EBL exposure comparison
Applied Quantum Materials AQM SiOx & Dow Corning HSQ

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Aaron Hryciw, PhD, PEng
Fabrication Group Manager
Electron-beam exposure tests of AQM SiOx and Dow Corning HSQ

- Comparison between two silsesquioxane-based negative-tone electron-beam resists:
  - Specimen 1: Dow Corning HSQ, 6% w/w in MIBK (XR-1541-0006)
  - Specimen 2: Applied Quantum Materials AQM SiOx, 6% w/w in MIBK

- Features used for exposure tests: large areas, 1D line arrays (gratings), and 2D dot arrays

- Substrate: 1 cm × 1 cm Si chips, cleaned in 3:1 piranha for 15 min + DI rinse + N₂ dry

- Spin-coat (Brewer Spinner and Hotplate):
  - Dehydration bake: 180 °C for ~19 min
  - Spin: 2-second ramp to 3000 RPM, hold for 60 s
  - Soft bake: 80 °C for 4 min
  - Resist thickness: ~100 nm (contact profilometry after development)

- Exposed using Raith 150-TWO:
  - 30 kV, 7.5 µm aperture, 100 µm × 100 µm writefield, ~8 mm working distance
  - Base doses: 1000 µC/cm² (areas), 2000 pC/cm (single-pixel lines), 0.01 pC (single-pixel dots)

- Develop: 75 s in 25% TMAH (room temperature) + 60 s DI rinse (in beaker) + 30 s DI spray + N₂ dry
Exposure pattern overview

Single-pixel lines, 100 nm pitch

2 µm × 100 µm rectangle for profilometry

Single-pixel dots, 100 nm pitch

DF = Dose Factor. Exposure dose = base dose × DF.
Dow Corning HSQ, 6% w/w in MIBK

Single-pixel lines, 100 nm pitch

Overexposed for DF ≥ 1.0
Dow Corning HSQ, 6% w/w in MIBK

Single-pixel dots, 100 nm pitch

DF: 0.6  0.8  1.0  1.2  1.4  1.6  1.8  2.0

100 nm tall pillars are stable for DF ≥ 1.4
AQM SiOx, 6% w/w in MIBK

Single-pixel lines, 100 nm pitch

Overexposed for DF $\geq 1.2$
AQM SiOx, 6% w/w in MIBK

Single-pixel dots, 100 nm pitch

100 nm tall pillars are stable for DF > 1.2
• Both Dow Corning HSQ and AQM SiOx are both silsesquioxane-based, negative-tone, electron-beam lithography resists with good dry etch resistance, high resolution, and excellent line-edge roughness.

• This study compared Dow Corning HSQ and AQM SiOx, both 6% w/w in MIBK.

• Single-pixel line and dot array structures were successfully fabricated in both HSQ and AQM SiOx on Si substrates using comparable exposure doses (within ~20%).

• Although etch resistance was not tested, these initial results suggest that AQM SiOx could be used as a direct replacement for many existing EBL process flows using Dow-Corning HSQ.