Shipley

Anti-Reflective Coating

193 AR

Advanced 193 Materials

AR™19 193 nm Anti-Reflectant

AR™19 is an organic, bottom anti-reflectant for 193 nm (ArF) photoresists. AR19 reduces resist photospeed swing and reflective notching, leading to higher resolution, larger process latitudes, and reduced line-edge roughness. It also acts as a chemical barrier between the underlayer and resist, providing a common substrate for all layers. AR19 is tailored for high absorbance at 193 nm exposure wavelength, a sharp resist/anti-reflectant interface, good coating properties, and a fast etch rate. The solution viscosity is adjusted for a target thickness of 820Å, which corresponds to the broad, second minimum in reflectance. AR19 works as a system with Shipley's and other 193 nm photoresists.

Features:

- Resist E_0 swing reduced from 43% to 6%
- Fast etching
- Process capability over a broad range of bake temperatures
- Compatible with common spin coating and EBR solvents

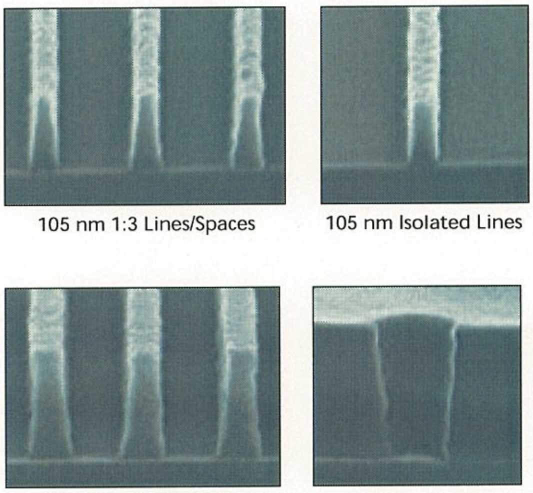
Substrate

AR19 is compatible with a wide range of substrates, including silicon, SiO_2, polysilicon, Si_3N_4, TiN and aluminum.

Coat

AR19 is spin-bowl compatible with common spin-coating and EBR solvents (see *Table 1*). Dedicated spin bowl and drain lines are not required. *Figure 2* shows the relation between spin speed and film thickness. Nominal film thickness may vary slightly due to process, equipment, and ambient conditions. The kinematic viscosity is listed in *Table 2* (see next page). Do not use adhesion promoters, such as HMDS, between anti-reflectants and resist layers.

Figure 1. Lithographic Performance on AR19 (0.60 NA, 0.70σ)



105 nm 1:3 Lines/Spaces — 105 nm Isolated Lines — 150 nm 1:1 Lines/Spaces — 160 nm Isolated Contact Holes

Figure 1 displays the lithographic performance of Shipley 193 nm photoresists on AR19.

Table 1. Compatible Solvents

Ethyl lactate	Methyl Ethyl Ketone
Propylene Glycol Methyl Ether	3-Pentanone
Propylene Glycol Methyl Ether Acetate	Cyclohexanone
60% PGME/40% PGMEA	g-Butyrolactone
50% PGMEA/50% Methyl Ethyl Ketone	

Figure 2. Spin Speed Curve

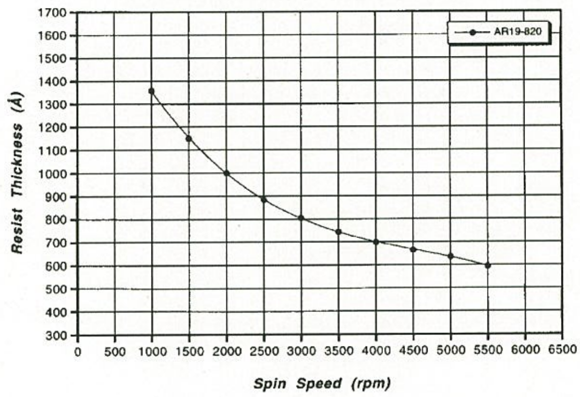


Table 2. Kinematic Viscosity	
AR19	2.6 cSt

Cure

Shipley 193 nm Photoresists show no interface issues on AR19 over a wide range of cure temperatures (190°C–240°C), as seen in *Figure 3*. The recommended process conditions for AR19 are shown in *Table 3*.

Figure 3. Interfacial Effects vs. Cure Temperature

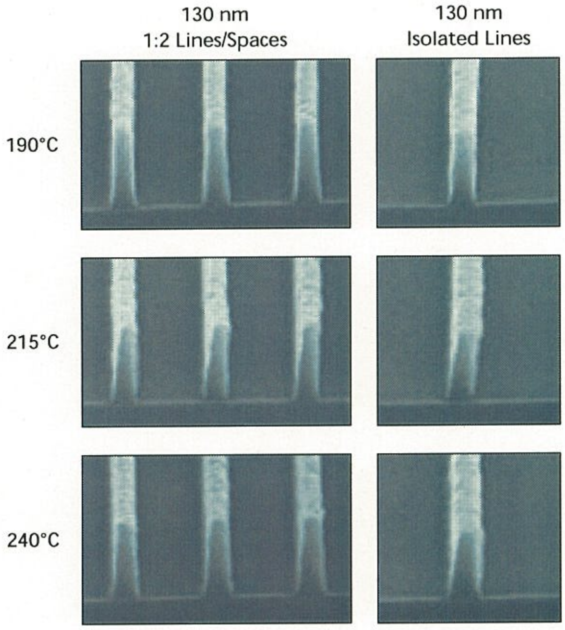


Table 3. Recommended Process Conditions	
Film Thickness:[†]	820Å
Cure:	215°C/90 sec. Proximity Hotplate

[†]Optimum AR19 film thickness will depend on substrate reflectivity, thickness, topography, and desired etch performance.

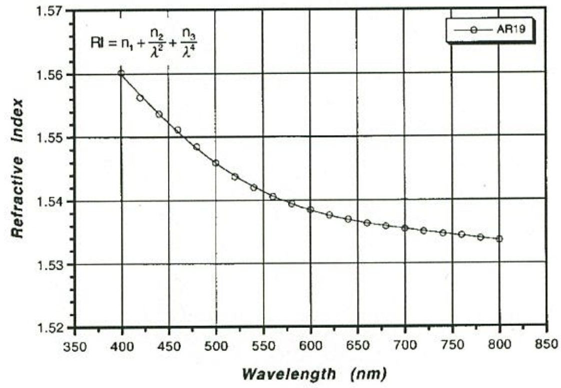
Film Thickness Measurement

Optical constants n and k, measured at 193 nm with a Woolam variable angle spectroscopic ellipsometer, appear in *Table 4*. *Figure 4* shows the refractive index of AR19 as a function of wavelength.

Table 4. Optical Constants at 193 nm*	
n	1.79
k	0.397

*At 215°C cure temperature

Figure 4. Dispersion Curve



Cauchy coefficients for AR19 are listed in *Table 5*.

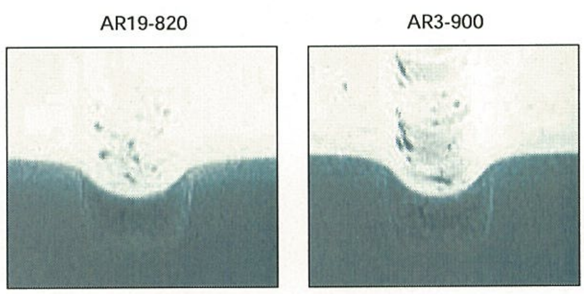
Table 5. Cauchy Coefficients*	
n_1	1.526
n_2	5.22e+5
n_3	1.23e+12

*At 215°C cure temperature

Planarization

AR19-820 has a degree of planarization equivalent to AR3™-900 DUV anti-reflectant, as seen in *Figure 5*.

Figure 5. Planarization



300 nm Isolated Trenches

Reflection Control

AR19 absorbance spectrum is displayed in *Figure 6.* The film is transparent in the visible region.

Figure 6. Absorbance Curve

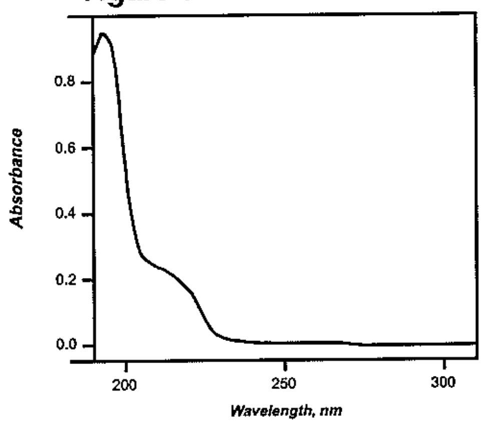
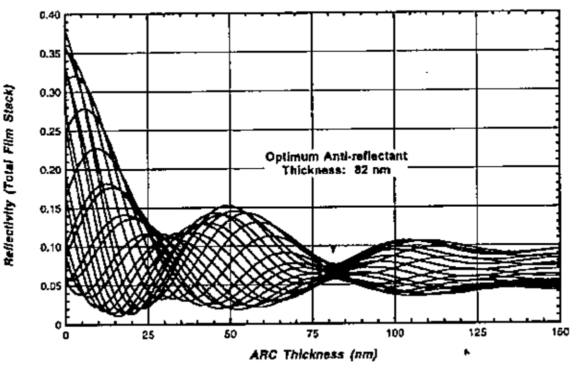


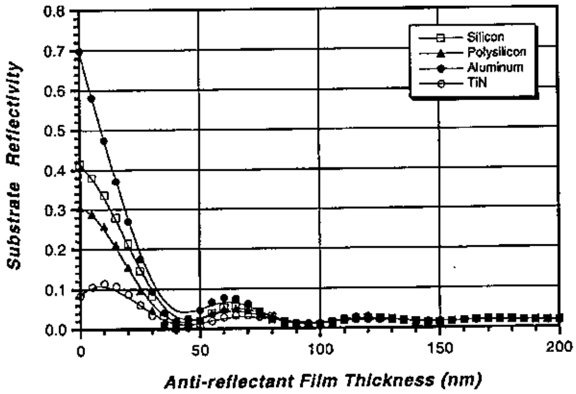
Figure 7 shows modeled reflectivity vs. anti-reflectant thickness for resist thicknesses from 400 to 500 nm in 5 nm increments. The plot displays the effectiveness of AR19 and indicates an optimum anti-reflectant thickness at 82 nm.

Figure 7. Reflectivity vs. Anti-Reflectant Thickness



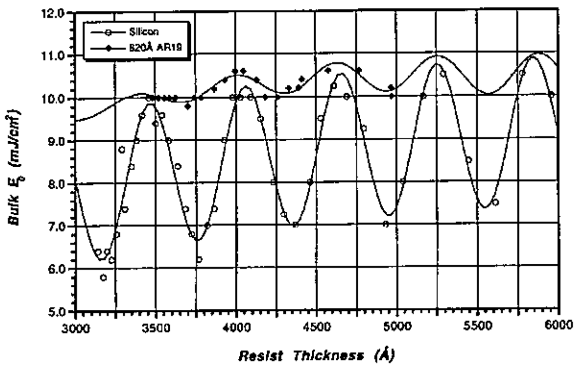
A plot of modeled substrate reflectivity for AR19 over silicon, polysilicon, aluminum, and TiN is shown in *Figure 8.*

Figure 8. AR19 Reflectivity Over Reflective Substrates



The swing curve is reduced from 43% to 6% through the use of AR19 verses silicon and is demonstrated in *Figure 9.*

Figure 9. Interference Curves, Bulk E_0



Line-edge Roughness

AR19 reduces line-edge roughness when compared to silicon, as seen in *Figure 10.* Line-edge roughness is defined as the range of linewidths measured along the line.