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Morphology and Growth of LiB_3O_5(LBO) Crystals Grown from Pure and NaCl Melt-additive Solution

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The growth of non-linear optical crystals of large size and excellent quality is of prime importance for frequency conversion applications. In the flux growth of LiB_3O_5 (LBO) [1], the presence of extended BO_3 and BO_4 chain-like structures gives rise to highly viscous melts [2]. As a consequence, mass transport is restricted and the depletion of material at the melt-crystal interface results in unstable hopper growth. The addition of small amounts of NaCl to the melt is effective in breaking BO_4 bond chains. The resulting reduction in viscosity facilitates an increase in growth rate by up to a factor of three.

In the present study, LBO crystals of typical dimension $30\times30\times26$ mm^3 were grown by top-seeded solution from borate fluxes doped with 2 mol% and 4 mol% NaCl, and without NaCl. The addition of small quantities of NaCl to the starting solution resulted in significant effects in crystal growth, morphology and quality. It was found that the metastable zone for crystallisation became wider as the concentration of NaCl in solution increased, so the seeding temperature showed a marked reduction. This reduction gives a higher supersaturation in the solution and results in the growth rate changes. The crystal morphology also showed a remarkable change with additive concentration. The crystals grown in pure solution are bounded by {110}, {011}, {201} and {100} faces, however, for the 2 mol% NaCl solution, one of the {100} faces almost disappears and, for the 4 mol% NaCl solution, the {100} faces are not observed. The change of the morphology due to NaCl concentration in the solution can be explained from Periodic bond chain analysis and the variation in growth rate with supersaturation determined by Zhong et al [3]. In order to investigate the adverse effect of NaCl in the crystal quality, we have measured bulk laser damage threshold. The defects of the crystals are also analyzed by x-ray topography.

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