Czochralski-grown LGSB crystals as high-performance NIR laser crystals and SFD crystals in the VIS spectral range

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Currently, many researches are focused on the development of new bifunctional laser and nonlinear optical (NLO) crystals or on the improvement of the existing ones based on new concepts. Very recently, our group has developed Czochralski-grown $La_xGd_yNd_zSc_{4-x-y-z}(BO_3)_4$ (LGSB:Nd) bifunctional crystals [1-3], as very promising active media for the construction of highly efficient lasers in the near-infrared (NIR) domain and also compact visible (VIS) lasers based on self-frequency doubling (SFD) processes. Considering the incongruent melting of LGSB:Nd crystals, the starting melt compositions and the pulling and rotation rates were optimized. Also, a special thermal setup was engineered to grow LGSB:Nd-type crystals by the Czochralski crystal growth method. High optical quality LGSB:Nd crystals doped with various concentrations of Nd^{3+} ions (2.3, 3.5, and 4.6 at.%) were grown by the Czochralski method, for the first time according to our knowledge. The as-grown crystals are shown in Fig. 1.

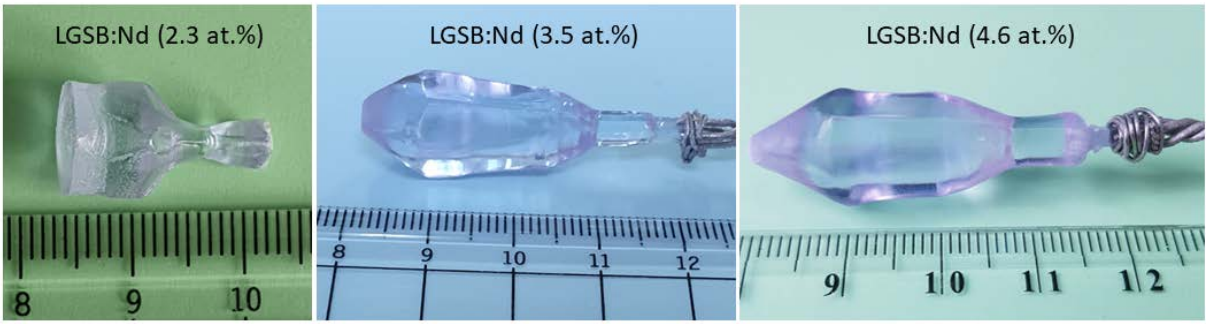

Fig. 1. Photos of Czochralski-grown Nd:LGSB-type crystals.

The structural and optical properties of the grown crystals as well as their laser performances were evaluated. The obtained results confirm the good optical quality of all investigated crystals and prove their favorable intrinsic properties to generate laser emission in the NIR domain (~ 1 μm) with very high efficiencies. A high slope efficiency of 0.73 was obtained for the LGSB:Nd (4.6 at.%) crystal in quasi-continuous-wave (quasi-CW) operation. The main NLO properties of all grown crystals were found to be similar to those of undoped LGSB crystal [3]. Preliminary SFD experiments were also carried out. In the case of the LGSB:Nd (3.5 at.%) crystal, a green (~ 530 nm) SFD power of 48 mW was achieved for an absorbed pump power of 3.94 W. The crystal samples in all laser experiments were not anti-reflective coated.

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