Directed self-assembly of PS-PEO using solvent vapors assisted nanoimprint lithography

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Soft lithographic techniques such as nanoimprint lithography (NIL) have been employed to fabricate nanometric sized features on surface in a large-area and in a reproducible manner. More recently, combining NIL with directed self-assembly (DSA) of block-copolymers (BCP) has permitted to lower the feature size to tenths of nanometers modulating the physical confinement of the polymers blocks with the stamps feature sizes.[1, 2] These pioneering approaches, while effective, are affected by the BCPs glass transition, since when is too high, ends in decomposition of the material. Such restriction limits strongly the use of a wide variety BCPs that in theory could be interesting for DSA. To overcome this shortcoming, we have combined nanoimprint lithography with solvent annealing rather than thermal annealing, the so-called solvent vapors assisted nanoimprint lithography (SVA-NIL).[3] In this technique, to imprint the polymers it is needed a certain fluidity that is achieved by swelling the polymer with specific solvent vapors instead of overcoming its glass transition. It has been shown that in this technique, the temperatures needed can be as low as 50ºC and pressures around mbars instead of the high pressures required in thermal NIL. SVA-NIL concerns three steps: swelling of the polymer, printing while swelling, and finally drying while printing. To demonstrate this technique, we have employed SVA-NIL in commercially available lamellar polystyrene-b-polyethyleneoxide (PS-b-PEO) and used moist toluene vapors. The time required for swelling was seen to be only few minutes and the drying step was only thirty minutes. The AFM image of a printed area with squares of 200x200μm showed the PS-b-PEO microphase segregation organized in vertical lamellas outside the squares with a 35nm pitch. More interestingly, it was observed that inside the squares the BCP arranged in horizontal lamella. Therefore, it is a very promising technique to modulate BCPs feature size where can be obtained a highly ordered BCP with alternating fashions in a one step procedure in mild conditions.

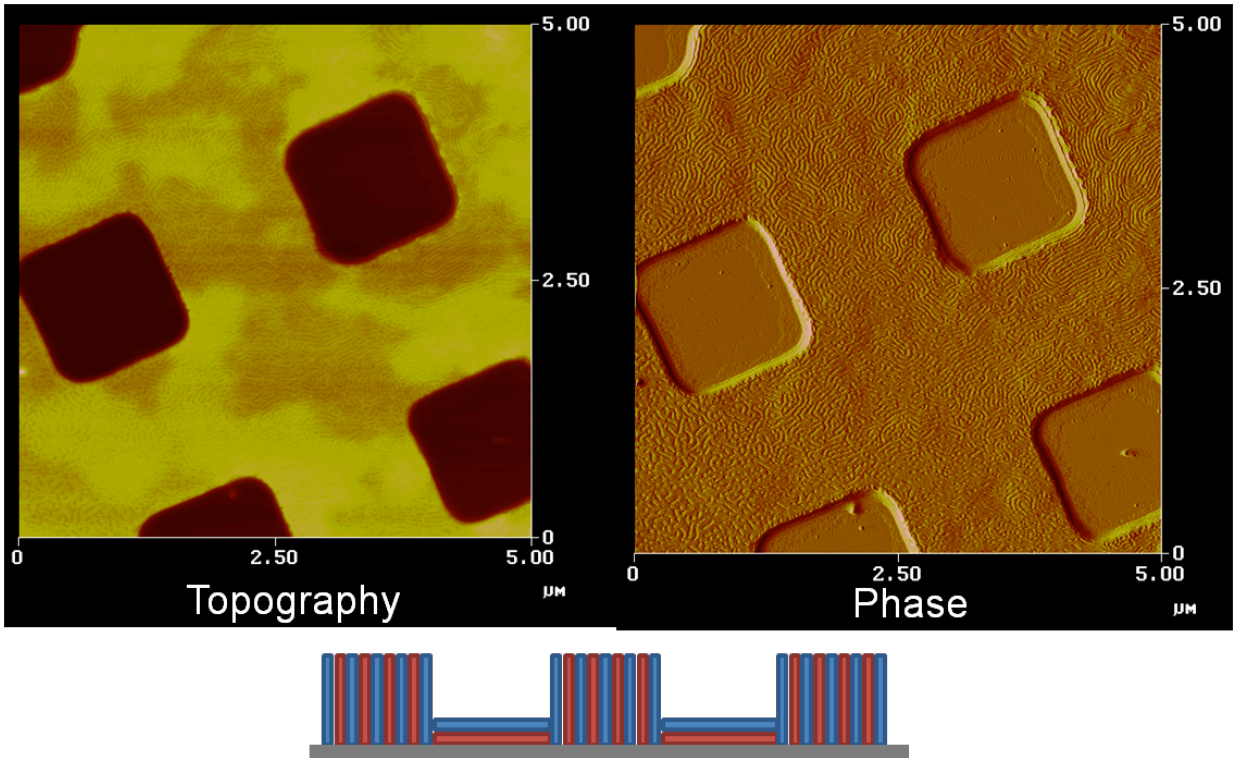

Figure 1: Directed self-assembly of PS-PEO by solvent vapors assisted NIL: The squares 200x200µm of the NIL silicon stamp provide the correct confinment to obtain directed self-assembly of a thin film of PS-PEO. The technique employed, SVA-NIL, allows to obtain microphase segregation of BCPs at very low temperatures and pressures, using solvent annealing.

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