# Spectral holes in photorefractive $LiNbO_3:Er^{3+}$ and $LiNbO_3:Tb^{3+}$ single crystals

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Litihum Niobate ($LiNbO_3$) is a paradigmatic photorefractive material. It provided the first experimental evidence of the photorefractive effect and still maintains a key position in the field. It has been extensively investigated as holographic media. One of the most important problems in the holographic information storage is that of fixing the information. A promising technique is to use two-color holography in which charge generation occurs by means of a two-step photoionization with two-color light. Several research groups have recently demonstrated the bipolaron-based two color recording in undoped and doped $LiNbO_3$ with UV, blue and green gating lights. Moreover, nonvolatile recording has been reported in $LiNbO_3:Er^{3+}$ and $LiNbO_3:Tb^{3+}$ under uncoherent light exposition to UV and blue-green light. However, the role of the Tb and Er ions in the photorefractive process has not been completely understood. Due to the importance of provide spectroscopic information on the optical properties of these materials, in order to lead to better device performance, the aim of this letter is to present the results of an experimental study on the effects of the Er and Tb on the optical properties of $LiNbO_3$. Evidence of spectral dips appearing in the blue intrinsic emission of the host $LiNbO_3$ to support the identification of an active host-ion radiative energy transfer mechanism in our single crystal samples.

*Keywords:*

## Summary

High optical quality single crystals of $LiNbO_3:Tb^{3+}$ (LNTb) and $LiNbO_3:Er^{3+}$ (LNEr) were grown in congruent composition in the Research Institute for Solid State Physics and Optics in Budapest, Hungary.

In figures 1 and 2 the intensity of the spectra were adjusted in order to compare their shapes. From these figures radiative energy transfer mechanisms from the host material to the Er and Tb ions is clearly demonstrated by the observation of reabsorption bands in the emission band of the $LiNbO_3$ lattice. The reabsorption bands occur in the intrinsic emission of each sample just at the wavelengths of the Er and Tb absorption bands in the LNEr and LNTb samples, respectively.

While preliminary data on optical interactions between the Er and the $LiNbO_3$ lattice in LNEr single crystals have been presented previously[1], experimental results on the radiative energy transfer between the Tb ions and the host $LiNbO_3$ is presented in this paper for the first time to the best of our knowledge. Optical experiments are currently been performed in our laboratory in order to get a better understanding on the effect of these optical interactions on the mechanisms of two color holographic recording in these kind materials.

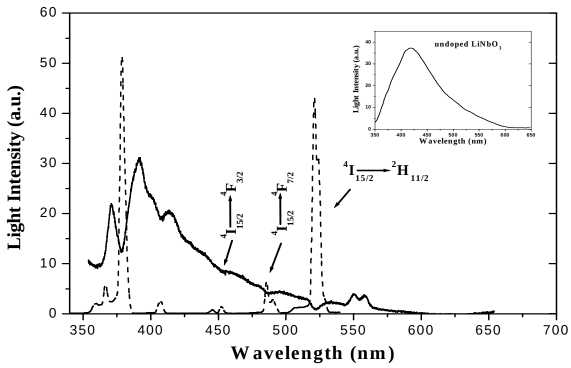


**Figure 1.** Shows the emission spectrum of the LNEr sample excited at 337nm (continuous line) and the characteristic excitation spectrum of the 548nm Er emission (dashed line). In the same figure the emission band of an undoped $LiNbO_3$ single crystal under excitation at 337nm is presented (inset) for the sake of comparison.

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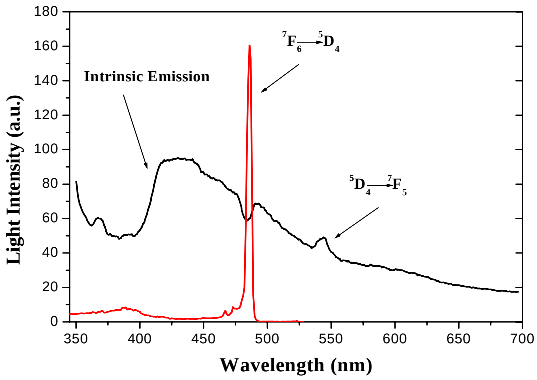


**Figure 2.** displays the emission spectrum of the LNTb crystal under pulsed laser excitation (10ns pulse width pulses) at 337nm, observed 100ns after the light excitation of the sample (continuous line). In this figure the excitation spectrum of the $^5D_4 \rightarrow ^7F_5$ $Tb^{3+}$ emission at 545nm is also portrayed (dashed line).

## References

[1] E Alvarez, R Sosa, I Foldvari, K Polgar, A Peter and A Muñoz. Phys. Stat. Sol. C **2**, 175 2005).