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Directed Self-assembly for Lithography Applications

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Economics dictated that semiconductor devices need to be scaled approximately to 70 percent linearly in order to follow the pace of Moore's law and maintain cost effectiveness. Optical lithography has been the driving force for scaling; however, it approaches its physical limit to print patterns beyond 22nm node. Directed self-assembly (DSA), which combines "bottom-up" self-assembled polymers and "top-down" lithographically defined substrates, has been considered as a potential candidate to extend optical lithography. Benefit from nanometer-scale self-assembly features and the registration precision of advanced lithography, DSA provides precise and programmable nanopatterns beyond the resolution limit of conventional lithography. We have demonstrated DSA concepts including frequency multiplication and pattern rectification using guiding prepattern with proper chemical and topographical information generated by e-beam lithography. In addition, we seek to integrate DSA with 193 nm optical lithography in a straightforward manner in order to move DSA from the research stage to a viable manufacturing technology. Recently, we implemented various integration strategies using photolithography to produce guiding patterns for DSA. This new ability enables DSA to be applied to large areas with state-of-the-art lithography facilities.