溶液法による高品質 3 インチ 4H-SiC 結晶の成長

Growth of high-quality 3-inch 4H-SiC crystals by solution method

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In SiC solution growth, we have achieved ultra-high-quality crystals by dislocation conversion [1]. In order to apply high quality process to large-size SiC crystals, we proposed a high-speed predictor model using machine learning to decrease optimize time [2] and a switching flow method to stabilize step flow and avoid of inclusions [3]. In previous study, we reported a high quality and inclusion free 3-inch SiC crystal. SiC crystal thickness is 0.5 mm and BPD free area was small. In this study, we try to enlarge the BPD free area by increasing the thickness of grown SiC crystal.

SiC crystal growth experiments were conducted by TSSG method. 3-inch 1° off-cut towards [11$\bar{2}$0] Si-face 4H-SiC were used as seed crystals. $Si_{0.58}Cr_{0.4}Al_{0.02}$ was used a solvent. The growth time is 35 h under He gas. During crystal growth, the crystal position was moved to keep meniscus height stable.

Fig. 1 shows a 3-inch SiC crystal with hexagonal shape and 2.5 mm thickness. Smooth surface morphology was obtained, especially on the edge area. The growth rate on the edge area was controlled by keeping meniscus height to avoid of inclusions and new generated BPDs due to inclusions. Fig. 2 shows the X-ray topography of selected area from Fig. 1. In this area, there is no BPD and only one TSD in the center of spiral, which indicates ultra-high-quality crystal. Spiral growth in the upstream area contributes high quality crystal and provides the step source for long-term crystal growth. As growth proceeds, BPD free area will further increase from upstream area to the whole crystal.

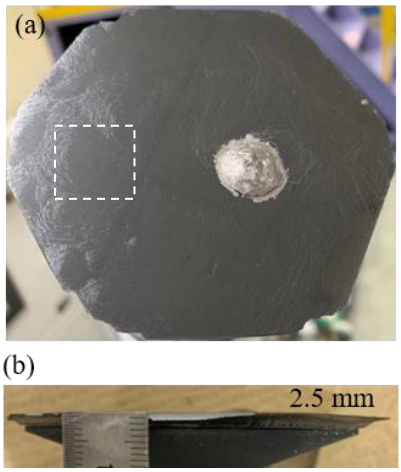

Fig. 1 Surface morphology of 3-inch 4H-SiC crystal: (a) the top view and (b) the side view.

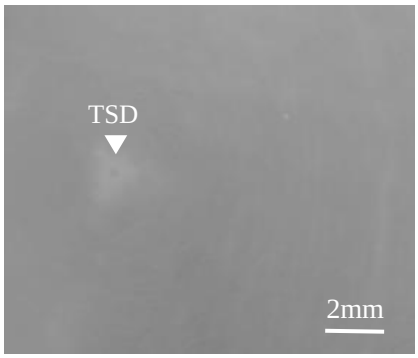

Fig. 2 X-ray topography image of selected area from Fig. 1.

In summary, we enlarged the BPD free area by increasing the thickness of crystal and we will further increase the crystal thickness for ultra-high-quality SiC crystals.

Reference

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[3] T. Endo, et al., Presented in ECSCRM MO.P.SG5 (2018).