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Er^{3+}/Yb^{3+} doped calcium germanate for solid-state lighting and high-sensitivity thermal sensor applications

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Materials based on germanium-calcium doped with 1% Er^{3+} and 10% Yb^{3+} were prepared using the solvothermal methodology and thermally treated at 700, 900, and 1100 °C for 3 hours, revealing significant insights. The crystalline structure of trigonal GeO_2 and tetragonal $Ca_2Ge_7O_{16}$ was identified at all treatment temperatures, while the trigonal $Yb_2Ge_2O_5$ structure appeared between 900 and 1100 °C. Calcined samples exhibited shifts in diffraction peaks, indicating the incorporation of dopants and the evolution of material properties with increasing temperature, resulting in varied morphologies, from blocks to rods on the micrometer scale. Upconversion spectra under 980 nm excitation (Figure 1) revealed emissions in the green ($^4S_{3/2}$, $^2H_{4/2} \rightarrow {}^4I_{15/2}$) and red ($^2F_{9/2} \rightarrow {}^4I_{15/2}$) regions, confirming the efficiency of energy transfer between Yb^{3+} and Er^{3+} ions, essential for photonic device applications. Thermal sensitivity, analyzed between 298 and 373 K, showed a value of Sr = 1.282 %·K^{-1}, comparable to other Er^{3+}/Yb^{3+} doped germanate systems. [1,2] The high repeatability of thermometric parameters (~95.0% at 298 K) suggests the material's excellent reversibility and thermal stability. In this regard, the structural, morphological, and spectroscopic characterization of Er^{3+}/Yb^{3+} doped samples demonstrate their potential for applications in high-sensitivity photonic devices and thermal sensors.

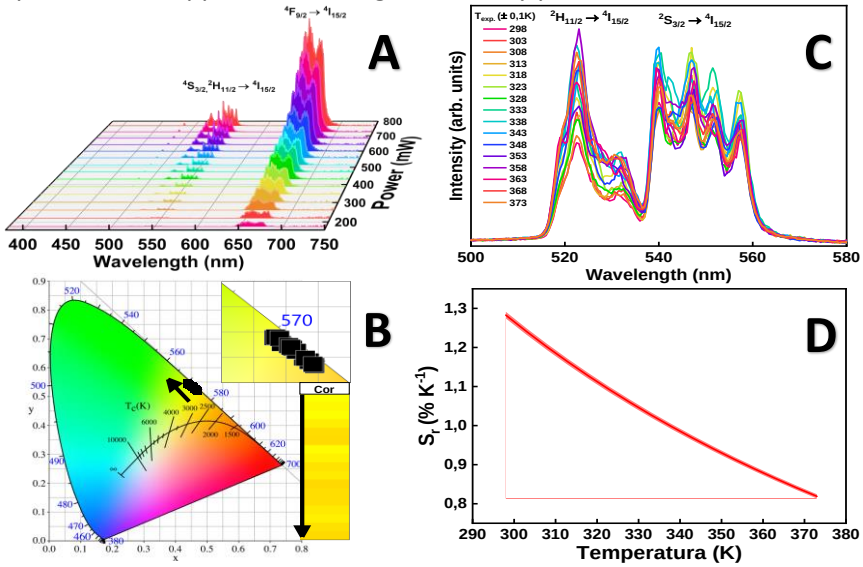

Figure 1. (A) Upconversion spectra, (B) CIE 1931 chromaticity diagram, (C) Upconversion spectra as a function of experimental temperature (298 to 373 K), and (D) Relative thermal sensitivity as a function of experimental temperature (298 to 373 K) of Er^{3+}/Yb^{3+} doped samples calcined at 900 °C.

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References

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