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Crystal Physics

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Rare-earth ion loss of Er- or Yb-doped $LiNbO_3$ crystals due to mechanical destructive effect of high-energy ball milling

Structural changes of Er- or Yb-ion doped $LiNbO_3$ (LN) nanocrystals were studied in relation to the high-energy ball milling process. The evolution of the size of the particles and the formation of different phases were followed by dynamic light scattering and X-ray diffraction measurements, while the electronic transitions of rare-earth (RE) ions were investigated by absorption spectroscopy in the infrared spectral range. During the milling process, a part of the LN crystal structure was destroyed, while huge amount of RE ions left the LN lattice by out-diffusion and formed RE_2O_3 phase. In addition, it was concluded from infrared absorption measurements, that the ratio of the RE loss in our grinding procedure can be described by a $0.8^{t/10\ min}$ function (Figure 1.).

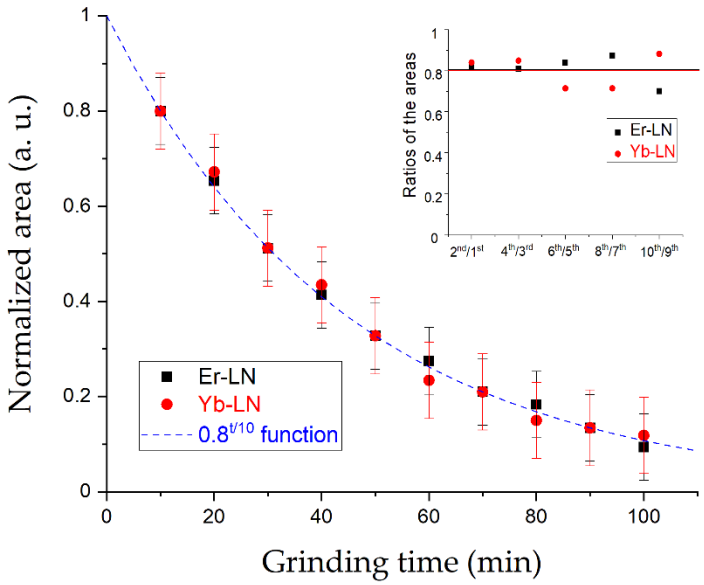

Figure 1. Change in the RE content with the grinding time (absolute errors from the uncertainty of the area ratios are displayed). Inset graph shows the ratios of the areas of the absorption peaks for every pair of samples (1st: 10 min ground, 2nd: 20 min ground, etc.).

The change in the absorption spectra and the phases formed during the grinding process were found to be very similar for both investigated RE ions and were independent of their original concentration in the starting crystal samples [1].

Analytical chemical methods for advanced and environmental materials.

High-resolution continuum source atomic absorption spectrometry (HR-CS-AAS) using graphite furnace atomization with solid (powder) and solution sampling were developed and applied to quantitate impurities (K) from microsamples of optical crystals of lithium niobate. Flame HR-CS-AAS methods were developed with matrix-matching to check the accuracy of the methodology. ELCAD-OES methodology was further developed for increasing sensitivity and applied for the quantitation of some alkaline metals in fruit juices. A literature survey was published on fruit juices and related analytical methodologies [2].

Air quality (AQ) parameters were monitored with low-cost sensors (LCSs) before, during and after the garden fence rebuilding of a dwelling house, located in a suburban area. The AQ variables, recorded concurrently indoors and outdoors, were PM_1, $PM_{2.5}$, PM_{10}, CO_2, HCHO and VOCs. Indoor fine and medium-size PM was mostly of outdoor origin; its increased levels were observed during the renovation. The related pollution events were characterized by peaks as high as 100, 95 and 37 $\mu g/m^3$ for PM_1, $PM_{2.5-1}$ and $PM_{10-2.5}$, respectively. The results show the influence of the renovation-related activities on indoor AQ in terms of aerosols and gaseous components [3].

$LiNbO_3:Tm^{3+}$ crystals for ultrasound optical tomography.

Ultrasound Optical Tomography (UOT) is a novel imaging technique that offers high spatial resolution using ultrasound (US) and the optical selectivity of visible light. This technique may reach deeper into tissues than other techniques combining light and US, with orders of magnitude better contrast-to-noise ratio. In the UOT method pulsed US waves and laser light are delivered into the target tissue using a US transducer and optical fiber. Photons interacting with the US pulse are frequency-shifted and later separated from the carrier light using a narrow-band optical filter formed in the cooled rare-earth-ion-doped lithium niobate crystal ($LiNbO_3:Tm^{3+}$) using optical pumping and spectral hole burning techniques at wavelength of 794 nm. Our group has produced the required stoichiometric $LiNbO_3$:Tm samples with 1cm thickness and with high optical quality which was successfully utilized for the above experiment at the collaborative Swedish research group. The results indicate that the UOT technique can become an important and valuable tool for lesion characterization in breast tissue [4, 5].

Bi-doped stoichiometric $LiNbO_3$ (SLN) crystals. – Interest in bismuth and magnesium co-doped lithium niobate has recently increased since a real-time holographic display application was published using its congruently grown version. For a better understanding of microscopic processes of photorefractive and photochromic effects in Bi-Mg co-doped stoichiometric lithium niobate crystal, a temperature-controlled two-wave mixing (TWM) setup was utilized using laser excitation at wavelengths of 405 and 447 nm. From TWM measurements at temperatures from 5 °C to 45 °C an activation energy of the centres responsible for photorefractive effect was estimated at about 0.1 eV. By using numerical simulation and the previously measured photochromic parameters, it was shown that the measured optical

energy transfer cannot originate only from the diffraction on photochromic (amplitude) grating but also on photorefractive (phase) grating.

References

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