High-sensitivity hybrid EUV resist synthesis via vapor-phase infiltration

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Extreme ultraviolet (EUV) nanolithography resist challenges

Thinner Resist → Improved pattern transfer

High Etch resistance resist → Improved pattern transfer

Higher Resolution
High aspect ratio → Pattern collapse

Improved patterning
Low aspect ratio pattern transfer

Atomic absorption cross section

Organic

High aspect ratio
Pattern collapse

Inorganic

Improved pattern transfer


Brookhaven National Laboratory Center for Functional Nanomaterials
Infiltration synthesis using ALD system

ALD - Surface-limited reaction & thin film deposition

Infiltration synthesis: Precursor diffusion & binding
Infiltration synthesis of hybrid resists

**Enhanced EUV Sensitivity (Improved Productivity)**

- **Zn** (Zinc) 65.39
- **In** (Indium) 114.818
- **Sn** (Tin) 118.71
- **Hf** (Hafnium) 178.49

**Tunability of compositional distribution**

![Images showing compositional tunability](image)

**Enhanced Etch Resistance**

- **Si nano-fins aspect ratio ~17**
- **31.6 nm**
- **533 nm**

- **Etch Rate for Cryo Si Etch Recipe (nm/sec)**
  - ~70
  - ~300
  - SiO₂ Selectivity
  - ZEP Selectivity

- **Number of Infiltration Cycles**

Monotonic increase for AlO$_x$ infiltration - internal crosslinking

Al primed ZnO$_x$ & Al primed SnO$_x$, drop in critical dose with sufficiently high infiltration

Increased EUV absorption due to Zn or Sn maybe compensating increased dose requirement due to inter-crosslinking
Controllable $\text{ZnO}_x$ infiltration into HSR & preliminary EUVL results

Controllable infiltration depths

Cross section of HSR-Z2C4 after post-infil bake

HSR-Z0C0

| 78 mJ/cm$^2$ |

HSR-Z2C4

| 72 mJ/cm$^2$ |
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