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Photorefractive Lithium Niobate crystals: light polarisation rotation highlighted by transmission Raman spectroscopy

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Abstract. Transmission Raman spectroscopy experiments as a function on time were carried out on iron doped photorefractive congruent lithium niobate crystals. A big change with time in Raman spectra is observed when the incident light is polarized along ordinary axis. The mentioned breaking of Raman selection rules is originated by photorefractive properties of the crystal.

1. Introduction

Lithium Niobate (LN) is a multifunctional crystal with piezoelectric, ferroelectric and nonlinear optical properties [1]. The photorefractive (PR) effect is one of the most widely investigating properties in LN [2]. The main interest concerns application to holographic memory [3]. PR effect is largely enhanced in Fe-doped LN, [1-2] and is much reduced as the dopant is Zr 2% [4]. The main drawback of PR is the defocusing of the light beam inside the crystal [5]. Raman spectroscopy is a well-known technique providing information about vibrational and structural properties of a material. Here we use Raman spectroscopy to evidence the change of polarisation accompanying the light defocusing.

2. Experimental results and discussion

Transmission Raman spectroscopy measurements were performed on 0.03mol% and 0.05mol% iron doped LN crystals and spectra were recorded as a function of time. A diode laser with a radiation at the wavelength of 532nm was used. For X(YZ)X configuration the evolution of transmission Raman spectra with time is plotted in figure 1. For this configuration, only E[TO] modes are expected according to Raman selection rules. We observe that A₁[TO] lines unexpected by Raman selection rules and symmetry [6], are activated with time, and notably differ from data recorded in back-scattering [7]. The transmitted beam pattern with the same X(YZ)X configuration was recorded at different moments and is presented below (figure 2). The defocusing of transmitted beam with time is due to the polarization transmission from ordinary to extraordinary axis [8].



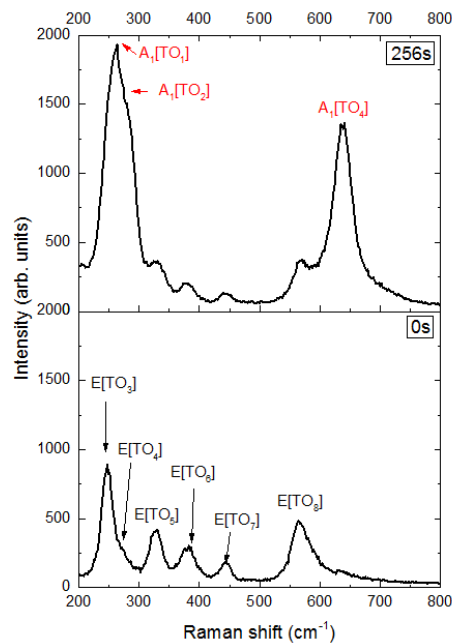


Figure 1. Transmission Raman spectra as a function of time in X(YZ)X configuration.

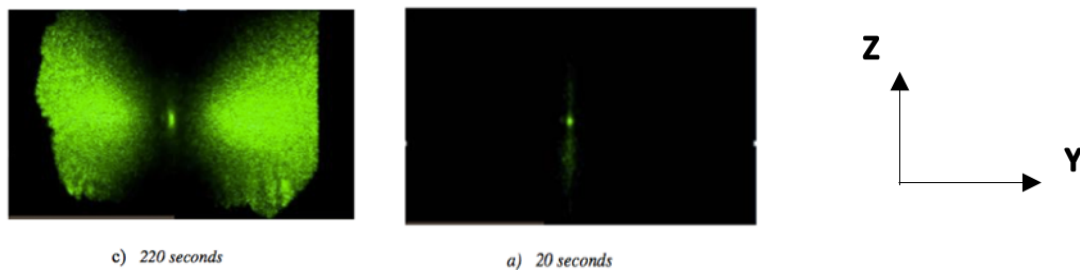


Figure 2. Recorded beam pattern of transmitted beam at 20 seconds and 220 seconds for X(YZ)X configuration

3. Conclusion

Transmission Raman spectra recorded with X(YZ)X configuration leads to breaking of Raman selection rules with activation of unexpected lines. This activation with time of forbidden $A_1[TO]$ Raman lines for this configuration result from photorefractive internal field which causes the polarization conversion from ordinary to extraordinary polarization and is originated by photorefractivity of the crystal.

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