Improvement of crystalline quality by using BN cap in solution growth of SiC single crystal

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Silicon carbide (SiC) is a wide-bandgap semiconductor that shows significant advantages in the next generation power device compared to silicon (Si), due to its excellent physical and electronic properties. Although the physical vapor transport (PVT) method has been one of the most successful and common method for growth of bulk SiC crystal and has realized mass production of SiC substrates with a diameter up to 8 inches, dislocations still remain in the SiC crystal by PVT with a density of $10^3/cm^2$, reducing the device yield and increasing the cost. Against this backdrop, the top seeded solution growth (TSSG) approach is underway for the purpose of obtaining an ultrahigh-quality SiC bulk crystal due to the growth condition close to the thermal equilibrium. Besides, TSSG is a suitable way for preparing low-resistivity p-type substrate and is helpful for fabricating SiC IGBT switching device with blocking voltage of more than 10 kV. However, the major technical challenge for the TSSG of SiC is suppression of undesirable crystal precipitated around the graphite holding shaft end caused by the parasitic reaction, making it difficult for single crystal growth with solvent inclusion free [1].

In this study, the part of holding shaft end was wrapped using the BN cap due to the smaller surface energy and lower wettability between the BN material and Si-based solvent. Compared to other materials (e.g., C, SiC, Si_3N_4, SiO_2, Al_2O_3 and MgO), BN is of great interest as it is one of the very few materials that are non-wetted by liquid silicon and shows a large contact angle, which will increase the energy barrier of nucleation and significantly inhibit the formation of SiC polycrystals on the BN surface [2], thus the parasitic reaction can be markedly inhibited, as shown in Fig. 1. In summary, the novel approach using BN cap is an effective way to improve the crystalline quality of SiC single crystal grown by TSSG.

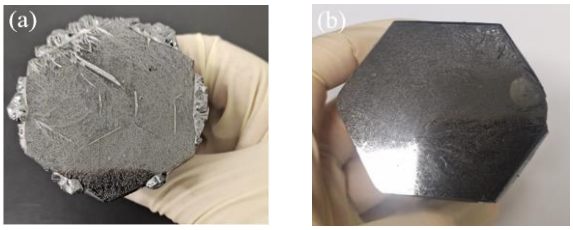

Fig. 1. Optical photos of 2-inch SiC ingot using TSSG method. (a) Without BN cap, (b) with BN cap

References

[1] Kusunoki K, Kishida Y, Seki K. Solution growth of 4-inch diameter SiC single crystal using Si-Cr based solvent. Materials Science Forum. 2019;963:85-88.

[2] Wang GB, Sheng D, Li H, et al. Influence of interfacial energy on the growth of SiC single crystals from high temperature solutions. CrystEngComm. 2023;25:560-566.