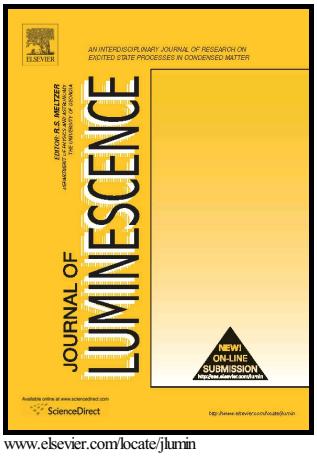

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Pressure-induced effects on the spectroscopic properties of Nd^{3+} in $MgO:LiNbO_3$ single crystal. A crystal field approach

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Abstract

The effects of pressure on the Nd^{3+}-doped $MgO:LiNbO_3$ single crystal have been studied by luminescence spectroscopy at low temperature and high pressures from ambient conditions up to 33 GPa. Specifically, the pressure-induced evolution of the emission spectra, corresponding to the $^4F_{3/2}\rightarrow{}^4I_{9/2}$,$^4I_{11/2}$ transitions, and the excitation spectra, corresponding to the $^4I_{9/2}\rightarrow{}^4F_{5/2}+{}^2H_{9/2}$, and $^4I_{9/2}\rightarrow{}^4F_{7/2}+{}^4S_{3/2}$ transitions, show a gradual red-shift that follows a linear pressure dependence and a decrease in the intensity of the spectra with increasing pressure. The initial effect of increasing pressure on the $MgO:LiNbO_3$ crystal is the modification of the relative amount of the several centers in the sample. At pressures around 20 GPa the characteristic multicenter Nd^{3+} structure eventually disappears indicating that all the centers have very similar environments near this pressure. At higher pressures, observed changes seem to have a different origin. The evolution of Nd^{3+} luminescence is studied in the frame of crystal-field theory in order to evaluate its capability of monitoring the pressure-induced structural changes. Crystal-field analysis, under approximated C_{3v} symmetry, shows a smooth increase of the overall crystal-field strength on the luminescent ion, which can be related to the volume reduction as pressure increases. Crystal-field parameters also show a general monotonic behavior with pressure that indicates a structural modification of the local structure that, maintaining the trigonal symmetry around the impurity ion, evolves towards a lower axial character. No evidences of a phase transition have been observed in the studied pressure range.

Keywords

High Pressure; Lithium Niobate; Rare Earth ions; Nd; Photoluminescence; Energy levels; Crystal-Field