Abstract

The main research objective of the presented doctoral dissertation was to develop a technology for the preparation of new nanostructured sulfide ($ZnCr_2S_4$, $CuCr_2S_4$) and selenide ($ZnCr_2Se_4$, $CuCr_2Se_4$) spinels and to determine the influence of crystallite size on the physicochemical properties of this group of compounds. The implementation of this goal included: 1) obtaining nanospinels using mechanical alloying and high-energy ball mining methods; 2) determination of lattice parameters, crystallite sizes, and lattice strains using X-ray structural analysis; 3) imaging the morphology of the obtained nanospinels using electron spectroscopy; 4) determination of magnetic parameters using temperature tests of changes in direct current (dc) and alternating current (ac) susceptibility as well as magnetization as a function of an external magnetic field; 5) calculation of the exchange integrals related to the magnetic interactions of superexchange and double exchange; 6) carrying out tests of electrical conductivity and thermopower.

The conducted studies of magnetic and electrical properties has shown that reducing the size of crystallites to the *nano* scale causes: 1) disturbance of the long-range and short-range superexchange interactions, which leads to the appearance of different orderings of magnetic moments, 2) weakening of the mechanisms of magnetic interactions of superexchange and double exchange, as indicated by the calculated values of the exchange integrals associated with these interactions; 3) disappearance of the magnetic saturation state; 4) changing the nature of the electrical conductivity of $CuCr_2S_4$ and $CuCr_2Se_4$ nanospinels from metallic to semiconductor, which is related to the narrowing of the mixed-valence band of the chromium ions W_d ($3d\ t_{2g}$); 5) changing the type of electric conductivity from *p* type to *n* type caused by an increase in the advantage of anionic vacancies over cationic ones.

As part of the research work, nanostructured spinel materials with unique physicochemical properties were obtained and the possibility of their modulation by appropriate selection of the size of crystallites was shown, which may result in their potential application in science and technology in the future.