Growth of SrB_4O_7 crystal fibers with near stoichiometric composition by the micro-pulling-down method

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SrB_4O_7 (SBO) has recently received much attention as a wavelength-conversion material that can operate into the deepest ultraviolet wavelengths (125 nm). The utilization of SBO for semiconductor lithography and laser ablation requires fully transparent crystals. Here, we show the growth of SBO crystal fibers with near-stoichiometric composition by the μ-pulling-down method. $SrB_{2x}O_{3x+1}$ ceramics sintered with various values of x were evaluated by X-ray diffraction (XRD). The melting point of the SBO ceramics was measured by differential scanning calorimetry (DSC) as 1017 ˚C, and the heat of fusion was 63.3 J/g. Figure 1 shows the external form of SBO crystal fibers grown with various x values. Crystal fibers shown in A and C were opaque due to the formation of growth ridges (black arrows). Also, we succeeded in obtaining transparent SBO crystal fibers by the growth with a stoichiometric composition. Then, we observed SBO crystal fibers grown with various x values by polarized optical microscopy. As a result, even when the deviation from stoichiometric composition was ±−0.1 mol % SrO (x = 2 ±0.004), SrB_2O_4/SrB_6O_{10} appeared. These results demonstrate that SBO shows no solid-solution width and that the stoichiometric composition is equal to the congruent composition. In contrast, since growth ridges including SrB_2O_4/SrB_6O_{10} were formed only on surfaces of the SBO single crystals, SBO crystal fibers grown with nonstoichiometric composition were opaque. We could explain the formation of growth ridges via compositional supercooling on rims.

