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Tunable emission of RE3+ multi-doped glass systems

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Rare-earth (RE) elements are widely used in electronics, optical fiber amplifiers, laser technologies, and other advanced applications. Despite their extensive use and importance, the purification of rare-earth elements remains expensive due to their similar chemical properties. While the most of works focus on high-pure RE, the expensive purification processes of these elements call attention to reuse and recycling technologies for RE minerals such as monazite and cerite and electronic wastes. Motivated to recycling and study optical applications of varied RE composition materials, we investigate the properties of multi-doped glass samples with general composition RE(100-x)[80Bi(PO_3)$_3$-10Bi_2O_3-10Na_2O]. The glasses were simultaneously doped with different rare-earth ions (Ce, Pr, Nd, Pm, Sm, Eu, Tb, Dy, Ho, Er, Tm, Yb) at a concentration of 0.2 mol% each, which were added to a total of 2.4%. A non-doped glass sample was also synthesized for comparison. The glass synthesis was performed using the melt-quenching method followed by annealing, resulting in transparent glass samples. Raman spectra suggest that the RE doesn't affect the structure of the glass. It is possible to observe in the UV-Vis spectra several narrow peaks of 4f-4f transitions of the RE^{3+} ions. It was possible to modulate the glass emission according to excitation wavelength used. Excitation at 348 nm resulted in an intense emission bluish emission at around 450 nm from transition $^1D_2 \rightarrow {}^3F_4$ of Tm^{3+}. When excited at 356 nm, it was observed a white emission mainly due to the bands between 480 and 573 nm mainly from Dy^{3+} emission $^4F_{9/2} \rightarrow {}^6H_{15/2}$ and $^4F_{9/2} \rightarrow {}^6H_{13/2}$.[1] Finally, the 393 nm excitation resulted in a reddish emission due to the 611 nm intense band characteristic of Europium $^5D_0 \rightarrow {}^7F_2$ transition.[2] These results demonstrate that the glass matrix is able to accommodate different rare-earth ions, resulting in color-tunable emission, opening possibility to optical applications with recycling materials.

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References

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