DESCRIPTION FOR THE GENERAL PUBLIC

The project pertains to the research of conductivity and photoconductivity (i.e. the effect of light-induced conduction of electric current) in materials, which are insulators (dielectrics) in ambient conditions. The materials under study are oxides, nitrides, oxi-nitrides and oxi-sulphates in the form of monocrystals, powders and nanomaterials doped with lanthanide metals, which constitute the luminescence centers. Doped materials have long been used as luminophores in light emitting diodes and as scintillators. A new significant application of the luminescent nanomaterials is the medical phototheraphy and photodiagnostics. The latter uses the phenomenon of persistent luminescence, which consists in the emission of light, prolonged up to several hours, from a nanomaterial introduced to a living organism. In spite of doping, not all materials display luminescent properties. Although the electronic structure of lanthanide dopants is relatively well known, the generally accepted procedure of matrices and dopants selection is based on extensive and costly synthesis of many compounds and then choosing the best one. The objective of the proposed research of conductivity and photoconductivity, together with spectroscopic research, is to determine and document the relations between macroscopic parameters of the host crystal lattice (e.g. the type of chemical bonds, interatomic distances, types of natural defects) and luminescence efficiency by virtue of the detailed comprehesion of the energetic structure of the lattice-dopant system.

The research will be conducted in two directions:

First of all, studying the dependence of the resistivity on the color (wavelength) of the excitation light and then comparing it to the absorption and emission spectra provides additional information on electronic structure of researched materials. This is necessary for better understanding of the mechanisms of the accumulation of the energy of the exciting photons and subsequent luminescence. The study of the existence of the excitons bound to the dopants is of paramount importance, since they are fundamental for luminescence efficiency, yet still not described by the currently used advanced theoretical models.

Secondly, the determination of conditions which induce changes in conductivity of the studied dielectrics will also be undertaken. The influence of the natural defects, which are generated in the technological process, and of additional doping on the materials resistivity will be investigated among other things. Such research has not yet been done in dielectrics, however it plays a key role in the design of integrated optoelectronic devices. Contrary to the currently used light emitting diodes, in which the p-n junction emits blue light, which is then absorbed by the phosphor and transformed into white light, the phosphor in the integrated device would be a part of the p-n junction. Development of such devices would revolutionize the light production market.

In addition to the conventional conductivity and photoconductivity research, high hydrostatic pressure experiments, with pressures exceeding 30 GPa (300000 atm) and produced in diamond anvil cells, will be performed. High pressure induces compression (i.e. change of volume) of the material and consequently a decrease in interatomic distances. In this case, the obtained results will be equivalent to the results, that could be obtained via synthesis of materials with similar structure but different interatomic distances.