DESCRIPTION FOR THE GENERAL PUBLIC

Reliable and selective detection of chemicals is important for numerous laboratory and industrial processes, in the monitoring of the natural environment as well as in clinical diagnosis and treatment. For instance, there is a large need for the effective sensing of toxic and hazardous pollutants, such as nitrogen oxides, carbon oxides, and ammonia. Traditional detection technologies, which employ, e.g., color changes, electrochemistry, or chromatography, have several disadvantages, including complex instrumentation as well as time-consuming procedures for sample preparation and analysis. This is crucial as not only precise but also fast, direct, and economical detection of various chemical compounds is needed. These requirements can be fulfilled by **luminescent sensors**.

Luminescence is the ability of a material to emit light caused by external stimuli, such as irradiation by other light (photoluminescence), electric current, mechanical action, etc. Applications of luminescent materials range from light-emitting diodes, and display devices, through bioimaging, up to optical memories and energy conversion. **Photoluminescent materials are also attractive for the efficient sensing of chemicals.** Their advantage relies on the convenient usage of a luminescence signal for sensing due to its visibility by the naked eye, well-developed detection, low detection limits, and simple sample preparation. The project will focus on the luminescent materials that can be used for the **sensing of gases**, such as oxides of carbon, nitrogen, and sulfur, as well as gaseous oxygen, nitrogen, hydrogen, ammonia, acidic gases (H_2S, HCl, HCN), and hydrocarbons.

We will focus on **photoluminescent materials based on molecules**, in particular on **metal complexes** consisting of metal ions and organic or inorganic ligands. These materials are composed of metal complexes linked by coordination bonds into coordination polymers and metal-organic frameworks or connected by weaker non-covalent interactions into supramolecular networks. Thanks to such structures, luminophores based on metal complexes can be sensitive to external stimuli. **The goal of the project is to synthesize and characterize novel luminescent gas sensors built of coordination compounds based on luminescent metal complexes.** The project will employ **the special type of complexes of platinum, palladium, silver, and gold**, which form supramolecular aggregates with short metal-metal (M-M) distances due to the **metallophilic interactions** (see Scheme below). These aggregates are responsible for strong photo-luminescence related to the M-M distance. We will show that the tunable M-M distance, and the resulting light emission, will be the source of efficient luminescence sensing of gases. The complexes of Pt, Pd, Ag, and Au will be combined with the second metal ion and additional organic components which will lead to the formation of porous materials. We will explore their **elasticity** supporting the modification of the structure and optical properties upon the insertion of gases. We will also test the possible **shape-memory effect of nanopores** – the ability of some coordination polymers to stabilize the specific shape of the structure after the removal of exchanged solvents. We will test how this effect can be employed to optimize the structure to get an enhanced optical response to gas molecules. We will also introduce chirality enabling the optical response exploring circularly polarized luminescence which is the differential emission of right- and left-circularly polarized light. All these aspects will formulate the pathway to achieve **multifunctional luminescent gas sensors** which will respond to diverse gases with the usage of various optical parameters. These materials will be obtained in crystalline form, but in the final stage of the project, we will process them to thin films better suitable for applications in real devices. Therefore, the project goals cover the synthesis of a novel class of functional luminophores working as high-performance gas sensors through the understanding of the mechanisms of gas sensing, up to the preparation of thin films for the new generation gas detectors.