

Development of Upconversion Phosphor-in-Glass Composites toward White Light Emitting Applications

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Rare-earth-doped upconversion phosphors offer the possibility of converting near-infrared excitation into visible emission and provide a route toward colour-tunable luminescent materials. In this work, $\text{CaLiLa}(\text{MoO}_4)_3$ phosphors co-doped with Yb^{3+} , Ho^{3+} , and Tm^{3+} were developed, with particular attention to tuning the blue, green, and red emission components toward white light and subsequently incorporating selected phosphors into a tellurite glass matrix.

The phosphors were prepared by solid-state synthesis, and the Yb^{3+} concentration was fixed at 20 at.% relative to the La^{3+} site, while the Ho^{3+} and Tm^{3+} concentrations were systematically varied. X-ray diffraction confirmed similar diffraction profiles across the investigated compositions without detectable secondary crystalline phases. Under 980 nm excitation, the phosphors exhibited characteristic blue, green, and red upconversion emission associated mainly with Tm^{3+} and Ho^{3+} transitions. Systematic variation of the Ho^{3+} and Tm^{3+} concentrations enabled control of the emission colour. Among the investigated compositions, the sample containing 20Yb–0.4Ho–0.4Tm showed CIE chromaticity coordinates of approximately (0.314, 0.305), representing the closest approach to the reference white point (0.333, 0.333).

Selected phosphors were subsequently incorporated into TeO_2 – ZnO – BaO tellurite glass to prepare phosphor-in-glass (PiG) composites using two incorporation approaches: addition of the phosphors to the initial glass batch and addition of the phosphors to the prepared glass melt. The PiG samples retained the characteristic blue, green, and red upconversion emission bands after glass processing, with no obvious systematic shift in their main emission wavelengths. X-ray diffraction showed predominantly amorphous characteristics, although the glass-melt-prepared composite exhibited a diffraction feature indicating a small detectable crystalline contribution.

Overall, the results demonstrate tunable upconversion emission toward the white region and retention of the characteristic emission after glass incorporation, providing a basis for further optimization of PiG composites for white-light-emitting applications.

Keywords: CIE chromaticity; Phosphor-in-glass; Tellurite glass; Upconversion luminescence; White-light emission