Study of Luminescence Properties of Yb^{3+} - Doped Oxides Using High Hydrostatic Pressure

A. Kaminska[1,2]

[1]*Institute of Physics, Polish Academy of Sciences, Aleja Lotnikow 32/46, PL-02668 Warsaw, Poland*
[2]*Cardinal Stefan Wyszynski University, College of Science, Department of Mathematics and Natural Sciences, Dewajtis 5, 01-815 Warsaw, Poland*

Rare earths (RE) doped oxides are attracting a lot of attention due to their advantageous optical properties and high potential in new optical device applications. Among RE ytterbium is an attractive dopant for obtaining effective luminescence at a wavelength of about 1 μm, related to the intra-configurational electronic transitions of the Yb^{3+} ion. A simple energy level scheme of Yb^{3+} ions ($4f^{13}$ electron configuration), which consists of two states only (the ground $^2F_{7/2}$ and excited $^2F_{5/2}$) excludes excited state absorption and all related energy losses. From this point of view, and because of the development of high brightness InGaAs-based laser diodes emitting near 980 nm, where the Yb^{3+} has a strong absorption peak, this ion may compete with Nd^{3+} as an active lasing center emitting in the same range of emission wavelength [1-4].

One of the most important issues in a deep understanding of the mechanisms of RE active ion luminescence is to determine the energy levels of the dopant, the location of these energy levels with respect to the valence and conduction bands of the host crystal, as well as a detailed investigation of the involved energy transfer processes.

Application of high pressure reduces the ion-ion distances causing the increase of the crystal field strength experienced by the dopant ion and changing the energetic structure of the band states of the crystal matrix. Thus the high-pressure spectroscopy is a very efficient tool for investigating the energy structure of RE ions and their interaction with the lattice.

In this work we present the study of the influence of hydrostatic pressure on the radiative intra-configurational $4f \rightarrow 4f$ transitions of Yb^{3+} ions doped to several oxide materials, witch differ in energy gap values and crystal structures. A thorough analysis of ambient pressure spectra and the pressure behaviour of the Yb^{3+} luminescence lines in $LiNbO_3$, YPO_4, $GdPO_4$ and $Gd_3Ga_5O_{12}$ allowed for determining the ambient pressure positions and pressure dependence of the Yb^{3+} energy levels in crystal fields of different strengths and symmetries. The comparison of decay times of Yb^{3+} luminescence in different crystal matrices and their pressure dependencies has been also performed.

The results revealed a high thermal and pressure stability of Yb^{3+} emission in the examined crystals, and also the significant effect of the local symmetry of ytterbium dopant on its radiative transition rate, which are the important factors from the point of view of potential applications of ytterbium as an optically active ion in different crystal hosts.

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