Crystal structures, thermal evolution and luminescent properties of new compound Sr$_3$Bi$_2$(BO$_3$)$_4$ and Sr$_{3-x}$Ba$_x$Bi$_2$(BO$_3$)$_4$ solid solutions doped by Eu$^{3+}$

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Borates are perspective materials for luminescent matrix due to the wide bandgap, relatively easy synthesis and high thermal stability. Sr$_3$Bi$_2$(BO$_3$)$_4$ new compound and Sr$_{3-x}$Ba$_x$Bi$_2$(BO$_3$)$_4$ solid solutions were obtained by crystallization from melt. The samples contain crystals of Sr$_3$Bi$_2$(BO$_3$)$_4$ and amorphous phase. After successful synthesis, the end-members of the series of solid solutions were doped by Eu$^{3+}$ atoms.

Crystal structure of Ba$_3$Bi$_2$(BO$_3$)$_4$ was firstly investigated in [1]. Crystal structures of Sr$_3$Bi$_2$(BO$_3$)$_4$, Sr$_{1.35}$Ba$_{1.65}$Bi$_2$(BO$_3$)$_4$ and Sr$_3$Bi$_{1.66}$Eu$_{0.34}$(BO$_3$)$_4$ were solved and refined in this work to $R_1 = 0.051$, 0.059 and 0.067 respectively using single-crystal diffractometer Bruker APEX II, MoK$_\alpha$ radiation. For example, unit cell parameters of Sr$_3$Bi$_2$(BO$_3$)$_4$ are $a = 7.5107(5)$, $b = 16.2737(11)$, $c = 8.8163(5)$ Å, $V = 1077.59(12)$ Å$^3$,
space group $Pnma$; there are three independent B atoms coordinated by three oxygen atoms and three sites for cations: $M_1$, $M_2$ and $M_3$. Site occupation factor of $M_1$, $M_2$ and $M_3$ was refined. All cation sites are coordinated by eight oxygen atoms.

The thermal behavior of Sr$_{3-x}$Ba$_x$Bi$_2$(BO$_3$)$_4$ solid solutions was studied using in situ high-temperature XRD in the range 25-800 °C by means of Rigaku Ultima IV powder X-Ray diffractometer (CuK$_\alpha$) with a high-temperature camera. According to the principles of high temperature crystal chemistry [2] for borates with triangle groups, maximal thermal expansion occurs along $a$ axis and minimal – along $c$ axis.

The emission spectra of Sr$_3$Bi$_2$(BO$_3$)$_4$:Eu are measured using Fluorolog-3 spectrophotometer. The (Sr$_{0.85}$Eu$_{0.1}$)$_3$Bi$_2$(BO$_3$)$_4$ has the strongest luminescence intensity.

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