Abstract

The Ph.D. dissertation presents the results of research on the influence of technological processes on the structure and AC electrical properties of granular nanocomposites $Cu_x(SiO_2)_{(100-x)}$, Zn-SiO_2 and InSb-SiO_2.

Granular metal-dielectric nanocomposites, which include metallic nanoparticles arranged inside the dielectric matrix, exhibit different properties than their macro counterparts. The basic issues related to the development of granular nanocomposites are the methods of producing nanostructures, control of their composition, size, and boundaries of separation between components, allowing for the understanding of the physical phenomena that govern their properties. What is more, the construction of such nanocomposites determines the type of electric charge transfer mechanism. The knowledge of this mechanism is necessary for the selection of potential applications in devices.

As part of the research, one series of $Cu_x(SiO_2)_{(100-x)}$ nanocomposite was produced by the method of ion-beam sputtering with pure argon ions. The ion implantation method was used to obtain three series of Zn-SiO_2 nanocomposite and two series of InSb-SiO_2 nanocomposite. Then, their chemical composition was determined by X-ray energy dispersion analysis. Using scanning or transmission electron microscopy, the structure of the tested materials was determined and the granular structure of nanocomposites was observed. The tests were carried out before and after annealing.

The AC properties of the obtained nanocomposites were investigated. Based on the temperature-frequency dependences of the conductivity of $Cu_x(SiO_2)_{(100-x)}$ nanocomposites, the x_C percolation threshold was determined, i.e. the content of the metallic phase for which the conductivity changed from dielectric to metallic type. It was established that the conductivity in the studied nanocomposites follows the hopping charge transport mechanism. Current resonance phenomena characteristic of conventional series *RLC* circuits were observed in the tested samples. A measurable effect of the work was obtaining a patent for a method of producing non-coil inductance.

AC measurements of electrical parameters of nanocomposites Zn-SiO_2 and InSb-SiO_2 showed the dielectric character and the presence of a hopping charge transfer mechanism in both materials. Based on the measured dielectric parameters, phase shift angle, and capacitance, the properties characteristic of series *RC* circuits and the polarization mechanisms using the Cole-Cole model were determined