Numerical studies on the dislocation density in the n-type 4H-SiC

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Silicon carbide (SiC) has great potential in the applications of high-power, high-temperature and high-frequency power electronics owing to its excellent properties such as high breakdown electric field, high thermal conductivity, high chemical stability and radiation resistance. The physical vapor transport method (PVT) is most widely used to produce large-size SiC wafers because of its low cost. However, SiC single crystals grown by the PVT method generally have high dislocation density, which greatly affects the performance of the device. To investigate the effect of nitrogen doping on the dislocation proliferation in SiC crystals, the thermal field of the ingot during PVT growth was calculated by COMSOL Multiphysics [1], the thermal stress was calculated by thermal elastic theory (Fig. 1), and finally, the dislocation density of the crystal was calculated based on the Alexander-Haasen model for the inhomogeneous nitrogen doping (Fig.2). By comparing the calculation and experimental results, we proposed a possible value of effective stress to evaluate the effect of nitrogen dopant on dislocation density, which is useful for the calculation of the dislocation density in the n-type SiC.

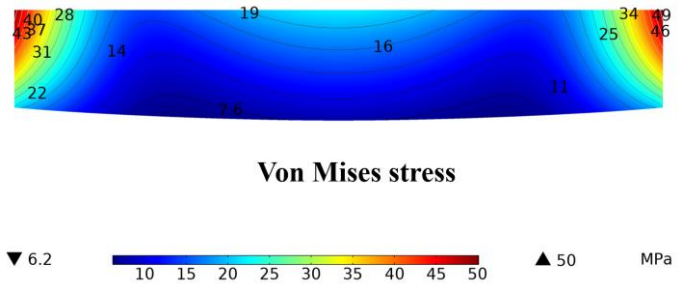

Fig.1 Thermal stress distribution in the 4H-SiC ingot during the crystal growth

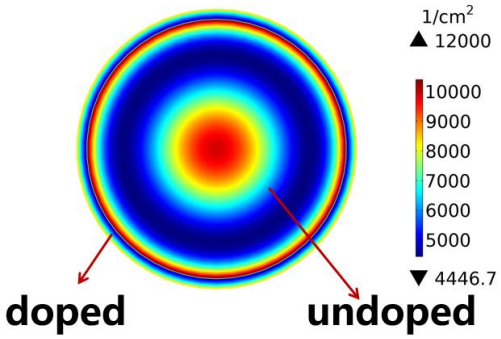

Fig.2 Calculated dislocation density in the inhomogeneous doped 4H-SiC ingot.

Reference

[1] H. Luo, X. Han, Y. Huang, D. Yang, X. Pi, Numerical simulation of a novel method for PVT growth of SiC by adding a graphite block, Crystals. 11 (2021) 1–9.