spin speed to meet target thickness as above.

- ▶ **EBR Process**

AZ EBR70/30 recommended for best result.

Also compatible to EL, PGME, or other solvents.

Recommended Standard Process (continued)

- ▶ **Softbake**

Recommended setting: 200°C/60seconds on contact hotplate. Depending on equipment, temperature may be set between 180°C to 220°C and proximity bake may be applied.

- ▶ **Strip**

AZ 300T and 400T strippers are recommended.

- ▶ **Solvent Safety**

BARLi II coatings are formulated with EL/PGME.

- ▶ **Storage**

Storing in refrigeration is recommended.

- ▶ **Shelf Life**

Shelf life in room temperature is 12 months.

AZ BARLi II Thickness Measurement

The Cauchy coefficients for AZ BARLi II coating are:

$$A = 1.6097$$

$$B = 0.0083014$$

$$C = 0.006187 \quad (\text{measured by J. A. Woollam V.A.S.E.® Spectroscopic Ellipsometer})$$

They fit the following equation:

$$n = A + B/\Sigma^2 + C/\Sigma^4$$

where B in μm^2 , C in μm^4 .

If using nm, then multiply B by 10^6 , C by 10^{12} ;

If using Å, then multiply B by 10^8 , C by 10^{16} .

Summary

- ▶ AZ BARLi II coating material has near-optimum values of refractive indices for i-line lithography.
- ▶ AZ BARLi II coating material is formulated in photoresist compatible solvents.
- ▶ AZ BARLi II coating material performs comparable to AZ BARLi coating.
- ▶ AZ BARLi II coating material is composed of polymer-bound dyes, no sublimation of monomeric dyes and other materials during soft baking.