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Printed nanostructured polymer films embedded with magnetic nanoparticles

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Nanostructured polymer films containing magnetic nanoparticles (NPs) are promising materials due to their potential applications in the areas of high-density storage and magnetic sensors. Owing to the advantages, like large-scale production and energy saving, printing techniques were employed to fabricate hybrid films composed of maghemite NPs and PS-b-PMMA diblock copolymer (DBC). External magnetic fields were applied during the printing process to guide the NPs within the polymer matrix. The mesoscopic structure of PS-coated maghemite NPs within the DBC films was investigated as a function of the NP concentration using optical microscopy, AFM, SEM and GISAXS. The PS-coated NPs were selectively dispersed in the PS domains of the lamella-structured hybrid films. At high NP concentrations, the coalescence of NPs into large micro-sized metal-oxide wires was observed. The superparamagnetic behavior of the hybrid film was proved using a superconducting quantum interference device magnetometer.

Summary

By employing printing technique, thin magnetic films were successfully prepared based on diblock copolymer and magnetic γ-Fe2O3 particles. Via joint utilization of external magnetic field and printing technique, homogeneous hybrid films with highly oriented magnetic nanostructures were prepared. These obtained magnetic films were investigated in both real space and reciprocal space. At macroscale, NPs self-assembled into highly oriented wires in polymer matrices with controlled widths and separation distances, which endows the hybrid films with magnetic anisotropy. At nanoscale, NPs grafted with PS chains were selectively incorpo-rated and dispersed inside PS domains at low NP con-centrations. As concentration increased, NPs assembled into nanosized cluster without losing the superpara-magnetic property. Due to the high PS weight fraction in the diblock copolymer and microphase separation, a high density of magnetic nanostructures containing dispersed single magnetic NPs or nanosized NP clusters were achieved.

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