Effect of processing parameters on self-assembly of cylindrical phase PS-b-PMMA BCPs on 300 mm Si wafers

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In this work, we investigate the effect of processing parameters, film thickness and annealing conditions, on micro-phase separation and domain orientation of cylindrical phase block copolymers (BCP) on 300 mm Si wafers. After surface treatment using a neutral layer and upon thermal annealing, the BCP film spontaneously separates into a hexagonal array of micro-domains that are oriented perpendicularly to the surface. The film was exposed to ultraviolet radiation in order to crosslink the PS and degrade the PMMA. Subsequently PMMA was removed by rinsing with organic solvent, creating a nano-porous template with well-defined pore dimensions. The templates developed with this method are proposed to be used as hard masks for various applications. We characterized the films and plot process windows in order to compare two BCP formulations; A and B, with natural periodicities of 29 nm and 37 nm, respectively. From previous works[1], it has been seen that the thickness of block copolymer films influences the equilibrium morphology of cylindrical domains. Our study shows a stable process window with good morphology for film thickness from $0.7L_0$ to $1.5L_0$ for BCP A, and from $0.7L_0$ to $1.0L_0$ for BCP B, where L_0 is the center-to-center distance of adjacent PMMA blocks. Power spectrum analysis was used to determine the effect of annealing conditions on periodicity. We obtained no significant change in the periodicity when we varied the temperature from 200 to 260 C. Pore size distribution was determined from top down SEM images using image processing algorithms. The size and spatial distribution of PMMA pore in the PS matrix for BCP A as well as BCP B are Gaussian distribution, all the results are discussed in details in this work.

Keywords: *block copolymer, self-assembly, micro-phase separation, cylindrical phase, neutral layer, periodicity.*

[1] E Han, et all, Macromolecules 2008, 41, 9090-9097