

Author's Accepted Manuscript

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Y.C. Ratnakaram, S. Babu, L. Krishna Bharat, C. Nayak



PII: S0022-2313(15)30630-X
DOI: <http://dx.doi.org/10.1016/j.jlumin.2016.02.009>
Reference: LUMIN13842

To appear in: *Journal of Luminescence*

Received date: 23 October 2015
Revised date: 11 January 2016
Accepted date: 1 February 2016

Cite this article as: Y.C. Ratnakaram, S. Babu, L. Krishna Bharat and C. Nayak Fluorescence characteristics of Nd³⁺ doped multicomponent fluoro-phosphat glasses for potential solid-state laser applications, *Journal of Luminescence* <http://dx.doi.org/10.1016/j.jlumin.2016.02.009>

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Fluorescence characteristics of Nd³⁺ doped multicomponent fluoro-phosphate glasses for potential solid-state laser applications

Y.C. Ratnakaram*¹, S. Babu¹, L. Krishna Bharat², C. Nayak³,

1. Department of Physics, Sri Venkateswara University, Tirupati-517 502, A.P. INDIA.

2. Department of Electronics and Radio Engineering, Kyung Hee University, Yongin-si, Gyeonggi-do 446-701, Republic of Korea.

3. Atomic and Molecular Physics Division, Bhabha Atomic Research Centre, Mumbai 400 085, India

Abstract

The multicomponent fluoro-phosphate glasses of the type, 49.5P₂O₅-10AlF₃-10BaF₂-10SrF₂-10PbO-10M (M= Li₂O, Na₂O, K₂O, ZnO and Bi₂O₃) doped with 0.5 mol % neodymium were prepared by melt quenching technique. Their structures were characterized by the X-ray diffraction with SEM analysis, Fourier transform infrared (FTIR), Raman spectroscopy and ³¹P and ²⁷Al magic angle spinning (MAS) nuclear magnetic resonance (NMR) techniques. XPS spectra were studied to know the bridging and non-bridging oxygen groups. X-ray absorption near edge spectroscopy (XANES) was used to study the electronic structure of neodymium in the host glass matrices. The Judd–Ofelt parameters (J-O) (Ω_2 , Ω_4 and Ω_6) were evaluated from the intensities of the absorption bands through optical absorption spectra. Further, J-O parameters have been used to calculate various radiative properties like probabilities of radiative transitions, radiative lifetimes and branching ratios for different fluoro-phosphate glasses. The luminescence kinetics from the excited neodymium levels have been studied upon selective excitation through photoluminescence measurements. Neodymium ion emits two near infrared laser emissions: ${}^4F_{3/2} \rightarrow {}^4I_{11/2}$ at 1.06 μm and another one ${}^4F_{3/2} \rightarrow {}^4I_{13/2}$ at 1.32 μm . The major intensity is observed for 1.06 μm for the prepared fluoro-phosphate glasses. The lifetimes of these levels have been experimentally determined through decay profile studies. The above results suggest that the prepared lithium fluoro-phosphate glass system could be a suitable candidate for using it as 1.06 μm laser source in the near infrared region of spectrum.

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