Characterization and Control of Defect Propagation in 4H-SiC Epitaxial Growth

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Imaging of dislocations and stacking faults by X-ray topography and photoluminescence (PL) is widely utilized to develop 4H-SiC crystal growth techniques and power devices. This paper introduces our recent achievements in detecting and discriminating dislocations and stacking faults in 4H-SiC by synchrotron X-ray topography, PL and optical second-harmonic generation (SHG) imaging and utilization of the techniques for defect reduction in SiC crystal growth.

Grazing incidence synchrotron monochromatic X-ray topography has been shown to be capable of non-destructive imaging and discrimination of dislocations and stacking faults in 4H-SiC substrates and epilayers. Generation, conversion and propagation of extended defects in 4H-SiC epitaxial growth are tracked by performing topography before and after the growth procedure [1]. Grazing incidence topography also enables signs of the Burgers vector of screw (left- and right handed) and edge (direction of an extra-half plane) dislocations to be detected [2].

High-resolution 3D imaging of extended defects in 4H-SiC may be a challenge for further understanding the behavior of extended defects during crystal growth. Conversion of basal plane dislocations to threading edge dislocations during 4H-SiC epitaxial growth is successfully tracked in 3D by synchrotron X-ray microbeam topography [3]. We have also demonstrated 3D imaging of extended defects in 4H-SiC epilayers by utilizing two-photon-excited PL and SHG, revealing the inclination angles of threading dislocations and the formation of stacking faults in epilayers [4, 5].

Utilizing information obtained by synchrotron X-ray topography and PL imaging, growth techniques to control defect propagation are developed [l, 6].

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