

Investigation Characteristics of Thermal Field in SiC Crystal Growth, Using PVT /by Ming-Hsien Shih...ect.

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Silicon carbide (SiC) has emerged as a transformative material in the field of power electronics due to its superior electrical, thermal, and mechanical properties, enabling high-efficiency and high-power device operation under extreme conditions. With the ongoing demand for larger wafer sizes, the growth of large-diameter SiC single crystals has become a critical technological objective. However, as the crystal size increases, maintaining a well-controlled and spatially uniform temperature distribution within the growth crucible presents significant challenges, particularly for the physical vapor transport (PVT) method, where thermal gradients strongly influence crystal quality and growth stability. In this study, a comprehensive numerical simulation framework was developed to investigate the thermal field characteristics during SiC single-crystal growth, using a resistively heated PVT system. The model incorporates the coupled effects of heat conduction, radiation, and material properties to accurately capture the temperature distribution within the crucible. By systematically varying the relative position between the heating element and the crucible, the resulting temperature field under different configurations was analyzed in detail. The simulation results demonstrate that careful adjustment of the heater–crucible configuration can significantly improve temperature uniformity. Lowering the vertical position of the heating coil leads to a downward shift in the location of the maximum temperature, while maintaining the peak temperature of approximately 2500 K. This behavior provides a practical means of controlling the thermal field without compromising the required high-temperature conditions for crystal growth. Moreover, the temperature distribution near the seed crystal surface is found to be relatively uniform, which is essential for achieving stable and defect-minimized growth. At a position approximately 60 mm below the source powder, the temperature difference across the growth interface is maintained below 10 K, indicating a sufficiently small thermal gradient. Such conditions are advantageous for suppressing the formation of parasitic polycrystalline regions,

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particularly near the edges of the crystal, thereby enhancing the overall crystalline quality. Overall, this study provides important insights into the thermal management of PVT-grown SiC crystals and offers practical guidance for optimizing heater design and process parameters. The findings contribute to the advancement of large-scale SiC crystal growth technologies and support the continued development of next-generation power electronic devices.