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Application of high-pressure spectroscopy in the study of rare-earth doped garnets

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Garnet crystals with various dopants are nowadays attracting a lot of attention due to their advantageous optical properties, by which these compounds can be widely used as phosphors, scintillators or laser crystals. Especially important in this field are the garnets doped with rare-earth ions, which can be easily grown using various methods.

One of the most important issues in a deep understanding of the mechanisms of RE dopant luminescence is to determine the location of its energy levels with respect to the valence and conduction bands of the host crystal, and a detailed investigation of the involved energy transfer processes. Since the application of pressure affects both the strength of the crystal field experienced by the dopant ion and the energy structure of the crystal matrix, high-pressure spectroscopy is very well suited for these purposes.

In this work, the results of high-pressure studies of Gd_3Ga5O_{12} (GGG), $Y_3Ga_5O_{12}$:Ce (YGG:Ce) and $Y_3Al_5O_{12}$ (YAG) crystals doped with Nd, Yb or Ce ions will be presented. First, the influence of pressure on the intra-configurational 4f → 4f transitions of Yb^{3+} ions will be shown [1]. Then the origin of the removal of splitting of the $^4F_{3/2}$ level of Nd^{3+} dopant in GGG by applying the pressure will be discussed [2]. Finally, the pressure-induced pronounced increase of the luminescence efficiency of Ce^{3+} doped GGG and YGG will be analysed [3, 4]. A model explaining this effect will be discussed.

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