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Carbonyl Iron Particles Modified with Pyrrole-Based Polymer and Electric and Magnetic Performance of Their Composites

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Abstract : Magnetorheological elastomers (MREs) are a unique type of materials consisting of two components, magnetic filler, and elastomeric matrix. Their properties can be tailored upon application of an external magnetic field strength. In this case, the change of the viscoelastic properties (viscoelastic moduli, complex viscosity) are influenced by two crucial factors. The first one is magnetic performance of the particles and the second one is off-state stiffness of the elastomeric matrix. The former factor strongly depends on the intended applications; however general rule is that higher magnetic performance of the particles provides higher MR performance of the MRE. Since magnetic particles possess low stability properties against temperature and acidic environment, several methods how to improve these drawbacks have been developed. In the most cases, the preparation of the core-shell structures was employed as a suitable method for preservation of the magnetic particles against thermal and chemical oxidations. However, if the shell material is not single-layer substance, but polymer material, the magnetic performance is significantly suppressed, due to the in situ polymerization technique, when it is very difficult to control the polymerization rate and the polymer shell is too thick. The second factor is the off-state stiffness of the elastomeric matrix. Since the MR effectivity is calculated as the relative value of the elastic modulus upon magnetic field application divided by elastic modulus in the absence of the external field, also the tuneability of the cross-linking reaction is highly desired. Therefore, this study is focused on the controllable modification of magnetic particles using a novel monomeric system based on 2-(1H-pyrrol-1-yl)ethyl methacrylate. In this case, the short polymer chains of different chain lengths and low polydispersity index will be prepared, and thus tailorable stability properties can be achieved. Since the relatively thin polymer chains will be grafted on the surface of magnetic particles, their magnetic performance will be affected only slightly. Furthermore, also the cross-linking density will be affected, due to the presence of the short polymer chains. From the application point of view, such MREs can be utilized for, magneto-resistors, piezoresistors or pressure sensors especially, when the conducting shell on the magnetic particles will be created. Therefore, the selection of the pyrrole-based monomer is very crucial and controllably thin layer of conducting polymer can be prepared. Finally, such composite particle consisting of magnetic core and conducting shell dispersed in elastomeric matrix can find also the utilization in shielding application of electromagnetic waves.

Keywords : atom transfer radical polymerization, core-shell, particle modification, electromagnetic waves shielding
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