Enabling High-Temperature Persistence Luminescence in $Ca_2Si_5N_8$:Eu^{2+},RE^{3+} via Trap State Engineering

Autorzy

Arslan Akbar

Justyna Zeler

Aleksandra Owczarek

Jakoah Brgoch

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Persistent luminescence at elevated temperatures can enable applications in high-temperature thermal sensing, structural health monitoring, and anticounterfeiting. However, achieving long persistent luminescence lifetimes under such conditions requires careful control over trap state energies within the host crystal structure. Shallow traps (near the conduction band) release charge carriers too readily, quenching luminescence at high temperatures, whereas excessively deep traps may not depopulate at all. In this study, trap state engineering is investigated as a route to enable high-temperature persistent luminescence in $Ca_2Si_5N_8$:Eu^{2+}, a red-orange-emitting phosphor, by systematically exploring the addition of a second trivalent rare-earth (*RE* = Dy^{3+}, Tm^{3+}, Nd^{3+}, Tb^{3+}). Co-doping modifies the trap depth energy and distribution, enabling control over thermally activated charge release. Through detailed analysis of emission spectra, trap depths, and luminescence decay profiles from room temperature to 325 °C, it is demonstrated that the trap states can be tuned to maintain persistent luminescence at high temperatures, thereby enhancing high-temperature performance. These findings establish a strategy for optimizing phosphor behavior in extreme thermal environments through targeted defect chemistry.

Słowa kluczowe

high temperature persistent luminescence, phosphors, thermoluminescence

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