Polymers – spinels nanocomposites for applications in modern sensors and actuators

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Introduction:

The composites are materials consisted of two or more phases of different properties. The properties of composites depend on the number of phases, their volume fractions, properties of individual phases and also on the way in which the phases are interconnected. Therefore, the properties of composites are neither the sum nor the mean of properties of constituent phases. Moreover, composites can exhibit property which don't exist in component phases. Additionally, many composites are characterized by the anisotropy of physical properties. Polaroid ™ (U.S. Patent 1,918,848) is an example of composite material which achieved commercial success due to its particular anisotropic electrooptic properties. Nowadays polarizing filters are used in Liquid Crystal Displays (LCD), optical microscopes and sun glasses.

The special group of composites applied in electrotechnics are the electroceramic composites containing usually ferroelectric ceramics. The application of spinels (materials with magnetic order dependent on the method of preparation) as the phase dispersed in polymer matrix allows to obtain materials for application in many modern devices. This will allow to eliminate permanent magnets of high mass and large dimensions in e.g. loudspeakers, isolators, filters, phase shifters and circulators (ferrites used in radar antennas for separation the entering signal from the transmitted one).

Scientific aim of the work and proposed research methods:

The aim of the work is development of the preparation method of the composites consisted of polymer matrix, e.g. polyvinylidene fluoride (PVDF) or cellulose and spinels, e.g. $CoFe_2O_4$ or $SrFe_2O_5$ as well as the investigation of dielectric and magnetic properties of these materials. In order to obtain these composites the optimized method will be used. This method involves fragmentation of the ceramic and polymer powders using the planetary ball mill, bringing the resulting product into liquid state by heating, and then cooling the composite in magnetic field to provide the permanent orientation of magnetic moments of the spinels particles. The fragmentation of the starting reagents in mill leads to obtaining the particles of nanometer size characterized by large effective surface that substantially influences the macroscopic properties of the obtained material.

The following measurement techniques will be used to characterize the composites: observation of the surface morphology using *Scanning Electron Microscopy (SEM)*, structural research including determination of the phase composition and the grain size of the obtained nanoceramic materials using *X – ray Diffraction (XRD)*, research of the molecule structure and their interaction using *Infrared Spectroscopy (IR)*. The letter will allow to detect the functional groups present in the obtained compound and to determine the role of hydrogen bonds. The investigation of the dielectric and magnetic properties will be performed used the Novocontrol spectrometer and VSM magnetometer installed on PPMS system. These investigation will facilitate the complete characterization of the materials based on the kind of the polymer matrix as well as the content and kind of spinels.