Diblock Copolymer Ordering by NanoImprint Lithography

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The ability to produce ever more powerful integrated complex devices or materials with new properties arises from the continuing advances in the materials synthesis and processes developments used to define patterns with continuously decreasing feature size. Despite development of sophisticated, but costly, patterning processes, top-down lithography is now running up against its fundamental limits, and alternative, 'bottom-up' approaches based on self-assembly have been proposed. One of them consists in using block copolymers (BCP) with almost continuously tuneable resolution from several tens to hundreds of nanometers. Although microphase separation leads to perfectly regular structures at the scale of the lamellar period, many defects exist at a larger scale of what could constitute a device (hundreds of micrometers).
The challenge of organizing BCP films in defect-free nanostructures has been addressed mainly by guiding the structures at a scale of the order of the BCP characteristic size using: chemical constraints at the scale of the chains achieved by substrate pre-patterning [1]; or graphoepitaxy where artificial substrate topography is created to influence and control the BCP domain orientation [2]. However the original silicon wafer has to be patterned for each sample.
In this paper we propose a new nanoscale patterning technique for large surfaces based on BCP ordering and NanoImprint Lithography. In our approach molecular ordering (short-scale) is provided by imprinted BCP formulations and self-assembly while long-scale organisation is driven by topography induced with NIL mold (figure 1), re-useable several times (> 1000 times). Combining BCP and NIL we will show how molecular patterning can now be controlled over wafer scale (figure 2). This process represents thus a true new competitive process due to its ease of implementation and low cost.

[1] Stoykovich M. P and al., Directed Assembly of Block Copolymer Blends into Nonregular Device-Oriented Structures, Science 308, 1442, 2005.
[2] Park S.-M and al, Directed Assembly of Lamellae- Forming Block Copolymers by Using Chemically and Topographically Patterned Substrates, Advanced Materials 19, 607, 2007

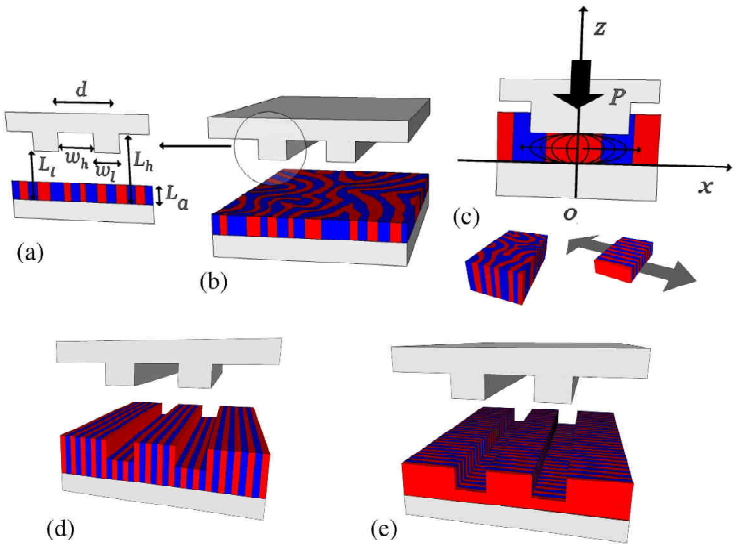

Figure 1: Schematics of the NIL process. Si mould (a, b, c) is printed at a in a BCP film. BCP organisations (d, e) tailored with NIL processes.

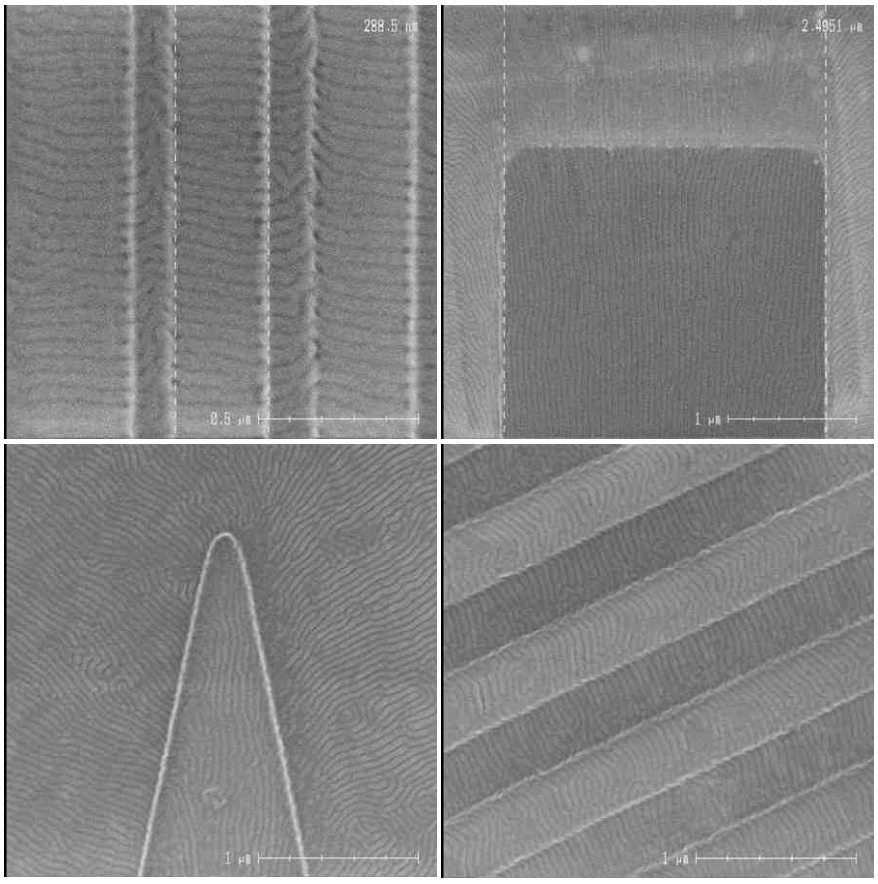

Figure 2: Scanning electron microscopy (SEM) images of PS52K-b-PMMA52K diblock copolymer films after NIL processing.