Directed Self-Assembly for Nanolithography: Writing with Polymers

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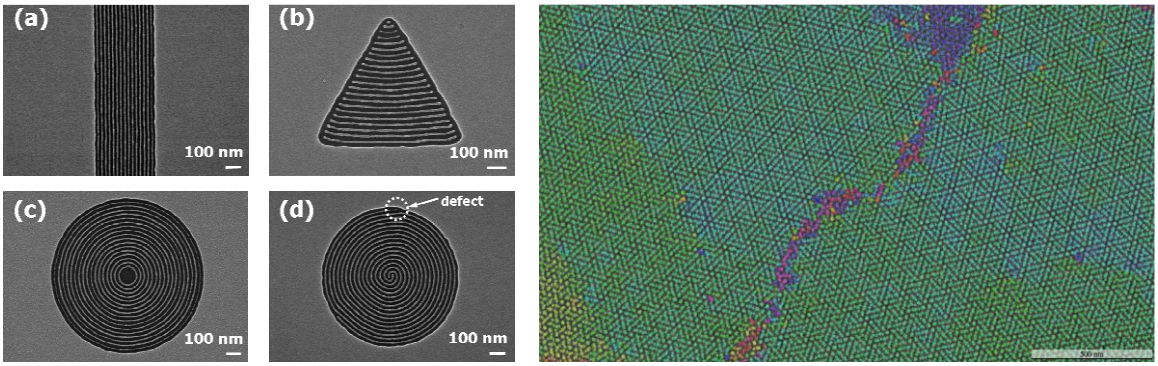
Nanopatterned surfaces are of central importance to a variety of areas and applications, such as computer chip architectures, tissue interfacing, biosensors, light management and plasmonics, among others. One of the most important materials for a myriad of functions is silicon, as the functionalization of silicon surfaces is of interest for computing applications, water splitting, batteries, on-chip sensing, molecular electronics, and solar energy conversion, amongst many others. Typically, the various approaches to nanopatterning of surfaces, including silicon, are broken into two major classes: top-down methods such as photolithography, e-beam lithography and scanning force microscopy variants, and bottom-up synthetic techniques, including self-assembly. Since lithography is the single most expensive step in computer chip manufacturing, the use of self-assembled block copolymers (BCPs) templates on surfaces is being seriously considered by the semiconductor industry to pattern, sub-20 nm features on a semiconductor surface; the Industry Technology Roadmap for Semiconductors (ITRS) terms this development 'directed self-assembly', or DSA. Here, we will describe the remarkable versatility of using BCPs, polymers that contain sufficient chemical information to form highly ordered templates over large areas. These templates, which range from arrays of parallel lines, to dots, to much more complex Moiré superlattice patterns, can be converted into functional materials, such as metal nanostructures, molecules-on-silicon, and plasmonic stamps. The versatility of using self-assembly will be combined with large-scale statistical analysis of 'quality', to better understand both the promise and limitations of this approach to nanopatterning surfaces.



Left: Figures a-d, aligned nanowires of platinum, prepared via directed self-assembly. **Right**: large-scale Moiré nanopatterns of ~10 nm silica dots with 3-fold symmetry produced through incommensurate block copolymer self-assembly. Scale bar = 500 nm.

References:

1. Jin, C.; Olsen, B. C.; Luber, E. J.; Buriak, J. M. Preferential Alignment of Incommensurate Block Copolymer Dot Arrays Forming Moiré Superstructures. *ACS Nano,* **2017,** *11,* 3237-3246.
2. Jin, C.; Olsen, B. C.; Luber, E. J.; Buriak, J. M. Nanopatterning via Solvent Vapor Annealing of Block Copolymer Thin Films. *Chem. Mater.,* **2017,** *29,* 176-188.