Description for General Public

Nanophotonics is now a rapidly growing interdisciplinary field of science, mainly due to the unique properties of optical waveguide structures with nanoparticles, obtained as a result of their interaction with photons.The most advanced systems are found in the currently used waveguide structures, characterised by sophisticated optical properties and an excelent thermal stability parameters required in modern optical fiber technology. Therefore, the construction of such materials requires an interdisciplinary approach to combine fields of materials engineering and photonics. State-of-art is a combination of noble metals properties, ie. silver (Ag^+), gold (Au^+) and technology of rare earth (RE) ions doped glassy materials. Modification of emission properties of glassy materials doped with lanthanide ions, which is obtained by co-doping with nano-sized metal particles, is innovative research area. One of the reason of introducing nanoparticles of noble metal to glassy materials is the possibility of increasing the luminescence signal in the visible range by energy transfer between metal nanoparticles and rare earth elements and by enhancement of electric field within rare earth ions that results from the surface plasmon resonance. Studies about interaction mechanisms of noble metal nanoparticles on luminescence properties of active glasses are at present the subject of research of many research centres all over the world. In results it entails new opportunities in the production of optoelectronic devices, especially for sources and optical sensors which have already been used in medicine, optics and nanophotonics. The scientific aim of this project is to analyse luminescence properties of photonics glasses and optical fibers to determining an interaction mechanisms (energy transfer, plasmon resonance) of noble metal ions (Ag+, Au+) and rare earth ions, also to determining optical properties of these materials enable to shaping of luminescence spectra. Material scope of research results from the need to determine the correlation between the structure of glassy material and efficiency of coupling between metallic nanoparticles and rare earth elements placed in the same optical medium. In results, two main complementary phenomena influencing on the changes in emission properties in photonics glasses will be determined. One of them is the energy transfer between metal nanoparticles and rare earth ions resulting from partial absorption of pumping radiation by silver and gold ions and the second one is the enhancement of the luminescence signal by changing the local field of the rare earth sample resulting from the surface plasmon resonance of interacting metallic nanoparticles. In the project, development of thermally stable glasses characterised by vary phonon energy with good optical properties enable to forming optical fibers from them was planed. It should be noticed that condition of high thermal stability (lack of crystallisation effect) will be fullfiled under modern optical fiber technology requirements. The next step is co-doping of fabricated photonic glasses (containing RE ions) with noble metal ions (Ag+, Au+) and analysis of their luminescence properties. A necessary complement to research is determining conditions of the forming process of nanoparticles as a result of heat treatment. Contribution to the collection of basic research is also the analysis of structural properties of glasses which enable obtaining metallic nanoparticles and forming their geometry in the controlled process of heat treating and also leading to shaping of luminescence properties of the matrix. Moreover, selection of a suitable chemical composition of the core glass and the dopant concentration (rare earth ions + noble metal) will allow the formation of metallic nanoparticles through a thermal treatment directly in the drawing process of optical fibers. Suggested issues comprise innovative character of basic research in the field of optoelectronics and nanophotonics, behind which there is the explanation of correlations that influence shape of the luminescence signal, which result from the local field enhancement (LFE) of the admixture and the energy transfer between metal particles and lanthanide elements. The fabrication of active fiber optic containing metal particles and comparing its luminescent properties with fabricated glasses is added value to planned research within the project. Motivation to take research problem of this project is development of optical fibres co-doped with lanthanide ions and metal nanoparticles and explanation of complex nature of metallic particles and lanthanides ions interactions. Considering the fact that there is no explicit description of the factors responsible for forming and managing the luminescence spectra of optical fibers, it is essential to explain these mechanisms with reference to the type of the glassy matrix and its impact on surface plasmon resonance phenomenon which enables modification of luminescence properties of rare earth elements. The project implementation brings new elements in the field of description of phenomena responsible for emission enhancement in optical fiber co-doped with lanthanide ions and metallic nanoparticles. The author of the project is convinced that comprehensive description of basic research will provide to submit an international research project on the new functionalized glassy nanomaterials used in medical applications.