# Ultrahigh-quality SiC single crystal grown by multi-step

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4H silicon carbide (4H-SiC), a wide band gap semiconductor, is undergoing rapid development in the filed of power electronics devices with high-power, high-temperature and high-frequency characteristics, due to its superior physical properties. Today's SiC single crystal is mainly prepared by physical vapor transport (PVT) method and experimentally produced a 200 mm (8-inch) in diameter wafer through diameter expansion process. However, the density of dislocation in the 4H-SiC wafer prepared by PVT method is still as high as $10^3$-$10^4$ $cm^{-2}$. High-density dislocation will inevitably propagate into epitaxial layers during the epitaxial process using chemical vapor deposition (CVD) method, resulting in reliability issue of SiC based electronic devices. One of the reasons that limit the high-quality crystal growth via PVT method is the quality of SiC seed crystal, and using SiC seed crystal with lower dislocation density is necessary to prepare desired SiC single crystal. Obviously, the preparation of high-quality SiC seed crystal is achieved by solution growth techniques, especially top seeded solution growth (TSSG) method rather than PVT, owing to the growth condition close to thermal equilibrium. Against this backdrop, a novel approach is proposed by us to prepare high-quality SiC single crystal through multi-step.

The process to obtain desired crystal is as follow. Step 1: a poor-quality 6-inch SiC wafer with a thickness of 1.5 mm prepared by PVT method was used as seed crystal and applied in the solution growth. Step 2: Growth layer with a thickness of 1 mm is formed on the surface of the seed crystal by TSSG method and the dislocation density in the grown layer is too low, due to the high-efficiency dislocation conversion during solution growth process. Step 3: the growth layer was polished to remove the Si-based solvent and SiC crystalline particle attached to its surface and then obtained a smooth single crystal layer with a thickness of 0.5 mm (RMS≤0.2 nm). Step 4: The polished specimen was used as a high-quality seed crystal and to grow the desired crystal by PVT method. We believe that it will be possible in the near future to prepare ultrahigh-quality SiC single crystal via this technology.

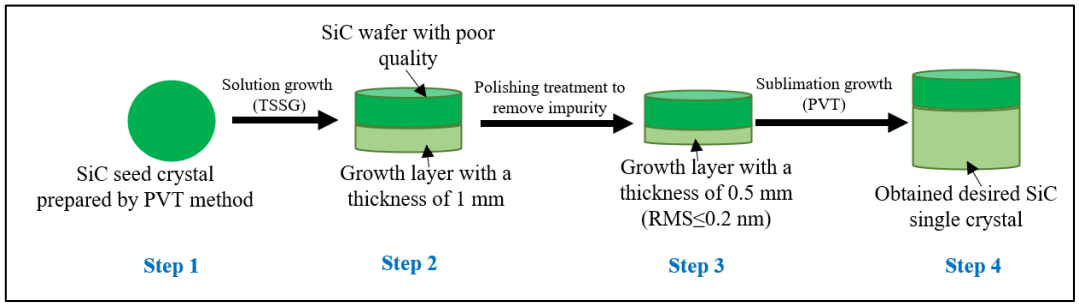


Fig.1. Schematic illustration of high-quality SiC single crystal growth by multi-step