Materials showing persistent luminescence (MPL) are a relatively new group of materials studied in recent years. Interest in these materials is associated primarily with their unusual property, which is the emission of light (usually in visible range) after ceasing irradiation. These materials although very often used in many kinds of "gadgets" (toys glowing in the night, illuminated buttons, or the clock glowing in the night) have great potential in science and industry. The main applications of the above-described materials in science are photovoltaics, bioimaging or sensors. In the first case, MPL are used because of their wide absorption of UV and visible light. Then, through the transfer of energy and different appropriately selected material parameters is emitted the visible or red light, which can improve efficiency of the solar cells. In this application very often is used term "light harvesting", because MPL absorbs a wide part of solar radiation and converts them into those useful for solar cells. Using such of systems increase solar cell efficiency that increase economic potential of green energy production. In the case of bioimaging MOL offer possibilities that for some materials are hard to achieve. Since the tissue absorb very well radiation from UV to red and are transparent only in the near and mid infrared regions (NIR, IR), the materials for bioimaging must emit in this range. It is also important to note that they must be also excited using IR. Therefore materials showing upconversion - UC (where emitted light have higher energy than absorbed one) are widely studied. But the synthesis of such materials is quite complicated and often expensive. MPL is an alternative to such structures, because their synthesis is much simpler, and in many cases also much cheaper. MPL don’t have to be excited in the infrared range because they can be irradiate "ex vivo" and because they emit for a very long time (up to several hours), the emission can be observed after incorporation into the body (in vivo). In the case of the sensors, the phenomena that is used is the appearance of the current under light illumination. This is due to the release of electrons from traps and their flow through the valence band to the levels of excited optically active ions. There is much more applications of these materials, what show that intensive studies of materials with high emission efficiency (luminescence intensity and duration) at appropriate wavelength are needed.

The aim of the project is to synthesize and investigate the optical properties of narrow energy bandgap materials, or with highly deformed structure and the ability to modulate persistent luminescence (time and intensity of emission, emission wavelength) by using various matrices or Rare Earth ions, high pressure sintering method, graphene addition or using the vacuum. The depths of the energy storage traps and energy transfers between them and the levels of luminescent ions will be determined. Process kinetics and changes caused by external factors (e.g. applied pressure, vacuum level) will be investigated. Attempt will be made for describing theoretical models of energy transfer mechanisms to help in the future design MPL at matrix and dopant selection stage.

As a result of the project, advanced materials with well-defined chemical and photo-physical properties will be developed. Study of the mechanisms of persistent luminescence and the factors having impact on it will allow for a better understanding of this phenomenon and create the possibility of making efficient materials that will be widely used in various areas of everyday life. MOL's energy transfers are still not fully explored and require intensive work to determine their mechanisms.