Investigations on organic-inorganic lead halides: characterization of phase transitions and dielectric properties of compounds with perovskite structure.

The doctoral dissertation focuses on the analysis of the thermodynamic and dielectric properties of lead-halide perovskites. The measurements performed show the variety of physicochemical properties of these compounds, such as induction of relaxation processes, occurrence of spontaneous polarization, switching of dielectric permittivity, and induction of ionic conductivity. The research shows that modifying the perovskite structure by changing the composition of cations or halides and reducing the structure to two-, one- or zero-dimensional has a significant impact on the existence of these properties.

The research focused on a compound with a two-dimensional (layered) structure with a methylhydrazinium cation (MHy^+) and lead bromide (MHy_2PbBr_4), This material exhibited ferroelectric properties at room temperature, making it potentially attractive for future application. Analysis of layered perovskite with the MHy^+ cation and lead chloride (MHy_2PbCl_4) showed the occurrence of pyroelectric properties. Studies on lead halide perovskite with methylammonium (MA^+) and MHy^+ cations have demonstrated interesting thermal and dielectric behavior, including stable phase transitions and relaxation processes related to the movements of MHy^+ cations, which can be modified by changing cation concentrations. Layered compounds with imidazolium and methylhydrazinium cations ($IMMHyPbBr_4$ and $IMMHyPbCl_4$) presented the existence of a phase transition of the first-order type, associated with the ordering of the position of the MHy^+ cation. These measurements confirm the significant influence of the methylhydrazine cation on the occurrence of polar phases in lead halide perovskite. The research also demonstrated stable switching of dielectric permittivity values in one-dimensional perovskite structures with a pyrrolidinium cation ($PyrPbI_3$) and the existence of three-state switching of the dielectric permittivity in perovskite with isopropylammonium cation ($ISOPrPbI_3$).

To sum up, the research expands the knowledge about the physicochemical properties of lead-halide perovskite, indicating the influence of organic cations on the occurrence of polar phases and the possibility of modifying their properties by changing their composition and structure.