"Nanochemistry and Nanobiotechnology"

Synthesis of nanomagnetite on the surface of amorphous silica colloids

Y.V. Lytvynenko, V.M. Kadoshnikov, Y.L. Zabulonov

State Institution "Institute of Environmental Geochemistry of NAS of Ukraine».
Ave. Academician Palladin, 34a, Kiev-142, 03680
E-mail: yu.lytvynenko@ukr.net

This work considers a method of amorphous silica nanodispersions production, on the surface of which nanocrystals of magnetite (Fe_3O_4) were synthesized.

Magnetite nanoparticles adsorbed on the surface of amorphous silica of a colloidal dispersion degree can be used for the oppression of certain cancer cells growth. The results of biomedical research conducted in the Institute of Oncology of SB RAMS at the model system cells of Ehrlich carcinoma [1] showed that the resulting nanoparticles of magnetite have antitumor activity (reduction of proliferative activity of cancer cells by 60-70%). Magnetite solubility in blood plasma and, accordingly, the antitumor effect associated with the formation of complexes between iron and amino acids, or amino acid residues in protein. The presence of silanol groups in SiO_2/Fe_3O_4 nanocomposites makes possible forming of additional linkages between the drug substance and the nanocomposite. The antitumor effect increases considerably when nanopowder with adsorbed doxorubicin (DR) is used. In this case DR has itself a cytostatic effect and nanopowder with adsorbed DR as well as without DR - cytolytic [2].

Efficiency of action of magnetite nanoparticles is determined by their size and stability of their crystals in aqueous solutions. For the SiO_2/Fe_3O_4 nanocomposites formation colloidal silica particles having a particle size of 50 nm are synthesized. The synthesis was carried in an aqueous alkaline solution with a pH of 10-12 of the monosilica acid in the presence of sodium ions at a temperature of about 70^0C and a ratio SiO_2/Fe_3O_4 = 3-3,25. The Fe_3O_4 nanoparticles (2-5 nm) were precipitated on the obtained SiO_2 microcrystals. For this purpose a solution of iron salts of Fe^{3+} and Fe^{2+} ions with the ratio of 2:1 and a pH value of not less than 10 was added in the SiO_2 colloidal solution with vigorous stirring. Interaction between SiO_2 and Fe_3O_4 microcrystals is accompanied by the change of ζ-potential of colloidal particles caused by change in diffuse ionic atmospheres of such particles. The deposition process of Fe_3O_4 on the SiO_2 surface is expressed in reduction of kinetic stability of the suspension and, respectively, the formation of coagulum (nanocomposite) that precipitates.

The particles size of the magnetite can be significantly reduced if its synthesis is carried out under conditions of constant and pulsed magnetic field (IMP). The studies [3] have shown that the Fe3O4 nanoparticles with nanosize and a narrow distribution of the particles size are synthesized under the action of pulsed magnetic field. Under the influence of IMP on a system of two colloids, which form the basis of the composite, as a result of "electromagnetic shaker" magnetite nanoparticles are produced in a competitive adsorption processes on the surface of the silica particles and their actual growth. It is determined that nanoscale magnetite particles are fully deposited on the surface of silica particles under the action of IMP.

The diffractometric measurements showed absence of crystal phase in such composite. Heating of the sample up to 350-400ºC leads to appearance of the crystalline phase that is diagnosed as nanomagnetit. The formation of nanomagnetite on the surface of coagulate is confirmed using mesbauer-spectroscopy by appearance of the crystalline phase containing iron in tetrahedra and octahedra that is typical for iron spinel (magnetite).

Thus, the synthesis of Fe_3O_4 on the surface of amorphous silica nanoparticles makes it possible obtaining nanocomposites with agglomerates dimensions about 50 nm comprising magnetite nanocrystals (2-5 nm).

1. *Ismailov G.K., Efremenko V.I., Kuregyan A.G.* Chem-Pharm Journal, 2005, - Vol. 39, №7. - P.P. 47-49.
2. *Zhukova M.V.* Encapsulation of doxorubicin into liposomes that contain phosphatidyl ethanol. I. Physico-chemical characterization and antitumor activity of the liquid-crystalline liposomes / M.V. Zhukov, M.A. Kissel, B.B. Kuzmitsky, A.E. Mashkovich, V.M. Liqueurs, O.V. Romanenko, S.G. Spivak // Chemical and Pharmaceutical Journal, 2006, - Vol. 40, №1. - PP. 31-33.
3. *Kadoshnikov V.M*. Properties of magnetic colloids activated by electromagnetic field / V.M. Kalashnikov, Y.V. Lytvynenko, J.L. Zabulonov, I.R. Pisanskaya // "Environmental Security: Problems and Solutions": VI International Scientific Conference 6-10 September 2010 .: Scientific papers in two volumes. - Alushta, Crimea, Ukraine - 2010. - Vol.1. - PP. 138-143