Nanoimprint Induced Block Copolymer Self-Assembly

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Directed self-assembly (DSA) of block copolymers (BCP) has shown remarkable development for advanced nanolithographic applications. Periodic dense arrays of nanodomains can be generated with extremely low defect density.[1] DSA using topographic or chemical pre-patterns has attracted significant attention due to its ability to realize large area, high resolution nanofabrication.[2, 3] However, the success of these techniques require generation of a pre-patterned surface for each self-assembly step using expensive lithographic tools.

Here we align block copolymers using thermal nanoimprint lithography (NIL), a process capable of high-throughput, high resolution, low-cost patterning.[4] The general principal is outlined in Figure 1. The thermal nanoimprint technique induces physical deformation of the block copolymer film. The block copolymer assembly within the mold is guided by the topographic pattern and after release the pattern can be transferred to the underlying substrate. Sub-10 nm features were aligned and transferred into an underlying oxide substrate (Fig. 2). Alternatively, we can pattern the BCP within wider molds to realize pattern density multiplication of ~50:1. The mold integrity is maintained and can be used to pattern addition samples. Hence, DSA of polymers via NIL technique offers a simple route to fabricate ultrahigh resolution patterns. Here we will discuss conditions important for successful DSA of BCP via NIL. In addition, we will show how to high resolution pattern transfer is accomplished to generate periodic dense arrays of sub-10 nm features in silicon dioxide.

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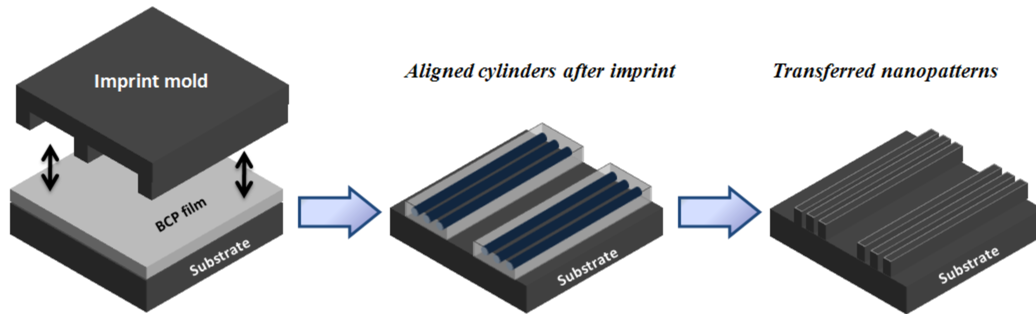

Figure 1: Schematic of Imprint and Pattern Transfer Process: Nanoimprint mold is fabricated in silicon using electron beam lithography and etching. BCP nanopatterns are transferred into the underlying substrates using RIE.

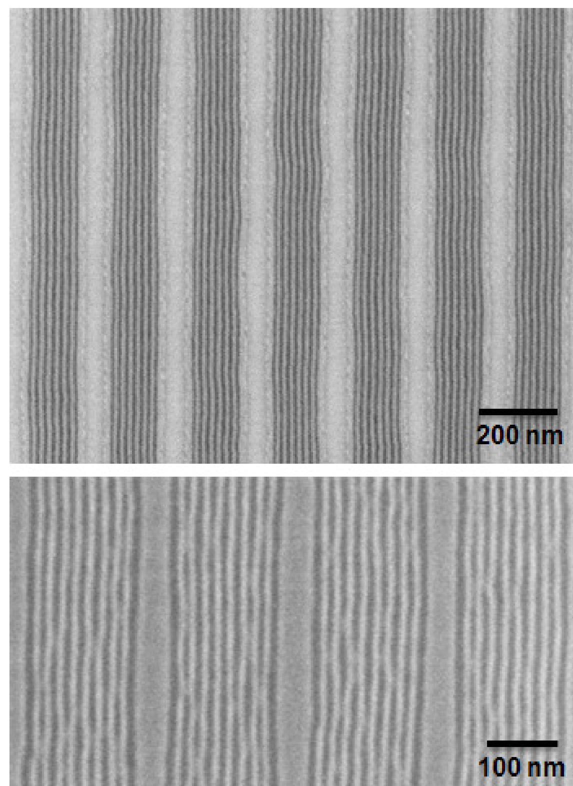

Figure 2: Imprinted BCP domains and Patterned Substrates: Aligned BCP domains are used as a template for pattern transfer of sub-10 nm patterns into underlying substrate.