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Sol-gel combustion synthesis and stability of $\text{La}_{2}\text{O}_{3}:\text{Bi}^{3+}$ powder phosphor

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Bismuth (Bi) ions exhibit interesting optical properties, yet have been less intensively studied compared to rare earth ions. Bi doped lanthanum oxide ($\text{La}_{2}\text{O}_{3}:\text{Bi}^{3+}$) phosphor was synthesized via the sol-gel combustion method at 250 °C using citric acid as the fuel. The product powder was annealed at different temperatures between 800 °C to 1400 °C in air for 2 h. X-ray diffraction (XRD) data confirmed that the $\text{La}_{2}\text{O}_{3}$ host as well as doped phosphor crystallized in a hexagonal lattice. For photoluminescence spectroscopy (PL) an excitation wavelength of 308 nm, the phosphor powder produced a blue emission band centered at 462 nm. The maximum intensity was obtained for the sample doped with 0.2 mol% Bi which was annealed at 1200 °C. It was observed that the luminescence from the samples decreased after storage of several weeks. XRD measurements revealed that the $\text{La}_{2}\text{O}_{3}$ had changed to $\text{La}(\text{OH})_{3}$, which does not give luminescence when doped with Bi. It has been reported that $\text{La}_{2}\text{O}_{3}$ can absorb moisture from the air and transform to $\text{La}(\text{OH})_{3}$. This was observed to occur completely in about 6 days. The poorly emitting samples were re-annealed between 500 °C and 800 °C for 2 h. For the highest temperature it was found that the structure reverted completely to $\text{La}_{2}\text{O}_{3}$ and the blue PL emission was once again observed at about the same intensity as for freshly prepared samples. Although $\text{La}_{2}\text{O}_{3}:\text{Bi}^{3+}$ can be used as a blue emitting phosphor, it is only suitable for applications where it will not be exposed to moisture in the atmosphere. For samples stored in a vacuum desiccator for one week, no change for XRD and PL were observed. Therefore, it may have an application as a moisture sensor, because while the luminescence remains high it is evidence that it has not been exposed to the atmosphere.

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