DESCRIPTION FOR THE GENERAL PUBLIC

Photoresponsive materials are those whose physical properties are modulated using light irradiation. They can be constructed from inorganic metal-based solids or organic molecules, but also from **metal complexes**, i.e., metal ions surrounded by organic and/or inorganic molecules, named ligands. Among photoresponsive materials, the broad interest is devoted to those revealing **photochromism**, which is the ability to change the optical properties by light irradiation. If these changes are reversible, e.g., using light of a different wavelength than the original one, we can name the material a photochromic switch. Such materials are applicable in data storage, smart windows, color-changing glasses, anticounterfeiting, and sensors. On the other hand, the broad application potential was found for **luminescent materials**, i.e., those that emit light due to the absorption of photons (**photoluminescence**, PL), electric current (**electroluminescence**, EL), a chemical reaction (chemi-luminescence), and others. The PL materials are, e.g., applicable in sensors of chemicals, temperature, or pressure, as well as in bioimaging and solar cells, while the EL-active ones are explored for light-emitting diodes (LEDs). Similar to photoresponsive materials, luminescent materials are built of inorganic metal-based solids or organic ones, but also of metal complexes based on transition metals or lanthanides (Ln).

The other important property of a functional solid, in particular a crystalline one, is its **polarity**, which can be generated by the crystallization of its polar components (e.g., possessing non-zero electric dipole moments) within the structural arrangement without the center of symmetry. Polar crystals demonstrate a series of unique properties with multiple applications. This includes **nonlinear optical effects** (NLO), which are phenomena nonlinearly dependent on the excitation light intensity. This is, e.g., second-harmonic generation (SHG) where light with the frequency ω is converted by a polar solid into the light of double frequency (2ω). The NLO effects are extensively explored for applications in laser systems and advanced photonic devices. Polar materials can also reveal a strong and stimuli-responsive dielectric response, e.g., **tunable dielectric constant** (DiE) and, more importantly, **ferroelectricity** (FeE), which is the ability of a material below a certain temperature to exhibit switchable and permanent electric polarization. The latter effect is applied to the construction of memory devices, e.g., FeRAMs (ferroelectric random-access memories).

This project aims at the construction of **multifunctional materials** linking the three above-mentioned properties of solids, i.e., photochromism, luminescence, and polarity, the latter leading both to NLO and ferroelectric effects. The project idea (see scheme below) is, first, to obtain photochromic luminescent metal complexes in which light-induced changes in PL will be reversed by other light, time (*t*), or temperature (*T*). These photochromic luminophores are planned to be combined with organic polar cations to construct unique crystalline **photochromic polar luminophores based on metal complexes**. They are expected to reveal the reversibly photoswitchable set of optical and electrical properties, including PL, NLO, DiE, and FeE effects. Moreover, taking advantage of linking optical and electrical effects, the efficient switching of optical properties by electric field will be observed, and this electro-optical switching is expected to be remarkably modulated by light, achieving, for instance, a four-state memory system differing in PL (PL1, PL1', PL2, PL2'). The most promising crystalline materials demonstrating such photoswitching effects are planned in the project to be processed into (a) a **liquid crystalline** phase offering the strategy for further enhancement of the switching abilities due to the intrinsically better responsiveness of liquid crystals to external stimuli, and (b) nanometric **thin films** for lowering the material's size and testing of their application potential in EL devices. Therefore, the project is focused on the search for synthetic pathways toward new generations of **advanced photo-switchable electro-optical materials for applications in data storage**, as well as displays, sensors, and anticounterfeiting. Simultaneously important is the demonstration and understanding of **unique physical effects** originating from linking a few different phenomena in a single material.