Characterisation of optical diffraction metrology templates for self-assembled block co-polymers fabricated by nanoimprint lithography

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Sub-wavelength diffraction metrology is a new technique which has been used to characterise structures with critical dimensions as small as 50 nm, to distinguish defects[1] produced during the nanoimprint process. The technique analyses a single diffraction pattern image from grating test structures, and based on the relative diffraction intensities, information can be obtained about the critical dimension, height and presence of defects in the structures.

Self-assembly of block co-polymers (BCPs) is a powerful technique enabling the fabrication of highly-ordered nanostructures by natural forces, overcoming the resolution limitations of conventional top-down techniques, such as optical or electron-beam lithography. The exploitation of self-assembly requires reliable, non-destructive metrology. One of the most important methods of guiding the structure to achieve high structural regularity is graphoepitaxy, where a precisely defined surface topography is used to confine the self-assembled structure.

For this work, topographical templates, consisting of linear gratings, were fabricated in silsesquioxane (SSQ) by a two step nanoimprint process. Firstly a silicone imprint was made from a master stamp, originally fabricated by UV optical lithography. The silicone stamp was then used to imprint in UV-curable SSQ to form a hard template for BCP assembly. The measured optical diffraction signal for the SSQ templates (wavelength 488 nm, incident angle 17°) is in good agreement with optically modeled signals generated using the rigorous coupled wave analysis (Figure 1), and the dimensions of the lines closely match results obtained using atomic force microscopy (Figure 2). These results demonstrate the suitability of optical diffraction as a metrology technique for shallow SSQ templates for use in the self-assembly of BCPs. Optical simulation results indicate that this metrology has potential for use in characterizing copolymer structures themselves (Figure 3).

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[1] T. Kehoe, V. Reboud, C. M. Sotomayor Torres, Microelectron. Eng. **86**, 1036 (2009).

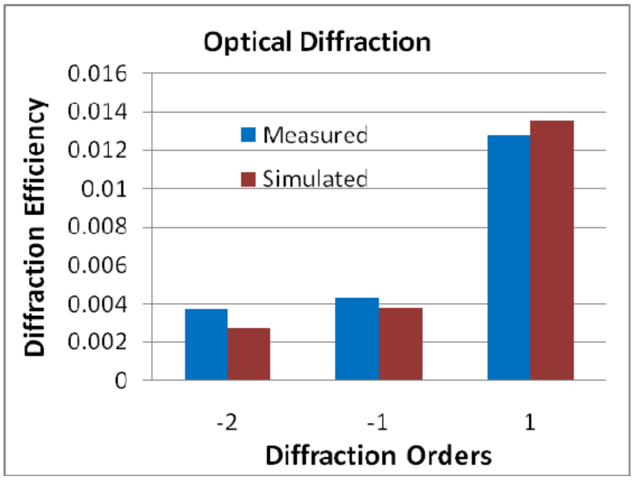

Figure 1: Agreement between measured and simulated diffraction efficiencies.

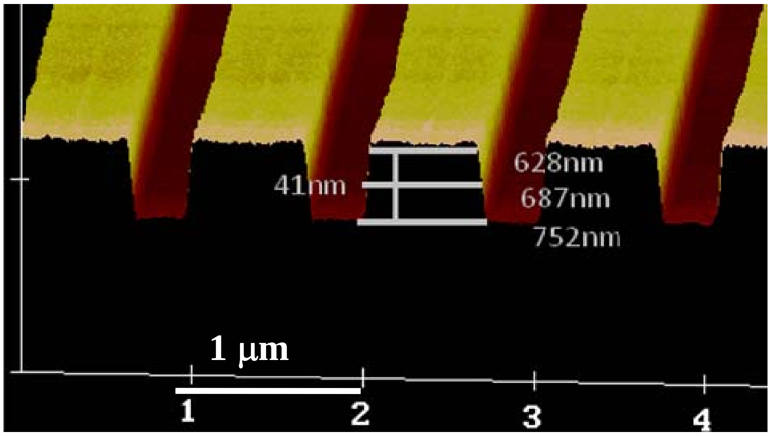

Figure 2: Dimensions of the lines obtained by optical diffraction compared to atomic force microscopy cross-section.

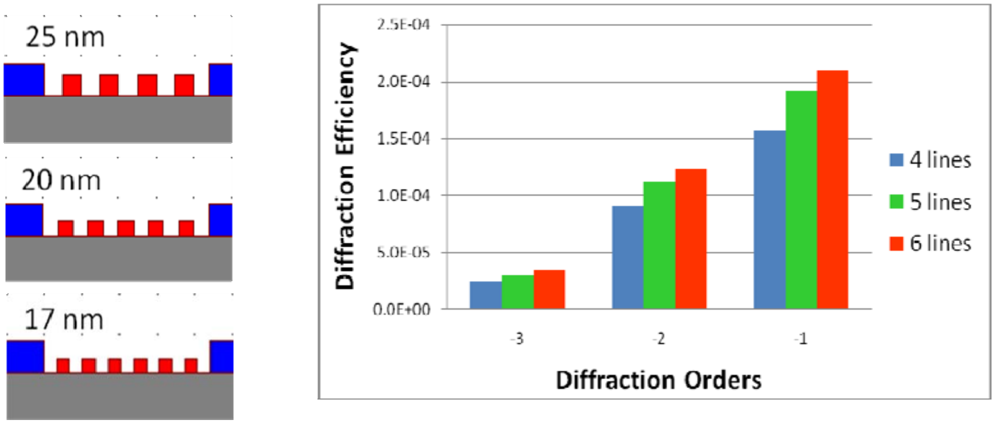

Figure 3: Optical simulations showing a significant change in optical diffraction intensities depending on the number and size of BCP lines in a template of fixed size.