The phenomenon of diffuse phase transition (DPT) in ferroelectric materials was observed as early as the 1950s. One of the first groups of materials in which this kind of phenomenon has been observed are solid solutions based on barium titanate (BT). The present study focuses on a polycrystalline solid solution of general formula $(Ba_{1-x}Sr_x)TiO_3$ (BST). Samples were made for dopant concentrations x = 0, 0.1, 0.2, 0.3, 0.4, and 0.45. The crystal structure of the studied ceramics was investigated using X-ray diffraction analysis. Changes in symmetry have been investigated and the temperatures at which these changes occur were determined, with particular emphasis on the transformation from tetragonal to cubic phase.

In addition, the studied samples were investigated by SEM, DSC, Raman spectroscopy, FT-IR, hysteresis loop method, SHG techniques. Dielectric, pyroelectric current and thermal conductivity studies were also performed. Diffuse phase transformations were observed, along with shifts in the temperatures of their occurrence toward lower values, with increasing Sr^{2+} content. In addition, suppression of ferroelectric properties and induction of relaxor-like features were found as strontium concentration increased. This dissertation also presents the effect of BST polarization by an external electric field on the nature and evolution of the properties studied. Ab-initio calculations were also performed for concentrations x = 0.125 and 0.25. They made it possible to study the effect of doping with Sr^{2+} ions on the density of electron states.