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# Identification of dislocations in 4H-SiC by SR topography in grazing-incidence geometry

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## Introduction

Electric power inverter systems consist of SiC devices have been expected to be one of the technologies to restrain global warming. However, currently SiC crystals contain lattice defects of high-density. The influences of those defects on devices performances are becoming important issues. We have developed a method to observed lattice defects near surface of 4H-SiC wafers using synchrotron orbital radiation topography with grazing-incidence geometry. On a way of these experiments we have found some rules among contrast of dislocations, Burgers vectors and core structures of edge-dislocations on basal-planes.

## Experimental results and discussion

Figure 1 is an image of basal-plane dislocation half-loop at **g**=$\bar{1}\,\bar{1}\,28$, λ=0.15nm on Si-face of SiC observed in High Energy Accelerator Research Organization, PF. BL15c. The (0001) plane is tilted towards the [$\bar{1}\,\bar{1}\,20$] direction by 8 degrees from the surface. In this condition, lattice defects within 10 mm depth are observed. Along this dislocation line, dark contrast at "A", dark and bright asymmetric line at "B", and bright contrast at "C" are observed. Absence in contrast can be seen at "B" at **g**=$\bar{1}$ 108, and so that "B" is analysied to be a screw dislocation part. The Burgers vector is determined to be 1/3[$\bar{1}\,\bar{1}\,20$]. By applying this dark and bright contrast rule, we could identify uniquely 6 different Burgers vectors for all basal-plane dislocations and threading edge dislocations in only one diffraction condition. Figure 2 shows basal-plane dislocations with threading-edge dislocations at both ends, which are commonly observed in substrates after epi-layer grwoth. By observations of the contrast of threading-edge dislocations, the 6 different Burgers vectors were. The dislocation directions were chosen to be clockwise rotations, such that "A"→"B"→"C" in Fig. 2(a), for example. The direction of the threading-edge dislocation at "A" is taken to be into the page, and the direction of the threading-edge dislocation at "C" is defined to be outward from the page. dislocation at "C" in Fig. 2 (a) is the same as that at "D" in Fig. 2 (b), and that at "A" is the same as that at "F". The contrast at "C" and "D" are the same as isolated threading-edge dislocations with **b**=1/3[$\bar{1}\,\bar{1}\,20$] running from a deeper part of the crystal to the surface. The contrast at "F" and The contrast of the threading-edge "A" is the same as isolated threading-edge dislocations with **b**=1/3[11 $\bar{2}$ 0]. As seen in Fig. 2, threading-edge dislocations have very characteristic contrast depending on their Burgers vectors. The origin of the observed dark and bright contrast is considered to be the similar effect described by Ando and Kato. [2]

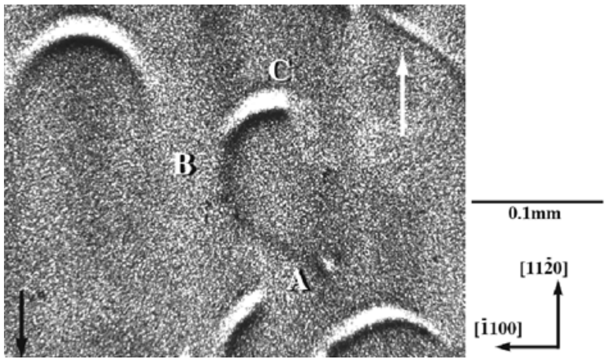


Fig. 1. Observed basal-plane dislocation half loop around surface of a bare-wafer. White arrow on the upper right indicates the direction of incident X-ray beam. Dark arrow on the lower left indicates the direction of Burgers vector 1/3[$\bar{1}\,\bar{1}\,20$].

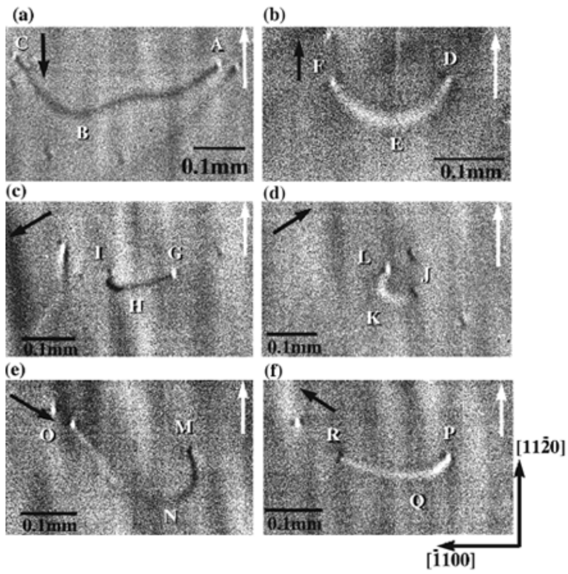


Fig. 2. Basal-plane dislocations with 6 different Burgers vectors terminated bythreading edge dislocations at two-ends.

## Reference

[1] Y. Ando and N. Kato: J. Appl. Cryst. **3** 74 (1970).