

Optical transition properties of Yb³⁺ in new fluorophosphate glasses with high gain coefficient

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Abstract

A new series of 0.4MgF₂–0.4BaF₂–0.1Al(PO₃)₃–0.1Ba(PO₃)₂ glasses doped with Yb³⁺ is introduced for fiber and waveguide laser applications. Spectroscopic properties including emission cross-section and lifetime and optical properties including refractive index, nonlinear refractive index, and Abbe number are reported as a function of Yb₂O₃ concentration. The refractive index n_d is linearly dependent on Yb₂O₃ concentration, while the nonlinear refractive index, $n_2 = 1.42 \times 10^{-13}$ esu, which is independent of Yb₂O₃ concentration, is extremely small. In addition, the Abbe number is remarkably high, >65, and is also independent of Yb₂O₃ concentration. To our knowledge, the emission cross-section σ_{emi} , which was found to be ≈ 0.87 pm² at the lasing wavelength of 996 nm, is the highest one among fluorophosphate glasses. This glass exhibits an extremely high gain coefficient, $G = 0.95$ ms pm⁴, and high quantum efficiency of $\eta = 94\%$. The combination of outstanding spectroscopic (high emission cross-section and gain coefficient) and optical (low dispersion and small nonlinear refractive index) properties demonstrates that the current Yb³⁺ activated fluorophosphate glass is an excellent candidate material for fiber and waveguide lasers.