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Pigmentary Colors from yellow to red in $\text{Bi}_2\text{Ce}_2\text{O}_7$ by rare earth ion substitutions as possible high NIR reflecting pigments

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Abstract

A new series of high near-infrared (NIR) reflecting pigments with colors ranging from yellow to red by tuning the $\text{Bi}_2\text{Ce}_2\text{O}_7$ with rare earth ion substitutions on both A and B sites were synthesized by a solid state reaction method. The resulting colorants were evaluated for their structural and optical properties. The absorption edge is gradually red shifted on substitution from Y to Tb resulting colors yellow to red. The XPS analysis surmises the presence of the elements with trends of reduction in Ce^{3+} concentration on both substitutions. These results suggest that the color shift is mainly due to charge transfer band shift of the O^{2-} to Ce^{4+} (4f-5d) and deep red shifted is due to the introduction of additional energy level by terbium ions. A brilliant yellow hue was obtained for $\text{Bi}_{1.75}\text{Y}_{0.25}\text{Ce}_2\text{O}_7$ ($b^* = 51.4$), whereas $\text{Bi}_2\text{Ce}_{1.50}\text{Tb}_{0.50}\text{O}_7$ ($a^* = 15.0$) exhibited a red color. High NIR solar reflectance of 93% and 88% were obtained for $\text{Bi}_{0.5}\text{Y}_{1.5}\text{Ce}_2\text{O}_7$ yellow and $\text{Bi}_2\text{Ce}_{1.50}\text{Tb}_{0.50}\text{O}_7$ red pigments respectively. The application study of these selected pigments was investigated in the polymer matrix which demonstrates their coloring performance for various potential applications. These results demonstrate the synthesized pigments as potential near infrared reflective candidates for cool roof applications.

Keywords: Yellow pigment; Red pigment; Terbium; NIR reflectance; Cool colorant

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