## DESCRIPTION FOR THE GENERAL PUBLIC

Luminescence is the ability of the material to emit light due to the absorption of photons, chemical reaction, mechanical action or electric current. Luminescent materials are highly desired as they were found a broad range of applications in new technologies, science as well as our everyday life. Efficient solid luminophores are used in lighting and display devices, for instance those based on light-emitting diodes (LEDs), optical communication, light conversion, photovoltaics, sensors of chemicals and physical external stimuli, bioimaging, molecular thermometry, and many others.

Several synthetic strategies have been successfully employed in the construction of efficient luminescent materials. They can be composed of traditional inorganic solids such oxides, fluorites or silicates incorporating emissive metal centres such as lanthanide ions, for instance, $Eu^{3+}$ ions showing characteristic, intense red photoluminescence under UV light excitation. The other approach involves the application of emissive organic molecules which can be combined with various metal ions into so-called metal-organic frameworks (MOFs).

In this project, we aim at design, synthesis and characterization of novel photoluminescent materials which will be constructed of charged molecular components crystallizing together, thanks to electrostatic attraction and weaker intermolecular interactions such as hydrogen bonds.

As molecular components, we will use **anionic complexes of chromium (Cr) at the (+III) oxidation state** which are expected to exhibit UV-light-induced luminescence (named photoluminescence) in the specific visible-to-near-infrared (vis-to-NIR) range. These Cr(III) complexes will be negatively charged due to the presence of anionic cyanide ($CN^-$) ligand, and their luminescence will be tuned by additionally attached organic ligands. **As the counter-ions, we will use photoluminescent metal complexes of lanthanides (praseodymium, samarium, europium, terbium and dysprosium), uranyl as well as transitions metals (iron, manganese and zinc),** all combined with precisely selected organic ligands. They will show intrinsic emission also in the visible range, however, not overlapping with the emission from Cr(III) centres. Moreover, they will be positively charged due to the presence of metal cations and neutral ligands, thus, electrostatic attraction between Cr(III) complexes and the second metal complex will generate the stable bimetallic molecular system leading to luminescent crystalline materials.

The presence of two different luminescent components in a single molecule-based material will result in the simultaneous observation of two separate emission signals. Such dual emission is expected to be strongly dependent on temperature and/or pressure which is planned to be deeply investigated within the project. Therefore, this project will result in **novel efficient luminophores** which emission characteristics (such as colour, overall emission light intensity, emission lifetime, intensity ratio between emission components) are very sensitive to external stimuli such as temperature ($T$) and pressure ($p$). These novel materials are expected to be perfect candidates for the fruitful application as **luminescent sensors of temperature (*luminescent thermometers*) and pressure (*optical pressure sensors*).** We also plan to construct the molecular material sensitive to both external stimuli at the same time, thus, the smart multifunctional ($T$,$p$)-sensor will be the ultimate result of the project.

The project will be focused not only on the design, synthesis and physicochemical characterization of new functional molecular materials but also on the thorough investigation of their photoluminescent properties under variable temperature and/or pressure. It will allow the better understanding of physical processes occurring between luminescent metal complexes within the crystalline molecular material under external stimuli. Therefore, the project is aimed both at the preparation of the novel generation of smart optical materials for sensing applications as well as the broadening of general knowledge concerning emission effects in luminescent molecule-based solids.