

## Directed self-assembly of block copolymers for sub-10 nm resolution lithography

Achmad Fajar PUTRANTO ([achmad-fajar.putranto@univ-grenoble-alpes.fr](mailto:achmad-fajar.putranto@univ-grenoble-alpes.fr)), Marc ZELSMANN

Laboratoire des Technologies de la Microélectronique  
Univ. Grenoble Alpes, CNRS, CEA/LETI-Minatec, LTM, 38000 Grenoble

Block CoPolymers (BCP) are composed of two or more chemically distinct polymers linked by covalent bonds. When self-assembled, these systems form periodic patterns in the length scale of 10-50 nm.<sup>1,2</sup> The patterns size is function of the number  $N$  of monomers in the polymers as well as the Flory-Huggins parameter  $\chi$  which is, in short, an indication of the chemical differences between the monomers. Sub-10 nm features can be achieved using low- $N$  and high- $\chi$  BCPs which is of particular interest for the micro-electronics industry (since such resolutions are challenging and costly to obtain with standard lithography techniques) but also for applications in nanoscience, sensing or photonics.

Nevertheless, using high- $\chi$  BCPs for nano-lithography is quite challenging. The orientation of the polymer micro-phases in thin film is strongly dependant on the nature of the interfaces (substrate and air) that are in contact with the BCP. Often, an intermediate layer between the substrate and the BCP, called *brush*, and a top-coat onto the BCP layer, are needed to control these interactions.<sup>3</sup> Moreover, without external guiding, ordering of BCPs is only obtained in grains not larger than a few micrometers. To circumvent this limitation chemical or topographical confinement are necessary. In graphoepitaxy, trench walls confine the polymer and guide the chains organization.<sup>4</sup>

Here, the proposed work will consist in realizing graphoepitaxy experiments using high- $\chi$  BCPs into trenches on silicon substrates. The influence of the BCP composition, layer thicknesses, brush and top-coat composition and self-assembly process by thermal annealing will be shown. Results will be observed by scanning (transmission) electron microscopy after a dedicated plasma etching process.<sup>5</sup> Example of vertically or horizontally aligned polymer micro-phases are reported below (Fig. 1).

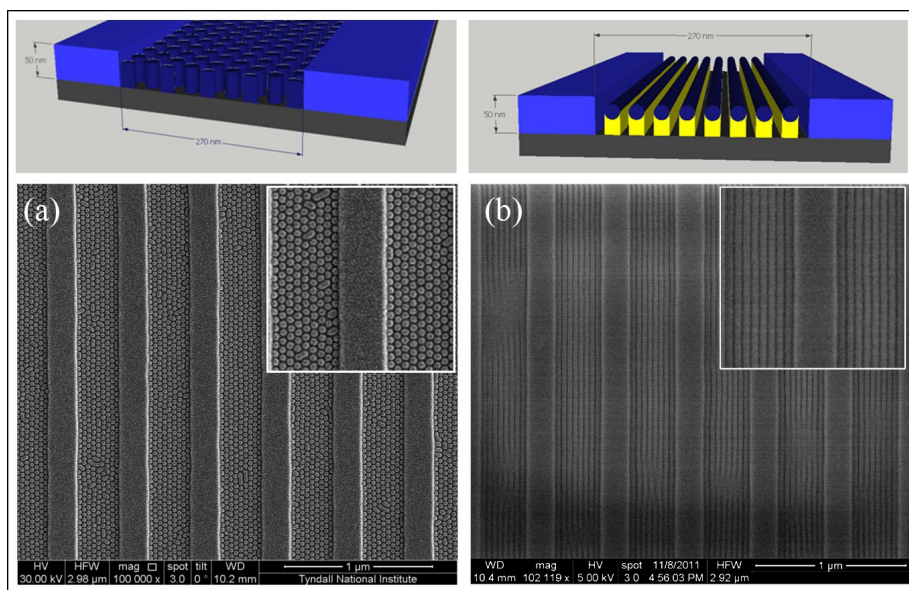


Figure 1. Graphoepitaxy of a high- $\chi$  BCP (PS-*b*-PDMS).

<sup>1</sup> Park M 1997, Science 276 1401

<sup>2</sup> Kim H-C C 2010, Chemical Reviews 110 146

<sup>3</sup> Chevalier X 2021, ACS Appl. Mater. Interfaces 13 11224

<sup>4</sup> R. A. Segalman R A 2001, Adv. Mater. 13 1152

<sup>5</sup> Pound-Lana G 2021, ACS Appl. Mater. Interfaces 13 49184