DESCRIPTION FOR THE GENERAL PUBLIC

Current technological development requires multifunctional materials that are able to exhibit at least two different electronic, magnetic, optical or mechanical properties. Primarily, combination of two physical properties in a single material is attractive because of a strong need for miniaturization, particularly visible in today's electronics. Moreover multifunctional materials can exhibit a coupling effect between two implemented functionalities which can lead to the strong impact of the first property on the second one. It was fruitfully realized in chemical sensors utilizing absorption properties where sensitivity of the material towards specific chemical compounds affects the optical properties, e.g. the colour of a substance. Photo-magnets are another example of multifunctional materials in which light irradiation can reversibly change the structure of the material and their magnetic properties e.g. light can cause the material to become a permanent magnet.

From the viewpoint of materials science, one of the most important optical properties is **luminescence** which can be defined as light emission of the material caused by external stimuli. The leading attention is paid to photoluminescent materials exhibiting light emission upon irradiation by using photons of a different energy, e.g. red or green emission are induced by the application of UV light. Luminescent materials are broadly applied in light-emitting diodes (LEDs), amplifiers in optical communication, optical data storage, photovoltaic devices, molecular thermometry, and bioimaging tools. Moreover, photoluminescence was found to be very sensitive to the application of secondary external stimuli such as pressure, humidity, magnetic field and chemical factors which opened a great perspective in sensors based on luminescence or advanced optical switches where light emission is manipulated precisely depending on the current need.

An attractive route for easily accessible modulation of light emission is the application of an electric field. This physical stimulus may lead itself to the emission of light within an exciting effect of electro-luminescence, broadly applied in light-emitting diodes. Moreover, the reports presented by scientists in the last few years show that also photoluminescence can be efficiently modulated using an electric field. It can be fruitfully achieved by very special photoluminescent materials which exhibit also a second physical property called **ferroelectricity**. Ferroelectric materials are well known for decades and their main feature is existence of spontaneous electric polarization that can be reversed by the application of an electric field. This polarization effect is related to the electric-field-induced displacement of polar molecular units within their crystal structure which is still observed after switching off the external field. The detectable remnant polarization exists and it can be reversed, thus two co-existing phases can be induced opening applications of ferroelectrics in memory devices.

The project aims at design, synthesis, and characterization of **luminescent ferroelectrics** which can exhibit both photoluminescence and ferroelectricity at room temperature. As a result of such multifunctionality, it is expected that an electric field can efficiently modulate the intensity and colour of light emission. This effect is related to the electric-field induced polar displacement which will affect the structure of the material and consequently its photoluminescent property. In the project, we focus on the very novel class of **luminescent molecular ferroelectrics** which is composed of molecular components, including metal ions combined with organic and inorganic molecules. We postulate that this approach will lead to luminescent ferroelectrics showing a strong coupling between two introduced properties resulting in an efficient modulation of photoluminescence by an electric field. We plan to construct luminescent molecular ferroelectrics by using bimetallic coordination polymers built of cyanide transition metal complexes combined with other metal ions of lanthanides, uranium, zinc, and cadmium with the partial support of polar organic cations and other small organic molecules. The project includes both syntheses, structural studies, physicochemical characterization as well as investigation of advanced physical properties such as photoluminescence under an electric field, and further processing of materials into nanoscale. Therefore, the project stays at the boundary of chemistry, physics and materials science, and will result in a unique family of multifunctional luminescent ferroelectric for future applications in smart optoelectronic devices.