mgr inż. Tomasz Ragiń
Politechnika Białostocka
Wydział Elektryczny
Katedra Elektroenergetyki, Fotoniki i Techniki Świetlnej

Białystok 2017

ABSTRACT

The aim of this work is to develop low-phonon glass based on heavy metal oxides co-doped with rare earth ions characterized by the mid-infrared emission for the use in photonic structures. Non-oxide amorphous materials, such as fluorides or sulphides, possess good laser properties for the mid-IR radiation emission, but their potential application use is limited due to the relatively fast aging, the adverse impact on environmental and the high complexity of the technological process, which ultimately affect the price of the final product. Based on literature considerations, it has been concluded that new amorphous materials based on oxides compounds enable to construct photonic structures operating in the mid-infrared region. The group of heavy metal oxide glasses possess properties of oxide amorphous materials and is characterized by low phonon energy as well as high transmittance, which is essential for effective mid-IR emission. Incorporation of rare earth ions into the glass matrix enables obtaining emission in the range of 2.7 – 3.0 μm due the energy transfer between the donor and acceptor.

The main research objective of the study was to **obtain luminescence in the range of 2.7 μm - 3.0 μm in heavy metal oxide active glasses for the use in photonic structures.**

The first chapter presents potential applications of the 2.7 - 3.0 μm radiation. The methods of lanthanide use in amorphous active structures for mid-IR radiation have been described.

In chapter 2, quantum transitions within rare earth ions energy structure have been characterized. The processes of energy transfer between trivalent lanthanide ions were defined.

Chapter 3 describes the properties of the non-oxide and oxide amorphous structures emitting in the mid-infrared spectral range.

Chapter 4 presents objective thesis and scope of the dissertation.

The fifth chapter contains the methodology of the conducted studies determining the physicochemical, thermal, structural and spectroscopic properties of the developed glasses. The process of material synthesis is presented, taking into account the optimization of the melting technology in order to improve transmission and luminescent parameters in the mid-infrared region.

In chapter 6, results of the experimental research have been presented. Glass with the molar concentration of $50BiO_2O_3$ - $20GeO_2$ - $25Ga_2O_3$ - $5Na_2O$ was selected and as a matrix for further doping with rare earth ions. Based on the FT-IR and transmission parameters results, the conditions necessary for luminescence in the range of 2.7 - 3.0 μm have been fulfilled.

In the seventh chapter, glasses doped with Er^{3+}, Yb^{3+}, and co-doped with Er^{3+}/Yb^{3+}, Ho^{3+}/Yb^{3+} ions were characterized in terms of luminescent parameters.

Chapter 8 presents the technological process of producing optical fibers with active core emitting in the wavelength range of 2.7 - 3.0 μm. The luminescent properties of fabricated optical fibers have been analyzed in terms of their possible use in photonic structures operating in the mid-infrared spectral range.

In Chapter 9, a summary of the study and conclusions from the work results were presented.