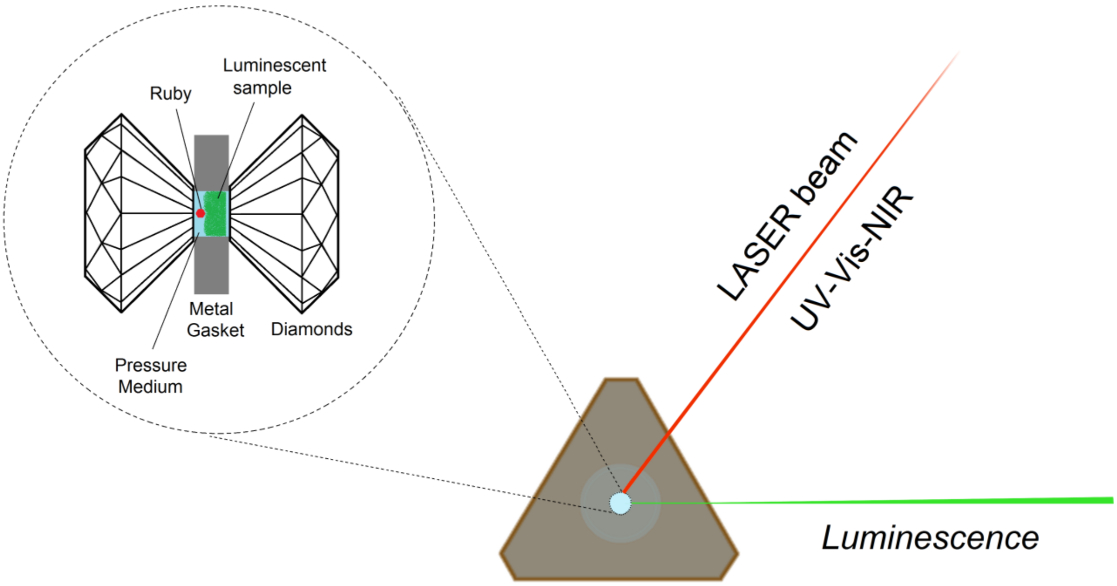
Functional nanomaterials are currently extensively studied, due to their unique optoelectronic, magnetic and structural properties, which are often altered in comparison to their bulk analogues. These effects are usually related to the large surface area to volume ratio of the nanostructures and quantum confinement of the electrons. Lanthanide (Ln^{3+}) based luminescent nanoparticles, exhibit multicolour emission under UV and NIR irradiation (i.e. energy up-conversion), long radiative lifetimes and narrow emission bands corresponding to 4f-4f transition within Ln^{3+} ions. Inorganic crystals doped with Ln^{3+} ions, are resistant to high temperatures and fotodegradation.

Currently, the high-pressure luminescence is a barely investigated phenomenon, especially in the case of inorganic nanomaterials, and requires extensive and detailed studies. The research concerning the behaviour and photophysical properties of luminescent materials in extreme conditions, as materials subjected to high-pressure compression (10 000 – 300 000 bar, i.e. 1 – 30 GPa), may turn out to be breakthrough both for science and industry. Generally, the changes of photophysical properties of materials subjected to high pressure, are related to the compression of the system, leading to the decrease of interplanar distances, shortening of bonds between atoms/ions, decrease of unit cell volume and formation of pressure-induced crystal defects.



Schematic setup configuration for high-pressure luminescence measurements in diamond anvil cell (DAC)

The goal of the project is investigation of the influence of high pressure on spectroscopic, structural and morphological properties of inorganic nano- and microcrystalline materials, doped with lanthanide ions (Ln^{3+}). The particular emphasis will be put on the studies concerning pressure-induced luminescence alterations of the mentioned materials, i.e. alteration of emission intensity, change of excitation/emission bands ratio, spectral shift of the bands maxima, luminescence colour tuning and a change of emission lifetime length. The pressure-induced changes of photophysical properties of the materials, will be studied in a diamond anvil cell (DAC). Thanks to this, it will be possible to online monitor and analyse the mentioned dependences (measurements during compression process). After increasing pressure to the desired value, the controlled decompression process will be performed, including the measurements of the spectroscopic and structural properties during the decompression process. This will allow the detection of the potential hysteresis of luminescence intensity, emission lifetimes, colour of emission, structure and morphology of the particles. In this way, the elastic and plastic deformations of the materials subjected to high-pressure compression, will be examined. The permanent enhancement of luminescence intensity, emission colour tuning, increase or shortening of the radiative lifetime (after compression-decompression cycle) may turn out to be very appealing for industrial applications. This would lead to the formation of new advanced materials, obtained/modified in extreme conditions of high-pressure. Moreover, the new, effective optical pressure sensors, which can be a good alternative for the commonly used ruby monocrystals, will be selected.