

Lanthanide-doped NaNbO_3 as a powerful anti-counterfeiting materials: a multi-mode emitter combining downshifting, persistent luminescence and upconversion

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Lanthanide doped perovskites have emerged as versatile materials for photonic applications due to their tunable optical properties. [1] Tuning perovskite properties such as phonon energy [2] and charge-transfer dynamics [3] allows selective enhancement of optical phenomena like upconversion (UC) or persistent luminescence (PersL). Here, we exploit the unique features of NaNbO_3 — low phonon energy and efficient Pr^{3+} - Nb^{5+} metal-to-metal charge transfer (MMCT) — to integrate both mechanisms in a single material. The Pr^{3+} doping generates red PersL, enabled by MMCT-derived trap states, while co-doping with $\text{Yb}^{3+}/\text{Er}^{3+}$ and/or Tm^{3+} produces tunable UC emission under NIR excitation. The materials were prepared by the fast microwave-assisted solid state synthesis that guarantees fast heating and cooling, leading to a high defect concentration. The structure and morphology of the materials were characterized with X-ray diffraction and Scanning electron microscopy. The photoluminescence measurements showed that the emission color can be tuned with co-doping while Pr^{3+} red persistent luminescence was always present independently on the co-doping (Yb/Er or Yb/Tm). Finally, excitation with 980 nm produced upconversion that could be color-tuned depending on the co-dopant pair, ranging from red/green (with Yb/Er at different concentrations) to blue (Yb/Tm). These results show that this system is a good candidate for anti-counterfeiting applications combining multi-modal luminescence phenomena.

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References

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