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LETTERS
TO THE EDITOR

Generation of Nickel Nanoparticles in the Presence of Monobasic Saturated Acids

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At present, the nanoparticles of iron, nickel, cobalt, and noble metals are actively studied. The nickel-based nanoobjects synthesized to the moment possess a magnetoresistance and a superparamagnetism. One of methods for generating metal nanoparticles is the polyol synthesis, which is actively developed at present. It is based on the reduction of precursors up to metals at their heating in the medium of polyatomic alcohols, which act both as a solvent and as a reducing agent. There are several works devoted to the generation of nickel nanoparticles by the polyol method, however they scarcely consider the influence of surfactants on the morphology of forming particles.

In the present work the morphology and magnetic characteristics of the nickel obtained by the polyol method in the presence of valeric, lauric, and stearic acids were studied. According to the data of electronic transmission microscopy, when the first two acids are used, the resulting samples consist of nanoparticles of 3 nm in diameter covered by an organic phase. In the case of stearic acid they are aggregated in aggregations of 24 nm in diameter covered by an organic phase. The observed special feature of the morphology in the case of stearic acid is assignable to the presence of long hydrocarbon "tails" on the surface of nanoparticles, which results in their stucturization due to hydrophobic interactions and to the formation of small aggregations. Particles of the polyol nickel obtained under the same conditions without application of surfactants are of 14 nm in diameter and also contain an organic shell on the surface.

The X-ray data show the presence of reflexes from an organic phase and metal nickel for all the samples. Whereas the bulk material has the specific magnetization of 54.39 A m^2 kg^{-1}, the maximal specific magnetization in the obtained samples is sharply decreased up to values within the limits of 0.4–1.0 A m^2 kg^{-1} and, accordingly, the remanent magnetization is also decreased. It is connected both with the presence of an organic phase in the samples (up to 40%) and with the fact that the obtained particles of size 3 nm are actually non-magnetic owing to the size effect, i.e. their blocking temperature is below room temperature. Observation of ferromagnetism (high values of a coercive force and a squareness ratio) in this case is connected with an additional stucturization of particles in the organic phase, which results in the interaction of nanoparticles within the aggregations formed by them (a dipole magnetic interaction).

Nickel nanoparticles were generated by the polyol method in the medium of ethylene glycol at heating in the presence of saturated organic acids. Magnetic measurings of hysteresis curve parameters were carried out on a vibratory magnetometer. The X-ray measurings of powders were carried out on a Dron-3M device using copper monochromatic radiation (CuK_α). Phase compositions of the synthesized products were determined using the PDF data file. The data of electronic transmission microscopy were obtained with the use of a Jeol JEM-107 device.

The effect of monobasic saturated organic acids on the morphology of nickel nanoparticles generated by the polyol method was studied. Characteristics of the hysteresis curve of magnetic properties point to the presence of magnetic dipole interactions between the non-magnetic nanoparticles of size 3 nm at room temperature.