MAGNIPHICO

MAGNetic storage media and lithograPHIc processes based on block-COpolymers self-assembly

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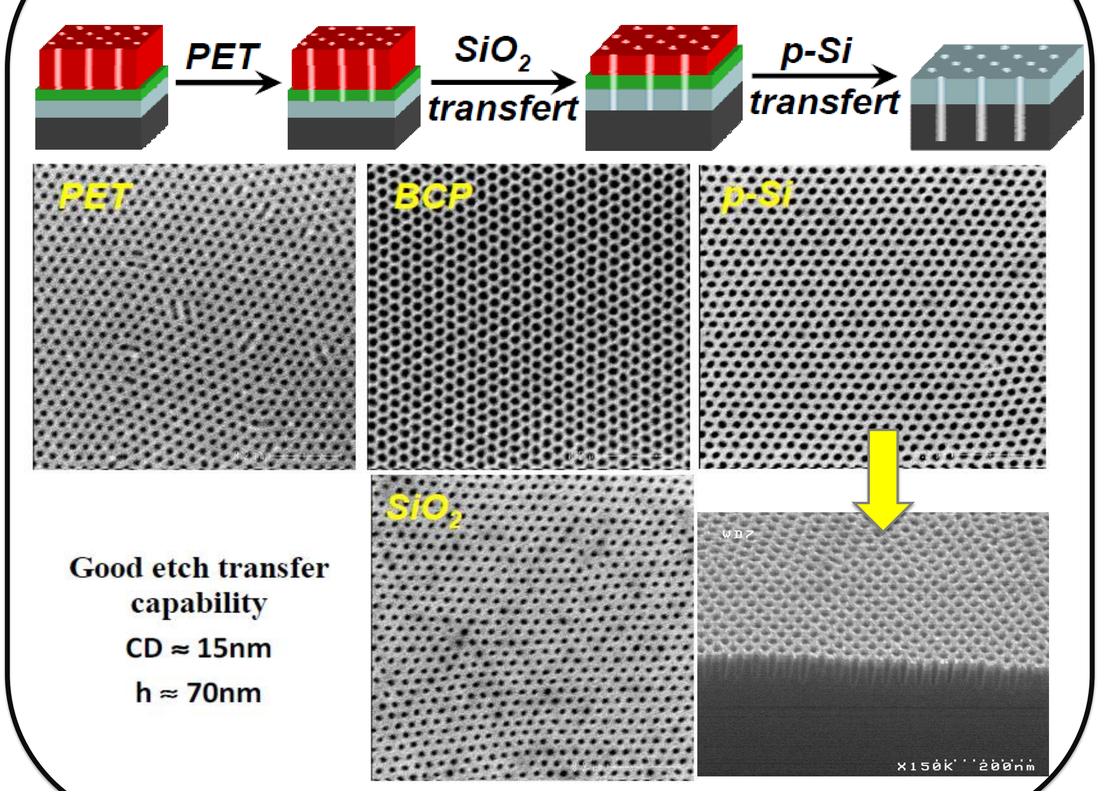
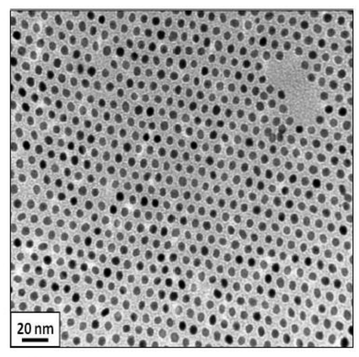
AGENCE NATIONALE DE LA RECHERCHE ANR

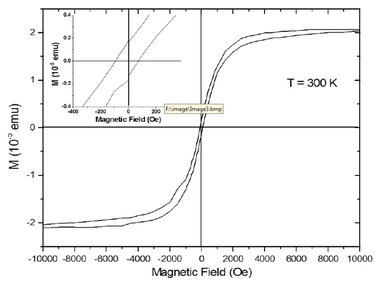
Context: In the MAGNIPHICO project it is proposed to use the block copolymer self-assembling properties as well as their ability to form well controlled nanostructures as templates and/or scaffolds in order to achieve resolutions in lithographic processes beyond the ones used. It is also proposed to use composites of block copolymers with state of the art magnetic nanoparticules in the form of inks for the manufacturing of thin film nanostructured and large scale ordered magnectic media for ultra dense magnetic storage applications.

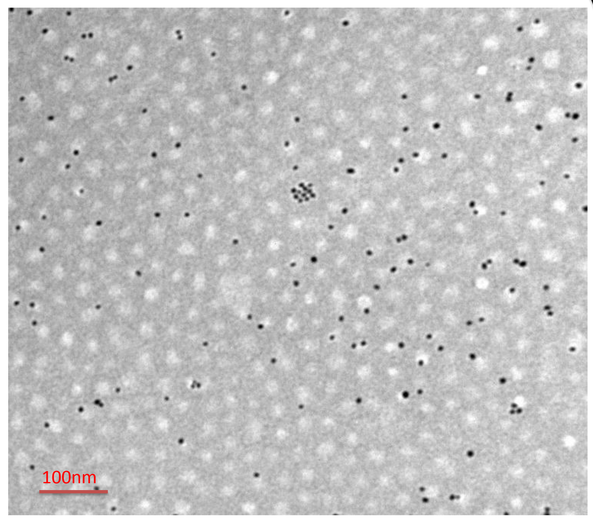
Plasma-etching: BCP transfert *LTM, CEA-LETI*



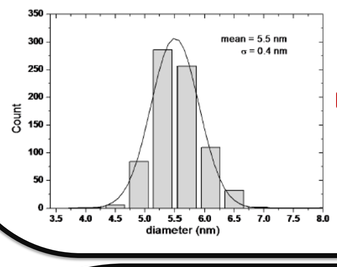
FePt magnetic nanoparticules: *ICMCB, LCPO*





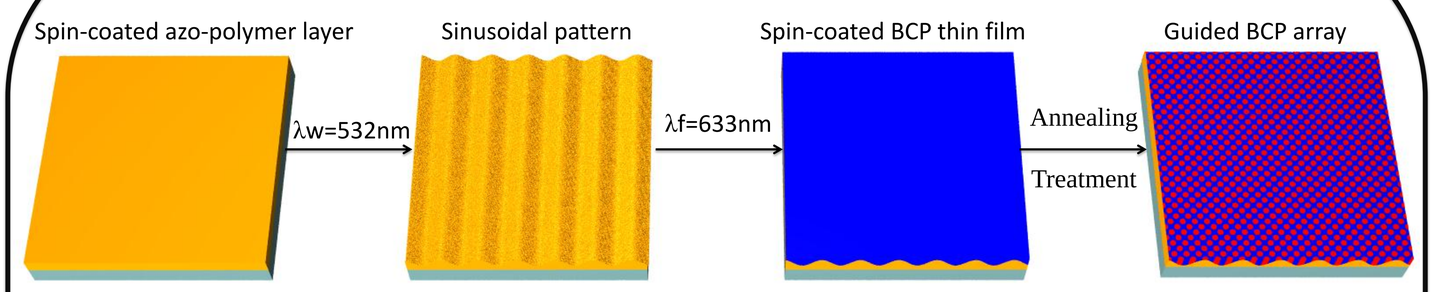


$L1_0$ ordered NPs with a core diameter of about 5,5nm (σ=0,4nm)



Magnetic thin films consisting of FePt NPs located within PEO domains

Mass transport lithography: *LOMA, LCPO*

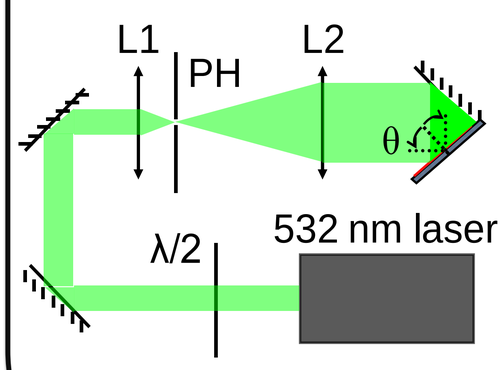


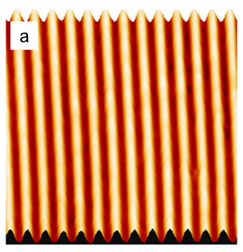
Graphoepitaxy: *CEA-LETI, Arkema, LCPO*

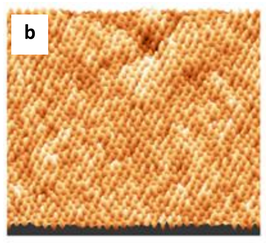
Delaunay Triangulation

Minimum of defects attended ⇔ commensurability respected
(L and S integer of $a_0 = (\sqrt{3}/2)\ L_0$)

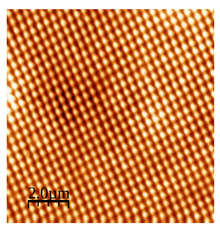
Lloyd's Mirror Setup:

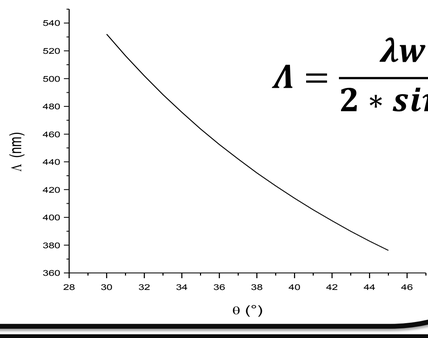






Stripe
Waffle

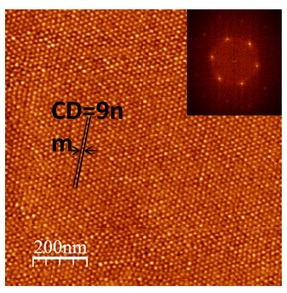




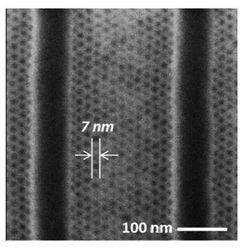
$$\Lambda = \frac{\lambda w}{2 * sin\theta}$$

High-χ Block-Copolymer: *LCPO, Arkema, CEA-LETI*

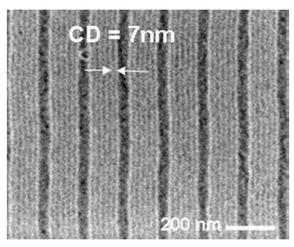
- Contained Fe, Si atoms
- CD of PS-b-PMMA=15nm
PS is a poor etch mask
- CD of High-χ BCP= 7-9nm



AFM phase image



SEM images



- **Possibility to obtain well-ordered nanostructures with sub-10 nm pitch**

Conclusion and Outlooks:

- BCP DSA shows high potential for lithographic applications (High-χ BCP is the way to follow to further increase the resolution).
- Defectivity of BCP self-assembly can be optimized by confinement methodology (*i.e.* graphoepitaxy obtained by 193nm lithography or e-beam lithography).
- Mass transport lithography brings a fast and inexpensive alternative to common confinement techniques.
- BCP self-assembly shows high potential for the spatial ordering of inorganic functional nanoparticules (*i.e.* magnetic in the Magniphico project).

Hexagonal-to-cubic phase transformation in composite thin films induced by FePt nanoparticles located at PS/PEO interfaces, Aissou et al., Langmuir, 2011.
Optimization of block copolymer self-assembly through graphoepitaxy: A defectivity study, Tiron et al., Journal of Vacuum Science and Technology B: Microelectronics and Nanometer Structures, 2011.
Nanoscale Block Copolymer Ordering Induced by Visible Interferometric Micro-patterning: a Route towards Large Scale Block Copolymer 2D Crystals, Aissou et al., Advanced Materials, 2012.

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