Organo-inorganic hybrid materials are one of the most extensively investigated materials in recent years. This is due to their unique properties which make these materials extremely promising for both photovoltaic and nonlinear device applications. However, known issues related to their inherent instability (degradation when exposed to water, oxygen, UV-light, high temperature) and toxicity (presence of lead) hinder further development of desirable devices on the long term. It is therefore the most urgent task to find a way to chemically stabilize the lead-free perovskites, preserving at the same time their excellent absorption combined with the controllable nonlinear properties. This fact motivates the ongoing active search of new hybrid perovskites. The obvious route to follow is chemical substitution.

This project is dedicated to the synthesis and characterization of new analogues of bismuth and cadmium halides with various organic spacers. The choice of metal ions is justified as they have not yet been systematically tested in comparison with the widely tested lead analogues. Several recent reports have shown that they have enormous research potential. Therefore, this group of compounds deserves a detailed study to understand how to successfully fine-tune electrical and optical properties in this class of materials. The recent results shows that halogenation of an organic cation trigger the desirable ferroelectricity, so this discovery opens up entirely new avenues for the search for new hybrid materials. Understanding the properties of hybrid organic-inorganic materials in terms of their ferroelectric properties is crucial for both the fundamental science and technology, in the context of potentially new generation photovoltaic applications. Dynamic ferroelectric polarization is believed to be one of the essential factors to protect carriers from being scattered by charged defects in halide perovskites.

The main goal of this project is to investigate and elucidate the mechanisms of phase transitions and their associated effects on representative families of hybrid organic-inorganic halide compounds. A deeper insight into the origin of the interesting properties will also be obtained through systematic structural, spectroscopic and dielectric experiments on native and halogenated samples. Comprehending the mechanisms responsible for the appearance of ferroelectric and nonlinear properties in hybrid organic-inorganic structures will also provide significant information to be utilized in the development of synthesis technology of these compounds. Gathering information concerning the electric fields influence on the optoelectrical properties of investigated compounds will enable to identify these chemical and thermodynamic parameters for which the ferroelectric ordering will occur.