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物理的気相輸送法を用いた 4H-SiC 単結晶成長における基底面転位の 3 次元解析

Three-dimensional modeling of basal plane dislocations in 4H-SiC single crystal grown by the physical vapor transport method

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Introduction

In bulk SiC PVT growth, significant progress has been achieved in reducing the most damaging defects: micropipes. In 2007, researchers at Cree Inc. reduced the micropipe density (MPD) by 90% in 150-mm substrates. As the density of micropipes in SiC crystals has been suppressed to a technologically tolerable level, quality improvement focus has shifted to less severely damaging defects such as dislocations. There are several types of dislocations, including basal plane dislocations (BPDs), which are deformation-induced dislocations, and grown-in dislocations (TED and TSD). In this paper, we develop a 3D model that can correctly describe the rate-dependent plastic deformation process of SiC crystal, and can effectively connect the generation of BPDs to the practical operational conditions.

Proposed solutions

To correctly track plastic deformation during high-temperature PVT growth, we improved the model proposed by Gao *et al.*[1] by first resolving thermal stress in the primary slip direction in 4H-SiC, and then substituting the resolved shear stress into the three-dimensional (3D) Alexander–Haasen model to obtain the BPDs.

Results

Fig. 1 shows the BPD distribution at growth times of 35, 42.5, 50, and 57.5 h. The crystal grows from the top to the bottom. The surface of the crystal bottom is slightly convex. The order of the BPD density at the crystal bottom is 10^4 cm^{-2}, and it shows six-fold symmetry on the basal plane, which is consistent with the experimental data [2]. It shows that the large BPDs were mainly generated between 42.5 h (Fig. 1(b)) and 50 h (Fig. 1(c)). Therefore, it is growth process mainly causing large BPD generation.

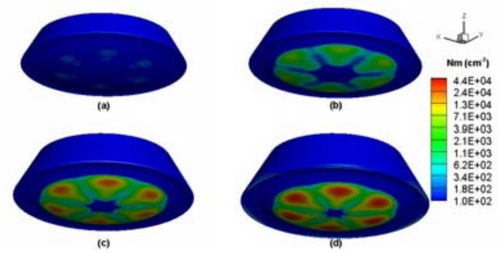

Fig. 1. 3D view of the BPD distribution at different growth times: (a) 35 h, (b) 42.5 h, (c) 50 h, and (d) 57.5 h.

References

[1] B. Gao, K. Kakimoto, *J. Cryst. Growth* **2014**, 386, 215–219.

[2] S. A. Sakwe *et al.*, *Silicon Carbide,* Edited by P. Friedrichs *et al.,* pp1-31.