

## Synthesis of Carbonyl Iron Particles Modified with Poly (Trimethylsilyloxyethyl Methacrylate) Nano-Grafts

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**Abstract :** Magnetorheological elastomers (MREs) are multi-phase composite materials containing micron-sized ferromagnetic particles dispersed in an elastomeric matrix. Their properties such as modulus, damping, magnetostriction, and electrical conductivity can be controlled by an external magnetic field and/or pressure. These features of the MREs are used in the development of damping devices, shock attenuators, artificial muscles, sensors or active elements of electric circuits. However, imperfections on the particle/matrix interfaces result in the lower performance of the MREs when compared with theoretical values. Moreover, magnetic particles are susceptible to corrosion agents such as acid rains or sea humidity. Therefore, the modification of particles is an effective tool for the improvement of MRE performance due to enhanced compatibility between particles and matrix as well as improvements of their thermo-oxidation and chemical stability. In this study, the carbonyl iron (CI) particles were controllably modified with poly(trimethylsilyloxyethyl methacrylate) (PHEMATMS) nano-grafts to develop magnetic core-shell structures exhibiting proper wetting with various elastomeric matrices resulting in improved performance within a frame of rheological, magneto-piezoresistance, pressure-piezoresistance, or radio-absorbing properties. The desired molecular weight of PHEMATMS nano-grafts was precisely tailored using surface-initiated atom transfer radical polymerization (ATRP). The CI particles were firstly functionalized using a 3-aminopropyltriethoxysilane agent, followed by esterification reaction with  $\alpha$ -bromoisobutyryl bromide. The ATRP was performed in the anisole medium using ethyl  $\alpha$ -bromoisobutyrate as a macroinitiator, N, N', N'', N'''-pentamethyldiethylenetriamine as a ligand, and copper bromide as an initiator. To explore the effect PHEMATMS molecular weights on final properties, two variants of core-shell structures with different nano-graft lengths were synthesized, while the reaction kinetics were designed through proper reactant feed ratios and polymerization times. The PHEMATMS nano-grafts were characterized by nuclear magnetic resonance and gel permeation chromatography proving information to their monomer conversions, molecular chain lengths, and low polydispersity indexes (1.28 and 1.35) as the results of the executed ATRP. The successful modifications were confirmed via Fourier transform infrared- and energy-dispersive spectroscopies while expected wavenumber outputs and element presences, respectively, of constituted PHEMATMS nano-grafts, were occurring in the spectra. The surface morphology of bare CI and their PHEMATMS-grafted analogues was further studied by scanning electron microscopy, and the thicknesses of grafted polymeric layers were directly observed by transmission electron microscopy. The contact angles as a measure of particle/matrix compatibility were investigated employing the static sessile drop method. The PHEMATMS nano-grafts enhanced compatibility of hydrophilic CI with low-surface-energy hydrophobic polymer matrix in terms of their wettability and dispersibility in an elastomeric matrix. Thus, the presence of possible defects at the particle/matrix interface is reduced, and higher performance of modified MREs is expected.

**Keywords :** atom transfer radical polymerization, core-shell, particle modification, wettability

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