Particle co-operated self-assembly in thin film of diblock copolymer

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Microphase separated mesoscopic lattice structures in a thin film of a block copolymer can be used as a template to achieve an ordered arrangement of nanoparticles [1-3] in order to produce new generation hybrid materials toward potential applications such as chemical sensor, biosensor, catalysts, chemical separation, photonic materials and high-density data storage. During the self-assembly process in a block copolymer film, van der Waals forces and balance of surface free energies lead to a spatial arrangement of the nanoparticles inside the domain-structures of the film. We have investigated the role of nanoparticles in such a kind of particle co-operated self-assembly process and the domain orientation in asymmetric block copolymer films with grazing incidence small-angle X-ray scattering (GISAXS) [4]. Thin films of polystyrene-*block*-polymethylmethacrylate P(S-*b*-MMA) containing varying amount of iron oxide nanoparticles are prepared on top of silicon substrates by spin-coating. During annealing at above the glass transition temperature of the P(S-*b*-MMA) block copolymer, the nanoparticles migrate to the cylindrical domains of PMMA. This results in an increase of diameter of the cylindrical domains and cylinder-to-cylinder distances. Besides, an addition of a small amount of nanoparticles orients PMMA domains perpendicular to the substrate. Thus, an ordered array of magnetic nanoparticles hosted by perpendicularly oriented PMMA domains is prepared. GISAXS experiments have been carried out at the beam line BW4 [5] of the DORIS III storage ring of HASYLAB at DESY in Hamburg. Atomic force microscopy (AFM) and scanning electron microscopy (SEM) have been used to image the spatial arrangement of the nananoparticles.

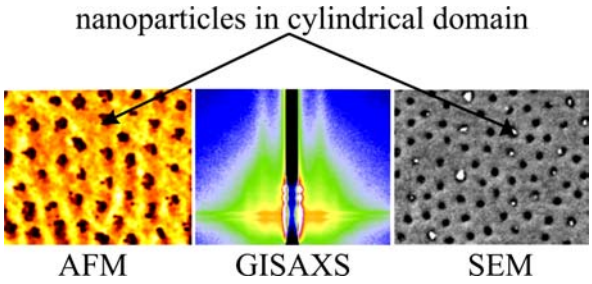

Figure 1. *Spatial arrangement of iron oxide nanoparticles inside the PMMA domains investigated by AFM, SEM and GISAXS*

References

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