Synopsis of the PhD thesis

Lead-free glasses activated by erbium ions for up-conversion luminescence processes used in optical technology

Author: mgr Joanna Janek

Promoter: prof. dr hab. Wojciech Pisarski

In spite of some restrictions in European Union, lead-free glasses and glass fibers containing lanthanide ions are very promising optical materials for systems converting near-infrared radiation into visible light and optical waveguide technology. An addition of fluorine ions to traditional oxide glasses starts to enhance contribution of radiative transitions and consequently increases significantly their luminescence lifetimes, quantum yields and other important spectroscopic parameters for lanthanide ions. Thus, mixed oxyfluoride glass systems are attractive materials, because they combine very good mechanical properties and thermal stability of oxide glass and improved radiative emission properties of fluoride glass. For that reason, optical fibers based on precursor oxyfluoride glasses are interesting not only from the technological point of view, but they also possess enhanced up-conversion luminescence properties.

The scientific aim of the doctoral dissertation was fabrication and characterization of lead-free glasses and glass-fibers doped with lanthanide ions including physicochemical and optical properties. In particular, the up-conversion luminescence processes in rare earth doped glasses and their glass-fibers were examined in details.

The PhD thesis based on eight published works in the international scientific journals consists of two parts. In the first part of the doctoral dissertation, lead-free germanate and borate glasses containing selected lanthanide ions were synthesized and then characterized using some experimental methods. The investigations were concentrated on preparation of glasses containing different oxide and fluoride modifiers MO/MF_2 (where M = Ca, Sr, Ba) and study of their physicochemical and optical properties. Based on several spectroscopic parameters of trivalent lanthanide ions the most promising glass system for was selected for further up-conversion luminescence investigations. The second part of the doctoral dissertation deals with study of up-conversion luminescence processes and their mechanisms in erbium doped glasses and glass-fibers under commercially available continuous-wave laser-diode excitation. In particular, the up-conversion luminescence processes of rare earth ions were examined as a function of temperature. Several spectroscopic parameters were determined in glasses singly doped with Er^{3+} and doubly doped with Er^{3+}/Yb^{3+}, such as fluorescence intensity ratio and temperature sensitivity. There are some problems, which are interesting not only from the scientific point of view. In practice, the obtained results may be important for photonics and up-conversion luminescence temperature sensors. Finally, the active glass-fibers doped with erbium emitting enhanced green light based on up-conversion luminescence process were fabricated from precursor lead-free oxyfluoride germanate glasses and then examined in relation to practical applications in waveguide technology.

Joanna Janek