Luminescence properties and electronic structure of $YAl_3(BO_3)_4$:Gd phosphor

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We are investigating the optical properties of yttrium borate phosphors in detail for the improvement in further luminous efficiency. $YAl_3(BO_3)_4$ doped with Gd^{3+} ions is the strongly UV-luminescent phosphor under VUV excitation[1]. Figure 1 shows the luminescence and excitation spectra of $YAl_3(BO_3)_4$:Gd and YBO_3:Gd at room temperature. These emission spectra under the excitation at 172-nm light consist of only a strong emission line at 313 nm. At present, the luminescence peak intensity of $YAl_3(BO_3)_4$:Gd is about 1.5 times as compared with that of YBO_3:Gd, and about 15 times of $BaSi_2O_5$:Pb (conventional UV phosphor). It is found that the 313-nm emission is effectively stimulated under the excitation in the range below 180 nm. The peak wavelength of each excitation spectra is about 170 nm. Therefore, these can use for the UV fluorescent lamp using the discharge of xenon gas without mercury.

In the present study, we have carried out the analysis of the electronic state and the crystal structure which calculated by the relativistic DV-Xα and Rietveld(RIETAN-2000) method, respectively. About $YAl_3(BO_3)_4$:Gd phosphor, Fig. 2 shows the calculation result of the electronic structure. It is suggested that the valence band consists of the O 2*p* states and the bottom of conduction band is composed of mainly the Y 4*d* and B 2*p* states. We will discuss the optical excitation properties of $YAl_3(BO_3)_4$:Gd phosphor on the basis of the experiment and theoretical results, and compare with those of $YAl_3(BO_3)_4$ and YBO_3 crystal.

Reference

[1] H. Yoshida, R. Yoshimatsu, M. Minamoto, Y. Nishikage and N. Yokosawa : The 203rd Meeting of the Electrochem. Soc., (2003).

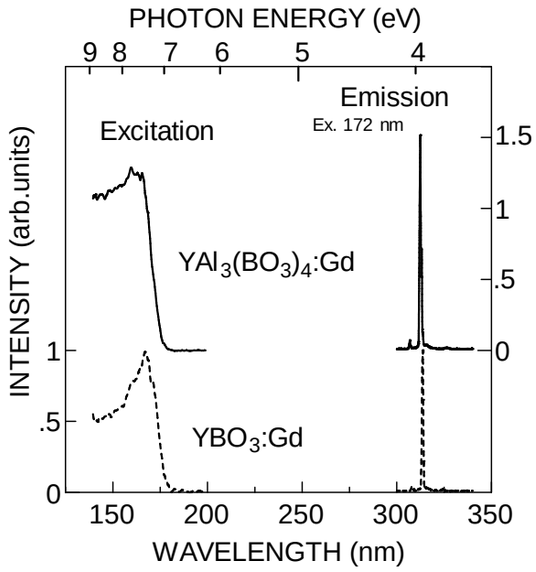

Fig. 1 The luminescence spectra of $YAl_3(BO_3)_4$:Gd and YBO_3:Gd under the excitation at 172-nm light (right side) and the excitation spectra for the 313-nm emission line (left side).

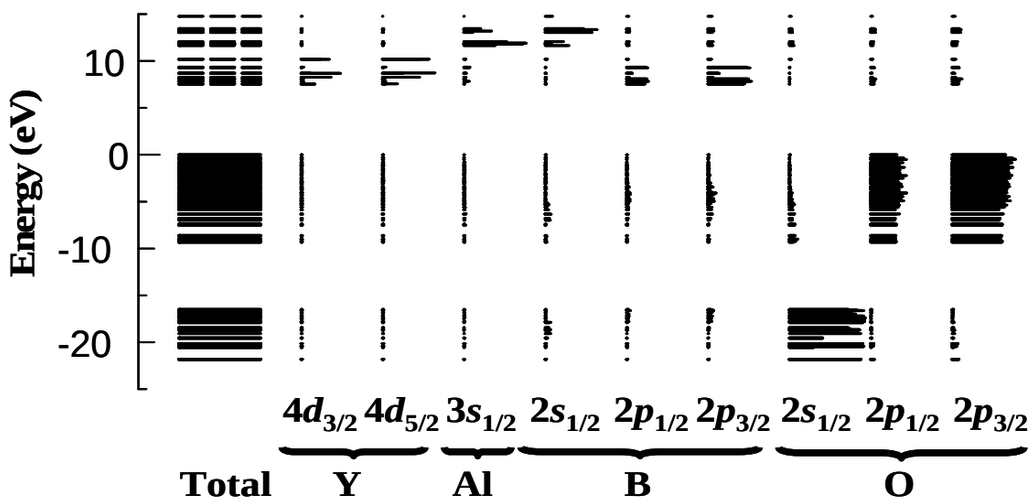

Fig. 2 Electronic structure of $[YAl_6B_8O_{42}]^{-39}$ cluster model in $YAl_3(BO_3)_4$:Gd phosphor calculated by relativistic DV-Xα method. The energy is referred to the top of valence band.