MITT.ÖSTERR.MINER.GES. 149 (2004)

OPTICAL SPECTROSCOPIC STUDIES IN $LiNbO_3$: Mg CRYSTALS BELOW AND ABOVE THE PHOTOREFRACTIVE THRESHOLD

Lengyel, K., Péter, Á., Polgár, K., Kovács, L. & Corradi, G.

Research Institute for Solid State Physics and Optics, Hungarian Academy of Sciences,
Konkoly Thege M. str. 29-33, H-1121, Budapest, Hungary
e-mail: klengyel@szfki.hu

$LiNbO_3$ is a well known non-linear optical material, but in many cases its application is limited by the photorefractive effect. The optical damage resistance can be improved by doping the melt with MgO above a threshold concentration. The threshold was found at about 5 mol % MgO for the congruent composition (BRYAN et al., 1984), but it strongly depends on the stoichiometry of the crystal. Several seemingly contradictory defect structure models have been developed to interpret this phenomenon (DONNERBERG et al., 1991; IYI et al., 1995; LIU et al., 1996).

Optical absorption methods are very simple and sensitive tools for the determination of the threshold concentration. The UV absorption edge and the IR spectrum of the OH^- ion vibration have systematically been measured in $LiNbO_3$ samples for wide composition and Mg concentration ranges. The Mg content (0-9 mol %) of the crystals with congruent, stoichiometric and an intermediate composition has been determined by atomic absorption spectroscopy. At the threshold the vibrational frequency of the hydroxyl ions moves abruptly to higher energies, while the shift of the UV-edge changes its direction. Above the threshold value, however, there is a linear dependence for the UV-edge and for the halfwidth of the A_1 Raman peak at 631 cm^{-1} and an approx. square root dependence for the OH^- frequency as a function of Mg concentration. The halfwidths of the A_1 Raman peaks at 251 and 275 cm^{-1} are also influenced by the sample composition. Our results confirm the model of LIU et al. (1996), in which the number of antisite Nb_{Li} decreases and that of $Mg_{Li}V_{Li}(NbO_3)_2$ defects increases with increasing Mg content up to the threshold, and for Mg concentrations exceeding the threshold, complexes containing Mg on both Li and Nb sites are formed.

References

BRYAN, D.A., GERSON, R. & TOMASCHKE, H.E. (1984): Appl. Phys. Lett., **44**: 847-849.

DONNERBERG, H., TOMLINSON, S.M., CATLOW, C.R.A. & SCHIRMER, O.F. (1991): Phys. Rev. B, **44**: 4877-4883.

IYI, N., KITAMURA, K., YAJIMA, Y., KIMURA, S., FURUKAWA, Y. & SATO, M.J. (1995): J. Sol. State Chem., **118**: 148-152.

LIU, J., ZHANG, W. & ZHANG, G. (1996): Phys. Stat. Sol. (a), **156**: 285.