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Keywords: powder diffractometry, X-ray line profiles, microstructure characterization

P17.07.07

Acta Cryst. (2008). A**64**, C599

Cathodoluminescence characterization of tridymite and cristobalite

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Cathodoluminescence (CL) spectra of tridymite and cristobalite have blue broad peaks around 430 and 400 nm, respectively, both of which can be assigned to self-trapped exciton (STE) localized to [AlO_4/M+]0 defect. CL intensities of these blue spectral peaks decrease with extending exposure time of electron irradiation as a short-lived luminescence observed in quartz CL, whereas quartz shows a less decrease of CL intensity compared with these minerals. Cristobalite has a higher CL intensity reduction rate during irradiation compared to tridymite. The irradiation at low temperature results in more rapid decay of CL emission, while quartz shows no obvious change in similar temperature. A confocal micro-Raman spectroscopy on the electron irradiated surface of these minerals reveals the amorphization caused by a penetration of electron beam in the surface layer with a depth of 4 to 6 micron meters. This suggests that such structural destruction diminishes the activity of CL emission centers related to STE localized to [AlO_4/M+]0 defects by migration of monovalent cations associated with exchanged Al in the tetrahedral site. Both samples present a considerable reduction of their CL intensities at higher temperature, suggesting a temperature quenching phenomenon. The activation energy in quenching process was evaluated by a least-square fitting of the Arrhenius plots, assuming the Mott-Seitz model. The result implies that the energy of non-radiative transition in this process might be transferred to lattice vibration as phonon in two different manners. This energy transfer might be related to different irradiation response of the CL with a change of sample temperature.

Keywords: cathodoluminescence, tridymite, cristobalite

P17.04.08

Acta Cryst. (2008). A**64**, C599

Strain profiles and crystallographic defects in 6H SiC implanted with 2 MeV As ions

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Silicon carbide is a modern semiconductor material with physical properties differing very much from the other dominating in electronic industry. The important method used in the technological applications of SiC is the ion implantation. The structural changes caused in SiC by this method are not yet very well known, especially in case of heavier ions. In the present work the ion implanted layers were produced in highly perfect (00.1) oriented 6H SiC wafers. The implantations were performed with 2 MeV As^+ ions to a number of fluences in the range from $6\times10^{12}cm^{-2}$ to $2\times10^{14}cm^{-2}$. They samples were examined before and after implantation with a number of synchrotron X-ray diffraction methods and Rutherford backscattering/channeling method. The X-ray methods included the investigation of local rocking curves recorded with a $50\times50\ \mu m^{-2}$ probe beam and white beam Bragg case section and projection topography. The synchrotron topographic examination performed before the implantation indicated well resolved individual dislocations of the density smaller than 10^3cm^{-2}. It was found with the use of numerical simulation that majority of the dislocations were the screw ones located along [00.1] direction. The implanted layers provided distinct interference effects both in the rocking curves and Bragg-case section topographs (strain modulation fringes). The presence of distinct interference maxima was essential for evaluation of the strain profile by fitting the theoretical rocking curves. The evaluated strain profiles approximated by browsed Gaussian curve were similar to the distribution of point defects calculated with SRIM2008 code. The profiles were similar to the defect distribution determined from the channeling measurements.

Keywords: silicon carbide, ion implantation, X-ray strain determination

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P17.03.09

Acta Cryst. (2008). A**64**, C599

Observation of dislocation in 4H-SiC by means of weak-beam and plane-wave X-ray topography

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Dislocations in 4H-SiC wafers have been studied using X-ray topography in Bragg-case using synchrotron radiation X-ray beam. Our standard geometry was grazing-incidence extremely asymmetric and diffraction vectors were 11-28 and the X-ray wavelength was 0.15 nm. In order to clarify the dislocation nature, the topographic images were compared with those taken under the weak-beam condition. The basal-plane dislocation images became much narrower in width and they were decomposed to separate lines under the weak-beam condition. The threading-screw dislocations showed changes in their shape and contrast as the crystal set was tilted from the rocking-curve peak, and finally the characteristic images near the dislocation core were observed under the weak-beam condition. Plane-wave topography was also performed to examine the dislocation images in detail. The monochromatic beam form Si 111 double-crystal monochromator was collimated using Si 331 asymmetric reflection, and topographic images at g=0008 from the sample crystal were recorded, and the wavelength was 0.16 nm. Strain contour due to the strain filed around defects were observed, and some typical images for threading screw-dislocations were observed. We discuss the dislocation nature based on these experimental results and theoretical calculations.

Keywords: X-ray topography, dislocation, SiC