

There is a great demand on cheaper, faster, better and energy-saving color displays, light sources, sensors, lasers, energy storage devices and renewable energy sources, for instance, devices that can harvest sunlight and transform it into an electric current. To construct such devices, materials are needed that exhibit useful specific physical or chemical properties and which are simple and cheap for fabrication. In recent years, hybrid organic-inorganic perovskites (materials composed of organic and inorganic components) received a lot of attention as materials extremely promising for various applications, including solar cells, light emitting diodes (LEDs) and photodetectors. This is due to their unique optical and electrical properties, including high light absorption, high charge mobility and efficient emission of light with a variety of colors. In addition, perovskites can be synthesized using wet chemistry methods, which significantly reduces the cost of their production, making perovskite-based devices much cheaper than a current technology.

There is growing interest in searching for new perovskite semiconductors crystallizing in structures without inversion center because such compounds may exhibit many useful properties such as ferroelectricity, piezoelectricity, pyroelectricity or second harmonic generation, important for many technological applications. Furthermore, the built-in electric field in the ferroelectric semiconductors leads to improvement of photovoltaic properties, making them exciting for next generation solar cells.

Properties of perovskite materials can be tuned by chemical modification. In this context, the use of two cations, larger separating inorganic slabs and smaller located within the slabs, with different chemical properties was recently shown to be a very promising way for obtaining crystals without inversion center. The loss of inversion center can also be triggered by mixing small cations located within the inorganic slabs. Thus, several recent reports showed that such perovskites have enormous research and application potential. However, ferroelectric perovskites comprising two cation types or mixed cations within the perovskite slabs are still scarce and their nonlinear optical properties remain almost unexplored. Furthermore, a key for a rational design of such perovskites is understating structure-property relationship, which has not been fully addressed up to now in this class of materials. Therefore, this group of compounds deserves a detailed study to understand how to successfully induce and tune their electrical and optical properties.

Within the project, we want to study more deeply several of the known analogues and synthesize a number of novel multilayered perovskites comprising various organic cations. We also want to synthesize analogues with mixed small organic cations. We will characterize their structural features, crystal lattice vibrations as well as optical and electrical properties in a broad temperature range. Systematic studies of these perovskites will help to answer questions, like how the modification of chemical composition affects the arrangement of structural units, distortion of inorganic slabs and molecular motions of organic cations, and what is the impact of these structural changes on their electrical and optical properties. This information will allow us to propose further ways for designing new multilayered perovskites with improved physicochemical properties, especially ferroelectric and optical ones.