Integration of scanning probe lithography with directed self-assembly of PS/PMMA based block-copolymers

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Directed self-assembly (DSA) of Block copolymers[1] (BCPs) is becoming a well-established method with a high potential of gaining industrial relevance due to high throughput and process simplification compared to other approaches. BCPs are macromolecules that are formed by two (or more) chemically distinct polymer chains (blocks) joined by interblock covalent bonds. In order to minimize the contact area between them, the blocks tend to separate due to a balance between repulsive intermolecular and attractive restore forces. This segregation leads to a regular arrangement of different structural configurations (plates, cylinders, spheres, or lamellae) depending on the ratio of molecular weights of the blocks. They possess the intrinsic property of forming dense nanoscale structures whose length scales are not accessible using traditional lithographic techniques.

Chemical guiding patterns are created on neutral surfaces that are usually prepared by depositing or grafting a polymer *brush layer*, which presents equal affinity for both blocks of the copolymer. The procedure for defining the *chemical guiding pattern* consists of creating a mask on top of the brush layer and then using this mask for a selective etching or exposure process. The mask is usually created by means of a standard lithography process (either DUV lithography or e-beam lithography). Different scanning probe lithographic techniques[2] might offer unique advantages if integrated in the DSA process. We will present how thermal probe lithography (tSPL)[3] has been used to create guiding patterns and the outcome will be compared to previous work done employing AFM oxidative nanolithography[4].

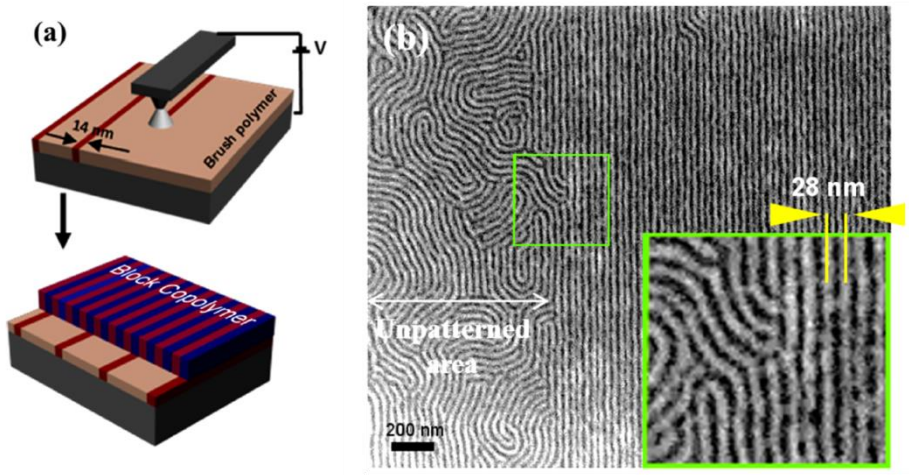

Figure 1. (a) Scheme of the process for DSA of BCP by AFM oxidation nanolithography. The AFM tip creates chemical patterns by local anodic oxidation on a PS−OH brush layer. After creation of the guiding pattern, the block copolymer is deposited and annealed.(b) SEM image showing the aligned block copolymer on top of the guiding pattern and the nonaligned polymer on top of the un-patterned area. Scale bar is 200 nm. (Inset) Magnified image of the area indicated by the green square.

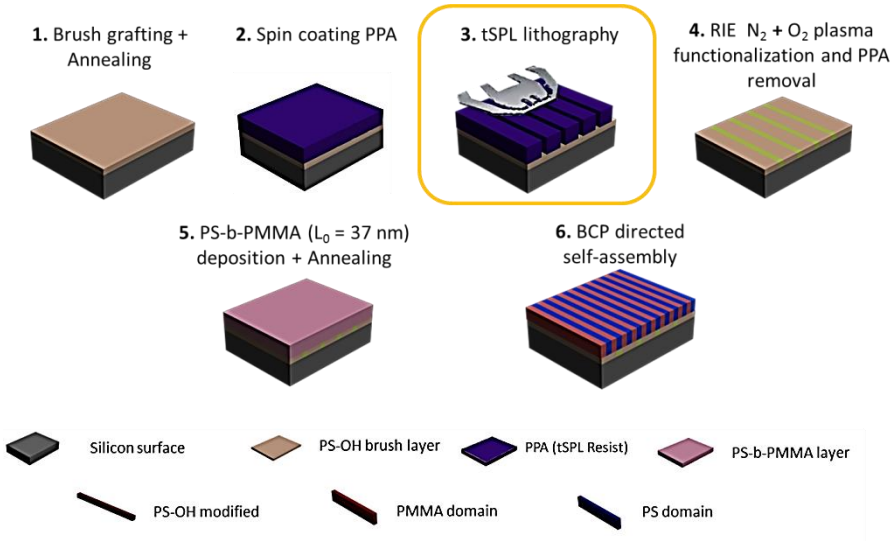

Figure 2. The process flow describing the integration of t-SPL with directed self-assembly of PMMA/PS based BCPs. Polyphthalaldehyde (PPA) resist is spin coated on the polymer brush (in this case PS-OH brush). Then the lithography step is performed with the desired pattern. Each "lamellae like" BCP needs a particular pattern in terms of periodicity and line width.

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