Abstract

The doctoral dissertation is based on the experimental and technological nature of the project. The first part describes the methods used to synthesize materials with a perovskite-type crystal structure. Current research and the state of knowledge about them are presented. The technological and research works are described in the second and third parts showing the multiferroic $PbFe_{0.5}Nb_{0.5}O_3$ (PFN) and $PbFe_{0.5}Ta_{0.5}O_3$ (PFT) and lead-free such as $Ag_{1-x}Li_xNbO_3$ (ALN) and $AgNb_{1-x}Ta_xO_3$ (ATN) compounds. The first two are interesting multiferroic materials with electromagnetic coupling.

The second group, in turn, belongs to the piezoelectric lead-free niobates and is a promising alternative to known materials such as PZT, PMN-PT, and PZN-PT, which have been leaders in piezoelectrics for over 50 years. In addition, they can be used in microwave, photovoltaic, and energy storage devices. The last, fourth part of the work consists of a summary and conclusions.

The dissertation emphasizes the development of new technology for obtaining materials: PFN, PFT, ALN, and ATN, based on a modified sol-gel processing method (Pechini and Marcilly) used for synthesizing the compounds mentioned above. As a result of the sol-gel treatment, suitable polymer precursors for the materials were obtained. Ultimately, the single-stage sintering process resulted in the practical quality of the ceramics at much lower temperatures than the commonly used conventional method. The main goal was to obtain single-phase, good-quality ceramics with a perovskite structure. The technologies developed are the first to be used to obtain these specific materials. This work also aimed to get good-quality perovskite single crystals PFN and PFT by the high-temperature solution-grown method. The production of these materials in the form of ceramics and single crystals is not trivial. Experimental and technological research checked the effectiveness and efficiency of specialized methods used to obtain the materials mentioned above. The crystallographic structure, chemical composition, and physical properties of all obtained ceramics and crystals were characterized. The experimental methods used in work are X-ray diffraction (XRD), scanning electron microscopy (SEM), differential scanning calorimetry (DSC), dielectric and magnetic tests. All the applied methods confirmed the effectiveness of the used technological processes.