Thermally-induced structural phase transition in rare earth orthophosphate nanocrystals for highly sensitive thermal history paints

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It was demonstrated that he temperature-driven irreversible structural phase transformations in the Eu^{3+} activated $LaPO_4$, $La_{0.5}Y_{0.5}PO_4$, and YPO_4 nanocrystals can be used for the thermal history measurements over the 200°C-1000°C temperature range. Increase of the temperature caused significant changes in the Eu^{3+} local surroundings and, in consequence modified the intensity and the emission spectra. We showed that the intensity ratio of Eu^{3+} $^5D_0 \rightarrow {}^7F_2$ to $^5D_0 \rightarrow {}^7F_1$ emissions may serve as a highly-sensitive indicator of the highest temperature to which the nanocrystals were exposed to. The relative sensitivity of $Y_{0.5}La_{0.5}PO_4$:2 %Eu^{3+} based thermal history paint was as high as 0.8 %/°C at 1000 °C. The thermal history surface map of the square steel plate covered with $Y_{0.5}La_{0.5}PO_4$:2 %Eu^{3+} paint, heated locally at one of the corner is obtained as proof-of-concept experiment. The proposed ratiometric readout strategy facilitates measurement and enhances the accuracy of thermal history analysis.

Słowa kluczowe

Luminescent nanoparticles, Rare earths orthophosphates, Structural transformation, Thermal history sensors

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