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LETTERS TO THE EDITOR

Special Features of Magnetite Nanoparticles Stabilization with SiO_2 Nanolayer

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The core-shell composite nanomaterials have been widely studied over the last decade in view of their special physical and chemical properties and a range of potential applications in electronics, photonics, catalysis, biology, and medicine [1]. Formation of functional protective nanolayers at the particles surface is among the topical issues in this regard.

We investigated the special features of synthesis of silicon-oxygen nanolayer at the surface of the disperse magnetite and studied magnetic properties of the resulting material as a candidate for application in the magnetic resonance imaging (MRI). We elaborated the conditions of the SiO_2 layer synthesis avoiding the chemical changes of the magnetite phase.

The nanosized magnetite was prepared via a liquid-phase synthesis involving co-hydrolysis of Fe^{II} and Fe^{III} chlorides. The nanoparticles were stabilized with a surface silica layer formed via liquid-phase controlled hydrolysis of tetraethoxysilane at room temperature. The formed precipitate was centrifuged off, washed with distilled water, and subject to freeze drying in order to avoid partial oxidation of magnetite into hematite. The particles composition was determined by photocolorimetry; the Fe^{II} : Fe^{III} ratio in the sample was of 1 : 2 [Fe^{II} 3.72, Fe^{III} 7.7 mmol/g], thus confirming the Fe_3O_4 mixed oxide formation.

The particles size was determined by means of light scattering and electron microscopy. The prepared composite (Fe_3O_4/SiO_2) material consisted of the nanoparticles of about 80 nm in size built of the Fe_3O_4 core (10–12 nm) and the SiO_2 shell (≈70 nm).

The prepared material was studied by means of Mossbauer spectroscopy at 300 K. Parameters of the obtained spectrum coincided with the available reference data [3], thus confirming the highly disperse state of the Fe_3O_4 particles.

Magnetic properties of the material were studied using a Lake Shore 7410 vibration magnetometer; the results revealed that the sample behaved as a superparamagnetic: the hysteresis loop was absent, the residual magnetization was not detected. Hence, the material was suitable for the MRI application.

Analysis of the Fe^{II} and Fe^{III} content was performed via a standard photometry procedure involving the interaction with *o*-phenanthroline (a KFK-2MP device, λ = 490 nm). The particles size was determined using a Mastersizer 3000 laser diffraction analyzer. The particles structure was studied using a JEOLS JEM–107 transmission electron microscope. Mossbauer spectra were registered using a YaGES-4 spectrometer.

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