Nanoparticle induced phase transformation and dielectric response of core/shell Fe/MgO–poly(vynilidene fluoride) nanocomposites

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Magnetic materials with high permeability and low magnetic loss at high frequency can play an important role in high frequency communication devices [1, 2]. In this case the magnetic material should have high saturation magnetization, high magnetic anisotropy and high electrical resistivity. In order to get suitable materials for applications accomplishing both high saturation magnetization and high electrical resistivity, the preparation of nanocomposite materials composed of nanoparticles with high saturation magnetization and insulating matrix such as polymer seem to be one of the preferred ways [3].

Here we report on Fe(Co) particles covered by a uniform 3 nm thick MgO epitaxial shell. Among commonly used schemes, we followed simple physics-derived solutions based on gas-aggregation methods that assure industrial scalability and ecology. Nearly spherical crystals self-assembled nanomagnets were obtained by means of vapor-phase condensation [4]. Nanocomposites of the core-shell particles (0.02, 0.2 and 2%wt) with poly(vynylidene fluoride) were prepared by solution casting under conditions leading to the non-electroactive □phase in the pure polymer [5]. The dielectric and thermal and mechanical properties of the composites were evaluated.

Far infrared spectroscopy and differential scanning calorimetry indicate that the nanoparticles seem to act as nucleating agents in the polymer crystallization process, affecting both the melting temperature (increases with increasing nanoparticle concentration) and the degree of crystallinity and the polymer phase. In this way, the material is obtained in the electroactive polar □-phase, with the possibility of interplay of the magnetic and electrical response of the material. The dielectric response of the composite, on the other hand slightly affected by the presence of the magnetic nanoparticles.

References

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