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Precise control of magnetic and dielectric nanoparticle placement within block copolymer templates for the fabrication of 3D magneto-dielectric metamaterials[1] XINYU WANG, DONGPO SONG, JAMES WATKINS, Polymer Science and Engineering Department at University of Massachusetts Amherst — Magneto-dielectric metamaterials fabricated using high permeability (high-μ) nanoparticles (NPs) with precise control over position and orientation could yield superior electromagnetic properties with low loss. In addition, proper tuning of the effective dielectric constant of the host composite could yield more efficient devices with a wider bandwidth. Lin et al. recently reported the use of strong interactions between NPs and one segment of weakly segregated block copolymer (BCP) systems to drive the assembly of well-ordered morphologies while confining the NPs specifically in the desired spherical, cylindrical or lamellar domains. Here we used this approach to assemble high-μ NPs into well ordered systems. Specifically, FePt nanoparticles functionalized with H-bonding donating ligands were shown to induce strong segregation in weakly segregated BCP systems. In addition, different NP/polymer segment interactions, such as π-π interactions, were introduced to incorporate dielectric NPs in order to tune the effective permittivity of the material. Small-angle X-ray scattering was used to track the morphological evolution of the composite. Transmission electron microscopy was used to investigate the location of the NPs in their respective polymer domains.

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