Growth and optical properties of Nd:LYSB as a new laser and nonlinear optical borate crystal

Broasca A[1,2]*, Greculeasa M[1,2], Voicu F[1], Hau S[1], Stanciu G[1], Gheorghe C[1], Croitoru G[1], Pavel N[1], Gheorghe L[1]
*Broasca A: alin.broasca@inflpr.ro
1 National Institute for Laser, Plasma and Radiation Physics, ECS Laboratory, Romania
2 Doctoral School of Physics, University of Bucharest, Faculty of Physics, Romania

In the last years, the pursuit of new nonlinear optical (NLO) and/or laser crystals has attracted more and more interest in the scientific community, due to their key role in the emergence of optoelectronic and photonic technologies. Herein, we report for the first time on the crystal growth by the Czochralski method of a new NLO and laser $La_xY_yNd_zSc_{4-x-y-z}(BO_3)_4$ -Nd:LYSB borate crystal. Because of the incongruent melting of LYSB-type compounds, the growth by the Czochralski method is difficult and requires a compositional refinement of the starting melt composition, optimization of the growth parameters, and also the use of a particular thermal setup. Fig. 1a presents the photo of the Nd:LYSB crystal grown from the starting melt composition $La_{0.725}Nd_{0.05}Y_{0.475}Sc_{2.75}(BO_3)_4$. The grown crystal has a huntite-type structure (noncentrosymmetric, space group *R32*), allowing $\chi^{(2)}$ effects. The chemical composition of the grown crystal was determined to be $La_{0.772}Nd_{0.046}Y_{0.287}Sc_{2.895}(BO_3)_4$, corresponding to an Nd^{3+} doping concentration of 4.6 at.%. The spectroscopic investigations were carried out at room and cryogenic (10 K) temperatures. The measured lifetime of the $^4F_{3/2}$ level was found to be 140 µs. Preliminary laser experiments were performed and laser emission at 1062 nm was obtained from a 3.90 mm thick crystal sample oriented along the ***c***-axis, under the pump at 808 nm with a fiber-coupled laser diode operated in quasi-continuous-wave (quasi-CW) mode. The laser operated with a slope efficiency of 54% when an extraction mirror with transmission T = 5% at 1.06 µm was employed (Fig. 1b). These preliminary results are very promising for a newly developed crystal and further improvements in terms of the optical quality of the grown crystal and laser emission performances are currently undertaken.

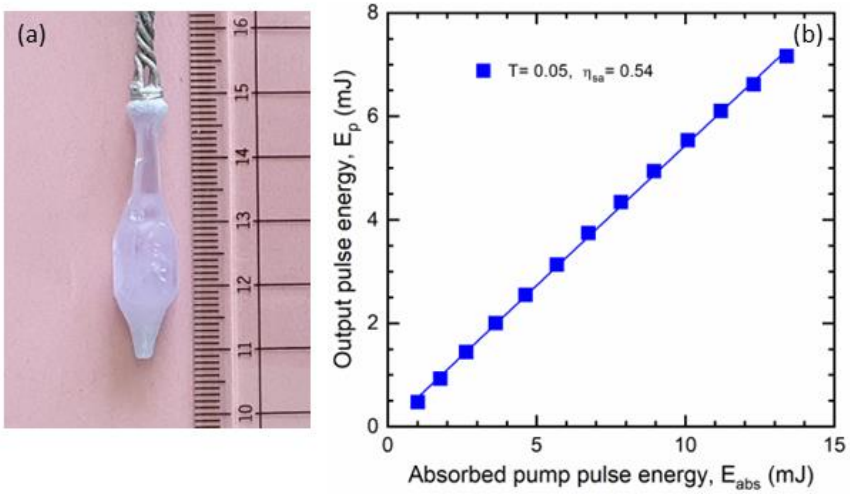

Figure 1. Photo of the as-grown Nd:LYSB crystal (a) and quasi-CW laser emission performances at 1062 nm of the Nd:LYSB uncoated crystal (b).

Funding
This work was supported by the Romanian Ministry of Research, Innovation and Digitization, through grant agreement PCE 49/2021, project number PN-III-P4-ID-PCE-2020–2203 and program NUCLEU - LAPLAS VII, contract 30N/2023.