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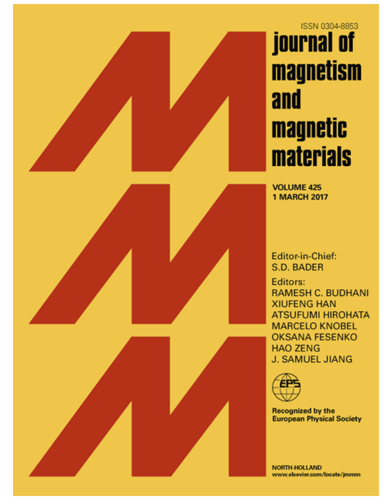

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Production and characterization of long-term stable superparamagnetic iron oxide-shell silica-core nanocomposites

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ABSTRACT. Methods improving the chemical and physical stability of magnetic nanoparticles are important in diverse research disciplines such as catalysis, magnetic resonance imaging, biomedicine, and bioseparation. It is essential that defined nanomaterial characteristics remain unchanged from the start of the nanoparticle production to their final application. A simple, fast and reliable strategy based on a thermal decomposition approach was established to design highly and uniformly loaded iron oxide-shell silica-core nanocomposites. They are formed by maghemite nanoparticles (8.4 +/- 1.0 nm) uniformly deposited on mesoporous silica nanoparticles (381 nm +/- 111 nm). Their magnetic properties as well as chemical, and mechanical stability were verified by SQUID magnetometry, Raman microspectroscopy, and electron microscopy (SEM and TEM), respectively. The produced superparamagnetic nanocomposites were stable over several months. The coating with organosilanes enables the transfer from nonpolar to aqueous phase which makes the magnetic nanocomposites also applicable for life sciences.

1. Introduction

Manipulation of magnetic nanoparticles under influence of magnetic field opens fascinating applications in catalysis, magnetic resonance imaging, biomedicine, bioseparation and life sciences.[1-7] However, the problem is the intrinsic instability due to their tendency to aggregate and oxidate in air. This induces research on new synthesis strategies with the focus on chemical stabilization.[8] The preparation of magnetic nanocomposites derived from two or more distinct constituents is of increasing interest due to the unique possibility of individually tailoring their morphological, chemical, and physical characteristics.[9] In general, chemically functionalized superparamagnetic nanoparticles show low agglomeration tendencies and lack of magnetic remanence after removal of a magnetic field. Superparamagnetism is only present in very small magnetic nanoparticles (<30 nm for maghemite[10]) and since the thermal energy of such small nanoparticles is higher than the magnetic anisotropy at room temperature, these nanoparticles are usually not separable by a permanent magnet.[11-12] The formation of magnetic nanocomposites can overcome this problem, because both superparamagnetic features and the magnetic separability by simple permanent magnets can be combined in one