Fabrication of short-period twinned structure in lithium tetraborate

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Lithium tetraborate ($Li_2B_4O_7$; LB4) is a vacuum-UV transparent nonlinear optical crystal and non-ferroelectric. Polarization cannot be reversed by the application of an external electric field, as is the case with ferroelectrics. Instead, c-axis inversion twins are formed. Repeated formation of twinning can create a periodic c-axis inverted structure. Periodically twinned LB4 can function as a quasi-phase-matching device like in ferroelectrics, and we developed a method for the formation of periodically twinned crystal. The twin boundary (TB) orientations are dependent on the crystal growth direction. (100) TB forms when the growth direction is near <010>. Symmetrically, (010) TB forms when the growth direction is near <100>. The objective of this study is to apply this property to fabricate short-period twinned crystals.

In our previous study, we have developed a producing method for periodically twinned LB4 using the follow [1]. A plate-like seed crystal including one TB and a movable Pt wire heater are prepared. The Pt wire heater melts surrounding seed crystal. As the heater moves at low speed, the melting area moves as well, causing the seed crystal to melt and grow. A thin twinned crystal forms in the trace of the heater passing though the initial TB. Thickness of the thin twinned crystal is $1/\sqrt{2}(\fallingdotseq 0.71)$ times the diameter of the melted area. For example, periodic twins with 100 μm-interval have been produced by repeatedly forming twins with a φ140μm melt.

The phase-matching wavelength of a QPM device is determined by the inversion period i.e., the spacing of the TBs. To increase the twin spacing, the diameter of the melted area can be increased by increasing the wire heater power. However, the diameter of the melt cannot be smaller than that of the wire heater. In this study, we developed a method to form even thinner twins by re-melting a part of the thin twins. Fig. 1 (a, b) shows 60 μm-interval TBs formed by using a φ140μm melt. This crystal can be used as a seed for bulk crystal growth. Fig. 1 (c) is a periodically twinned crystal grown by micro-PD method. Dimensions are 4×3.5×7.5 mm, and 60μm-interval TBs are included.

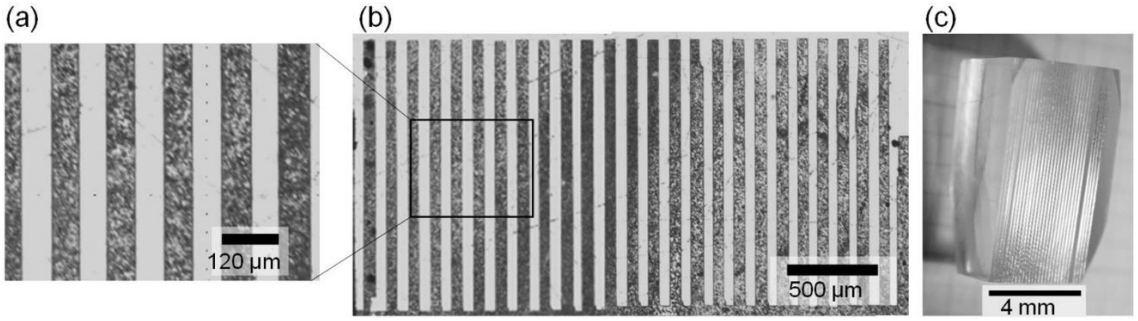

Fig. 1 Periodically twinned lithium tetraborate (60μm interval).

References

[1] K. Maeda *et al.* Fabrication of Quasi-Phase-Matchin Structure during paraelectric Borate Crystal Growth. *Applied Physics Express* **6** (2013) 015501.