Effect of neodymium incorporation on the structure and luminescence properties of YVO_4 matrix.

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Neodymium-doped yttrium orthovanadate YVO_4:Nd is a very powerful solid-state laser material. The Nd^{3+} ions in this material present a broad strong absorption band around 808 nm and very intense emission in the 1-μm range, which paves the way for many applications in the military and industry and in the fields of medical treatment and scientific research. Compared with a conventional Nd:YAG crystal, Nd:YVO_4 offers numerous advantages such as broader absorption bandwidth, larger effective stimulated emission cross-section, and higher allowed doping level. Among the various synthesis methodologies, the non-hydrolytic Sol-Gel process stands out as one of the most advantageous: it yields highly pure products (the metallic oxides originate in situ) with fewer pores; occurs at relatively low temperatures; allows for strict control of stoichiometry, powder morphology, and phase purity; provides distribution of cations all over the polymeric structure; and is easier to reproduce. This work reports the synthesis and characterization (X-ray diffraction and Raman and photoluminescence spectroscopies) of $Nd_{(x)}$:YVO_4, (where, $1.0 \leq x \leq 10.0$ % mol) obtained by the non-hydrolytic Sol-Gel route and annealed 800 °C for 4 h. The X-ray diffraction patterns, Figure 1, showed that the concentration of Nd^{3+} ions did not alter the structure of the YVO_4 crystal, which displayed peaks indexed to the tetragonal structure YVO_4 (JCPDS # 70-1281). Raman spectroscopy revealed bands due to the vibrational modes of the YVO_4 crystals. The excitation spectra presented bands between 500 and 900 nm, assigned to the Nd^{3+} transitions. In addition, a broad band around 310 nm appeared regardless of the concentration of Nd^{3+} ions; this band resulted from charge transfer (CTB) from V^{5+} to O^{2-} in the VO_4^{3-} group. Two major bands emerged in the emission spectrum: the one at about 1076 nm was attributed to the transition $^4F_{3/2} \rightarrow {}^4I_{11/2}$, whereas the other at 1344 nm was ascribed to the transition $^4F_{3/2} \rightarrow {}^4I_{13/2}$ of the Nd^{3+} ion.

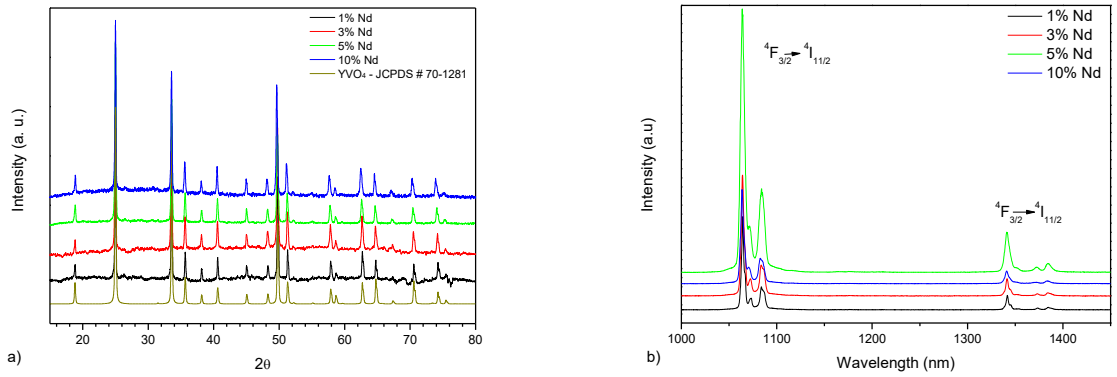

Figure 1: YVO_4 samples doped with different concentrations of Nd^{3+} ions; a) X-ray diffraction patterns and b) Emission spectra of Nd^{3+} recordes at λ_{em}: 310 nm.