PS-b-PHEMA: A Promising High χ Polymer for Directed Self-Assembly Lithography

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As the semiconductor industry moves to smaller and denser IC manufacturing, directed self-assembly (DSA) of block copolymers has been shown to be a promising alternative lithographic process for production of sub-30nm pitch structures. PS-b-PMMA has been widely studied and has been shown to be capable of self-assembly into large areas of regular grating structures with low defectivity using chemoepitaxial guiding methods. However, PS-b-PMMA has a practical DSA patterning pitch limit greater than 20 nm due to the modest χ value for PS-b-PMMA (0.038). One of the goals of our work has been to explore and develop alternative high χ value polymers that possess all of the requisite properties to be good candidates for DSA lithography. In this paper, poly(styrene)-b-poly(hydroxyethylmethacrylate), PS-b-PHEMA, will be discussed as a candidate for replacing PS-b-PMMA in DSA lithography. Due to the relatively strong hydrogen bonding provided by the HEMA group, it will be shown that PS-b-PHEMA possesses a χ value greater than 0.35 (i.e. roughly an order of magnitude greater than PS-b-PMMA or more) and is easily capable of producing grating patterns with pitches on the order of 10nm. It will also be shown that the etch contrast of PS-b-PHEMA in oxygen-type RIE block removal processes is approximately 1.5X to 2X that of PS-b-PMMA. It will be shown that PS-b-PHEMA can be rapidly thermally annealed on chemoepitaxial guiding layers to produce high quality grating patterns. The optimization of neutral and chemoepitaxial guiding layers for PS-b-PHEMA will also be discussed.