NANOSIZED MAGNETIC POWDERS BASED ON OXIDES FOR MEDICINE AND BIOLOGY

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The stoichiometric and nonstoichiometric nanosized powders of oxide cubic ferrimagnetics (Fe_3O_4, $Co_xFe_{3-x}O_4$, $Ni_xFe_{3-x}O_4$, $Mn_xFe_{3-x}O_4$, etc.), tin and zinc oxides, and also the composite material $SnO_2 + Fe_3O_4$ with a high value of a specific surface (120-190 m^2/g) were obtained by the method of mechanochemical synthesis from salt systems. The size distribution includes spherical nanoparticles with a diameter from 3 to 15 nm.

During mechanochemical synthesis, intense deformation (impact, friction) is found to lead to the formation of «active» non-equilibrium states in nanoparticles, which are characterized by non-stoichiometry, high elastic microstresses, change in the degree of order in the arrangement of ions of different types, change in lattice parameters, and amorphization of a surface layer.

The study have shown essential changes in the fundamental magnetic properties of cubic ferrite nanopowders as compared with bulk samples, which is caused by the large contribution of surface anisotropy and the magnetoelastic component. When a structural element decreases from 10^5 to 2-15 nm, a ferrimagnetic acquires the properties of a spin cluster glass with a high blocking temperature.

The results showed the aging of nanosized powders of cubic oxide ferrimagnetics obtained by the method of mechanochemical synthesis, which was manifested as a change in the phase composition, structural parameters, and basic magnetic properties.

The synthesized nanopowders of cubic oxide ferrimagnetics were studied for the purpose of using in medicine and biology for pharmokinetic studies, as well as for separation and purification of biological substances. Thus, the results obtained have shown that the nanosized cobalt ferrospinel powder possesses a sorption activity relative to DNA and protein molecules (for example, bovine serum albumin and Taq polymerase enzyme). The results of DNA are well presented for the SnO_2+Fe_3O_4 composite material. As a result, new sorbents and functional bionanocomposites stable in aqueous buffer solutions and controlled by an external magnetic field were created.

Ferrite nanopowders were used to study the stability and activity of enzymes which are widely used in clinical diagnostics (PCR) and molecular and biological studies. Immobilization of cobalt ferrospinel nanoparticles was found to prolong significantly the enzymic activity at room temperature. After holding for 40 days, the residual activity of enzyme, not adsorbed on nanoparticles, is no more than 3% of the initial one, while enzyme immobilized on nanoparticles retains more than 40% of the initial activity for 250 days. The absence of a strong chemical bond between enzymes and nanoparticles and the magnetic properties of nanoparticles allow us, if necessary, to remove nanoparticles from reaction mixtures or enzymic agents by the magnetic separation method.

The interaction of DNA with cobalt ferrospinel nanoparticles was studied to create a new nanobiocomplex (bionanoconjugate) for the detection and separation of nucleic acids (DNA and RNA) from solutions and the method of its obtaining. This result can be used in the development of new methods for molecular and genetic diagnostics.