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Luminescent Thermometry Performance in Glasses and Glass-Ceramics: The Role of Material Structure in Emission Behavior

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Glass-ceramics combine compositional versatility of glasses with mechanical stability of ceramics, enabling advanced applications like waveguides and sensors.[1] Rare-earth-doped (RE^{3+}) glasses and glass-ceramics are of interest for luminescent thermometry due to narrow emission bands and broad with matrix compatibility. This study examines the influence of material on temperature-dependent upconversion emission in glasses and glass-ceramics with different Yb^{3+}/Er^{3+} ratios. Differential Scanning Calorimetry (DSC) analysis showed relatively low characteristic temperatures for the glasses (T_g ~ 350 °C, T_x ~ 450 °C, T_p ~ 500 °C), which increased with RE^{3+} addition. High thermal stability above 100 °C enabled glass-ceramic formation through controlled heat treatments between T_g and T_x. Using the Kissinger method, the crystallization activation energy was estimated to be ~89 kJ/mol for T_p in the fluorophosphate glass-ceramics. This method will be an important parameter for investigating the volumetric crystallization processes in glass-ceramics.[2] The samples exhibited absorption ~250 nm and bands corresponding to the Yb^{3+}/Er^{3+} pair, especially at 980 nm, which sensitizes Er^{3+} to produce green (525, 546 nm) and red (659 nm) emissions. The populations of thermally coupled levels $^2H_{11/2}$ and $^4S_{3/2}$ followed a Boltzmann distribution.[3] The thermometers showed relative sensitivities of 0.69% K^{-1} and 0.60% K^{-1}, and absolute sensitivities of 3.3×10^{-3} K^{-1} and 2.9×10^{-3} K^{-1} for glasses and glass-ceramics, respectively.

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References

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