Nanochemistry and nanobiotechnology

Superparamagnetic behavior and AC losses in spinel ferrite nanoparticles

A.I. Tovstolytkin[1], O.V. Yelenich[2], S.O. Solopan[2], A.G. Belous[2]

[1] *Institute of Magnetism, National Academy of Sciences of Ukraine, 36-b Vernadsky Ave., Kyiv 03142, Ukraine. E-mail: atov@imag.kiev.ua*

[2] *Institute of General and Inorganic Chemistry, National Academy of Sciences of Ukraine, 32/34 Palladina Ave., Kyiv 03142, Ukraine.*

Studies on the MFe_2O_4 (M = Ni, Co, Zn, Mg, etc.) spinel nanoferrites, which can be widely used in various fields of science and technology, as well as in medicine, have been the subject of particular interest in recent years [1]. For medical applications, the nanoparticles have to meet special requirements, in particular, to be monodispersed, robust against agglomeration and exhibit superparamagnetic behavior [1,2]. The prospects of the use of magnetic particles in hyperthermia treatment of cancer impose an additional requirement: the ensemble of particles has to demonstrate high heating efficiency when placed in AC magnetic field. To date, however, the ways to enhance the heating efficiency remain to a large extent unclear.

In this work, nanosized particles of AFe_2O_4 (A = Mn, Co, Ni, or Zn) spinel ferrites were synthesized by coprecipitation from nonaqueous solutions. They were characterized by X-ray diffraction, transmission electron microscopy and magnetic measurements. Superparamagnetic behavior with blocking temperature below room temperature has been observed for cobalt, nickel and zinc spinel ferrite nanoparticles. Characteristic magnetic parameters of the particles including average magnetic moment of an individual nanoparticle and effective anisotropy constant are determined. The specific loss power which is released on the exposure of an ensemble of synthesized particles to an electromagnetic field is calculated and measured experimentally. It is shown that the particles demonstrate high heating efficiency in AC magnetic fields, with the $ZnFe_2O_4$ nanoparticles having the highest one. The key parameters responsible for the heating efficiency in AC magnetic field have been determined.

1. *Gubin S.P.* Magnetic Nanoparticles // Wiley-VCH, Weinheim. – 2009. – 466 p.
2. *Yelenich O.V., Solopan S.O., Kolodiazhnyi T.V., Dzyublyuk V.V., Tovstolytkin A.I., Belous A.G.* Magnetic properties and high heating efficiency of $ZnFe_2O_4$ nanoparticles // Mater Chem Phys. –2014. –**146**. –P. 129-135.