Title:

The origin of basal plane bending in SiC single crystals

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Abstract:

4H-SiC single crystal boules grown by the physical vapor transport (PVT) method frequently exhibit a basal plane x-ray diffraction peak shift as a function of the beam position along the crystal diameter. This effect was interpreted as a result of basal plane bending due to basal plane dislocations (BPDs) introduced by plastic deformation during growth. The amount and sign of the bending was measured by high-resolution x-ray diffraction (HRXRD). The morphology of dislocations on off-cut wafer surfaces was revealed by KOH etching and their detailed characteristics were investigated by transmission electron microscopy (TEM).

Omega rocking curve mapping using (0008) basal plane reflection was performed on seed crystals before growth and on wafers sliced from the seed and the tail part of PVT-grown boules. The peak shift for all wafers was about -2.5°/3" (-120"/mm). This corresponds to a radius of curvature of about 1.7 m. Negative sign indicates that the bending is concave toward the growth direction. It is proposed that the bending is due to BPDs nucleated by the thermoelastic shear stress produced during growth. The presence of BPDs with the net extra half plane pointing toward the seed face causes basal planes to bend concave toward the growth direction. The net BPD density necessary to account for the amount of the bending is about 2.2×10^5 cm^{-2} assuming all of them being 60° type. Off-cut wafers sliced from 4H-SiC boules were etched in molten KOH. Basal plane slip bands produced by plastic deformation were revealed. An average BPD density projected on the prism plane is estimated as 8×10^5 cm^{-2}. This is 3~4 times larger than the number of dislocations needed to account for the lattice bending. Plan-view TEM specimens were prepared from the wafers containing basal plane slip bands. Arrays of approximately parallel BPDs were observed. At high magnification, perfect dislocations were resolved into two partial dislocations. g · b and oscillating contrast analysis determined the direction and sign of Burgers vectors of each partial. All pairs of partials have the Burgers vectors of **b** = a/3[0-110] and **b** = a/3[-1010], supporting the interpretation of the origin of the BPD arrays due to plastic deformation during growth. The direction of the extra half plane associated with the edge component of corresponding partial was predominantly towards the seed face, which in agreement with the HRXRD results.