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Neutron reflectivity investigation on thermo-responsive copolymers with embedded magnetic nanoparticles

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Nanostructured thin films with embedded magnetic nanoparticles (NPs) are promising in magnetic applications due to their novel chemical and physical properties. The realization of desired magnetic properties depends on the arrangement of the NPs and can be tuned by employing diblock copolymers as host matrixes. Various ordered nanostructured templates can be achieved from the phase separation of diblock copolymers composed of two chemically incompatible blocks. Being coated with one particular type of polymer chains, magnetic NPs can have a selective affinity to one of the blocks and get well distributed within this domain [1]. So far, thermo-responsive copolymers are rarely investigated as host materials for magnetic NPs despite of their high potential.

Recently, we investigated the nanostructure and magnetic behavior of hybrid dry films consisting of magnetite (γ -Fe₂O₃) NPs coated with polystyrene chains and the diblock copolymer polystyrene-block-polyN-isopropylacrylamide (PS-*b*-PNIPAM) [1]. Results showed selective incorporation of NPs into the PS domains and a morphological evolution from parallel cylinders to perpendicular ones at low NP concentrations. A superparamagnetic behavior was found irrespective of the NP concentration. Since PS-*b*-PNIPAM films are most interesting under wet conditions, we extend our investigation from dry films to wet ones in order to explore the swelling behavior of the hybrid films and its impact on the magnetic properties. Neutron reflectivity is used to detect the morphology of hybrid films as a function of temperature in a humid atmosphere. In addition, polarized neutron reflectivity is used to probe the magnetic structure of the PS-*b*-PNIPAM films with magnetite NPs.

[1] Y. Yao, E. Metwalli, J.-F. Moulin, B. Su, M. Opel, and P. Müller-Buschbaum; ACS Appl. Mater. Interfaces, 6, 18152 (2014).

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