Size and Shape Control in Nanoimprint Resist Patterning and During Pattern Transfer with Applications in CMOS Memory Scaling

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Complex nanoshaped structures – defined here as shapes enabled by sharp corners with radius of curvature <5 nm – have potential applications in electronics, optics, and biomedicine. Nanoshaped fabrication at high throughput is well beyond the capabilities of advanced optical lithography. While the highest-resolution e-beam processes (Gaussian beam tools with non-chemically amplified resists) can achieve such nanoshapes, this is only available at very low throughputs with limited practical applications.

This presentation will explore the scaling of these nanoshaped structures to 15 nm half-pitch and below. At these scales a new "shape retention resolution limit" is observed due to polymer relaxation in imprint resists, which cannot be predicted with a linear elastic continuum model. An all-atom molecular dynamics model of the nanoshape structure has been developed to study this shape retention phenomenon and accurately predict the polymer relaxation. This modeling framework has been used here to propose process refinements that maximize shape retention, and design template assist features (design for nanoshape retention) to achieve targeted nanoshapes. This talk will also describe pattern transfer of nanoshaped resist patterns. An integrated view of nanoimprint and pattern transfer is needed to obtain nanoshaped structures in functional films and substrates. Finally, this presentation will discuss a potential application of nanoshape patterning in DRAM fabrication for sub-15nm half-pitch design rules. Current status and future challenges involved in deploying nanoshape structures in DRAM fabrication will be presented.