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Article

Synthesis of Microwave SolÃƒÂ¢Ã‚Â€Ã‚Â“Gel Derived $NaCaLa(WO_4)_3:Ho^{3+}/Yb^{3+}$ Phosphors and Their Spectroscopic Properties

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Abstract

Ho^{3+}/Yb^{3+} coÃƒÂ¢Ã‚Â€Ã‚Â•doped $NaCaLa_{1Ãƒ Â¢Ã‚Ã‚Ã‚Ãx}(WO_4)_3$ ternary tungstates with the proper concentrations of doping for Ho^{3+} and Yb^{3+} ($xÃƒÂ¢Ã‚Â€Ã‚Â‰=ÃƒÂ¢Ã‚Â€Ã‚Â‰Ho^{3+}$ + Yb^{3+}, $Ho^{3+}ÃƒÂ¢Ã‚Â€Ã‚Â‰=ÃƒÂ¢Ã‚Â€Ã‚Â‰$0, 0.05, 0.1, and 0.2, and $Yb^{3+}ÃƒÂ¢Ã‚Â€Ã‚Â‰=ÃƒÂ¢Ã‚Â€Ã‚Â‰$0, 0.2, and 0.45) were precisely synthesized using the solÃƒÂ¢Ã‚Â€Ã‚Â“gel method assisted by the microwave technique; their upconverted spectroscopic properties were studied in detail. The particles provided wellÃƒÂ¢Ã‚Â€Ã‚Â•crystallized morphology with a homogeneous and fine morphology, showing the grain sizes of 2ÃƒÂ¢Ã‚Â€Ã‚Â“5ÃƒÂ¢Ã‚Â€Ã‚Â‰ÃƒÂ Ã‚Âµm. After the low excitation at 980ÃƒÂ¢Ã‚Â€Ã‚Â‰nm, the $NaCaLa_{0.7}(WO_4)_3$:$Ho_{0.1}/Yb_{0.2}$ and $NaCaLa_{0.5}(WO_4)_3$:$Ho_{0.05}/Yb_{0.45}$ ternary tungstates provided strong upconverted yellow emissions, which are based on a strong green emission band of 545ÃƒÂ¢Ã‚Â€Ã‚Â‰nm and a strong red emission band of 655ÃƒÂ¢Ã‚Â€Ã‚Â‰nm. The optimal Yb^{3+}:Ho^{3+} ratio was obtained to be 9:1, as indicated by the compositionÃƒÂ¢Ã‚Â€Ã‚Â•dependent quenching effect of Ho^{3+} ions. The Raman spectra for the doped ternary tungstates showed the presence of strong peaks at higher frequencies, which were superimposed by strong Ho^{3+} luminescence lines. The dependence of pump power and Commission Internationale de L'Eclairage (CIE) chromaticity of the upconverted emission intensity was investigated in detail.

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