Macro-Perfection Growth of Lithium Tetraborate Crystals in Three Inch Diameter

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Lithium tetraborate ($Li_2B_4O_7$: LBO), as a new piezoelectric crystal, has excellent performance in electro-mechanical coupling coefficient and stability of frequency in comparison with commercial materials quartz, $LiNbO_3$, $LiTaO_3$ crystals, so it has become a SAW and BAW devices substrate material with temperature compensation in the future of wide use. With rapid development of movable communication, large diameter (>80mm) wafer is required for device production line. We have grown $\phi 3'' \times 2\text{-}4''$ LBO crystals with core-free, no striation, no crack and no scattering particle by the modified Bridgman method for the first time, The factors influencing macro-perfection growth of large diameter LBO are discussed in this paper.

Because the diffusion of non-stoichiometric component and impurities are very weak due to high viscosity of LBO melt in the growth, it is very important to control the stoichiometry of LBO raw materials exactly. The deviation from stoichiometry of LBO in 0.1～0.5 wt-% will cause the constitutional supercooling inclusions under the slight temperature vibration. The purity of raw materials is 3～4 N is enough for LBO growth. The phase of $Li_2B_4O_7 \cdot H_2O$ identified by the differential thermal analysis and X-ray diffraction patterns has no influence in the growth. For $\phi 3''$ LBO growth the concave solid-liquid (s-l) interface is easily formed because of the large volume of the melt in overheating and heat flow into the seed, so coring occurs often. The control of the position of s-l interface and the choice of the proper temperature gradients in melt and crystal can grow large diameter LBO crystals in the convex or plane s-l interface. The proper temperature gradient at s-l interface is 10—20℃/cm.