brewer science

Where innovation takes flight!℠

Brewer Science® E²Stack® AL412

EUV Assist Layer Material

The biggest problem facing EUV lithographers is solving the RLS trade-off: simultaneous improvement of resolution, line width roughness (LWR), and photosensitivity. E²Stack® AL412 spin-on assist layer material has been shown to reduce line edge roughness (LER) and pattern collapse, planarize topography, protect underlying layers from high-energy EUV photon damage, improve adhesion, and improve pattern transfer etch selectivity.

Benefits

- Reduce pattern collapse and microbridging caused by the high aspect ratios of printed features
- Reduce LER/LWR
- Promote adhesion and reduce the effect of strong capillary forces during development
- Experience less outgassing than positive-tone photoresists during EUV exposure

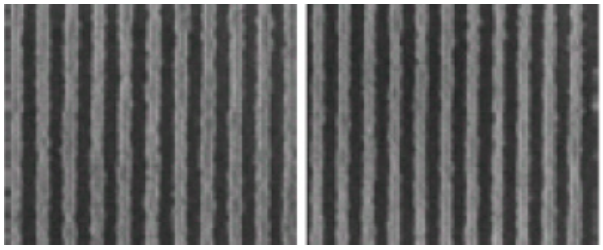
Outgassing Results

5.0×10^{13} molecules/cm², with a range of masses from 35 to 200 amu, excluding CO_2, as measured by SEMATECH EUV ROX system

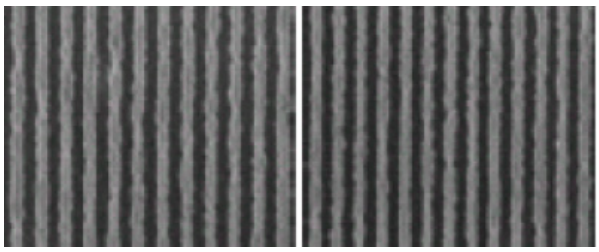
Well below SEMATECH microexposure tool's (MET's) outgassing limit of 6.5×10^{14} molecules/cm²

Results from SEMATECH MET

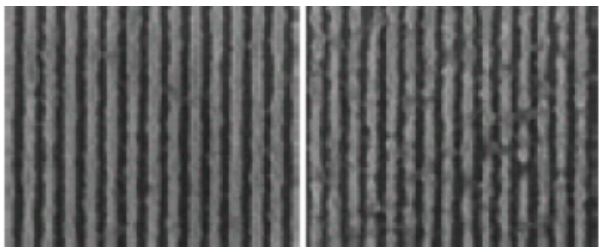
1:1 Lines and Spaces 16.8 mJ/cm²



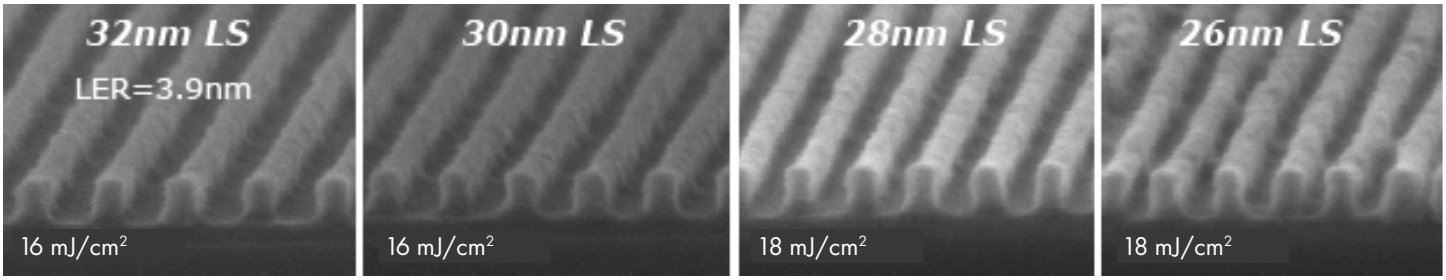
32 nm 30 nm



28 nm 26 nm



24 nm 22 nm



- Use of assist layer resulted in a decrease of LER values to < 4 nm, independent of resist used.
- An ultimate resolution of 26 nm L/S is achieved with good profiles.

imec

Lithography work was performed under the IMEC industrial affiliation program.

Material Properties

Generic Properties:

	248 nm	193 nm	13.5 nm
n	1.45	1.68	~1.00
k	0.44	0.11	0.006

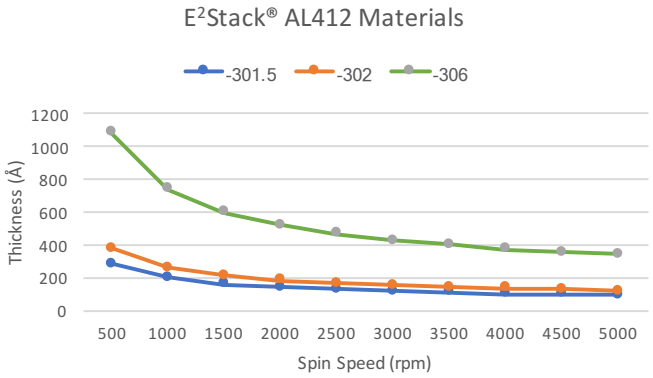
Ions (Al, Cu, Mg, Mn, K): < 25 ppb
Ions (Ca, Fe, Na): < 50 ppb

Shelf Life at 21° ± 5°C: 12 months

Product-Specific Properties:

Material	Thickness	Spin Speed (rpm)	Bake	Viscosity (cP)
E²Stack® AL412-301.5	12 nm	1500 rpm	205°C, 60 s	1.57
E²Stack® AL412-302	20 nm	1500 rpm	205°C, 60 s	1.57
E²Stack® AL412-306	60 nm	1500rpm	205°C, 60 s	1.75

Spin Speed Curve



Processing Conditions

COAT: E²Stack® AL412 material is applied by a spin-coating process. Apply with a dynamic dispense* at 1000 to 4000 rpm and immediately ramp, without a spread spin, to 1000 to 5000 rpm for 60 seconds.

**Dispense speed optimization for equipment set is required for thickness uniformity and defect reduction.*

BAKE: Single-stage hot plate bake at 205° ± 20°C for 60 seconds. Baking temperature optimization may be required to achieve the desired photoresist profile. A prebake of 90°C to 110°C for 30 seconds will increase the planarization of the material.

RESIST COAT: Resist can be applied over the material without any modification to standard resist spin or bake process. An adhesion promoter is not required.

EXPOSURE: In most applications, exposure dose may need to be optimized from that of a stand-alone resist process.

RESIST DEVELOP: Use standard photoresist develop parameters.

DRY ETCH: The material may be dry etched by a number of plasma etch methods in a range of etch gases including O_2, $O_2/CHF_3/Ar$, C_2F_6, Cl_2, N_2/O_2, O_2/HBr, and HCl.

STRIPPING: E²Stack® AL412 material can be removed by an oxidizing plasma or an oxidizing solvent-stripping process such as ozone plasma strip, Piranha, or RCA cleaning.

Effective Date: 06/09/2017