High-energy X-ray topographic examination on three-dimensional structure of dislocations in Si crystal ingots

Toshinori Taishi (7513) 1, Seiji Kawado (3776) 2, Hiroyuki Kodera (8459) 2, Kazuya Fukuda (9678) 1, Takeshi Heshikawa (14029) 1 and Kentaro Kajiwara (1794) 1

1 Faculty of Education, Shinshu University, Nagano 380-8544
2 X-Ray Research Laboratory, Rigaku Corporation, Akishima, Tokyo 196-8666
3 Faculty of Science, Toyama University, Toyama 930-8555
4 Faculty of Engineering, Kyushu Institute of Technology, Kitakyushu, Fukuoka 804-8550
5 Faculty of Engineering, Nihon University, Tokyo 165-8551
6 Japan Synchrotron Radiation Research Institute, SPring-8, Hyogo 679-5198

We have investigated nondestructive examination of lattice defects, such as dislocations, in Si crystal using synchrotron-radiation high-energy transmission X-ray topography at SPring-8. In this experiment, three-dimensional structure of dislocations and boundaries between single crystal and polycrystal in Si crystals with various B concentrations were investigated by the high-energy X-ray traverse and section topography at BL20B2.

<001>-oriented CZ-Si crystals were grown from Si melt with different B concentration using an undoped Si seed. The diameter of the crystal was controlled to be about 40 mm. A piece of carbon felt was intentionally dropped into the Si melt to make the dislocated crystal during the dislocation-free crystal growth. The crystal was held on a horizontal-axis precision goniometer, located at the second experimental hutch of BL20B2, keeping its growth axis horizontal, and examined by high-energy (60 keV) X-ray traverse and section topography. The X-ray energy was 60keV and the diffraction vector was 220. Topographs were recorded on an imaging plate or an X-ray film.

Figure 1 (a) shows an X-ray topograph of a heavily B-doped Si crystal with a B concentration of 1 x 10^{14} atoms/cm^3. Arrows indicate the positions where the carbon felt attached during the crystal growth. The boundaries from the positions were observed along {111} and {111}, and inside the boundaries many dislocations propagated along mainly {111}. On the other hand, it was confirmed that the generation of the dislocation was suppressed with increasing B concentration in the Si crystal.

Figure 1 (b) shows an X-ray topograph of the same crystal shown in Fig. 1 (a) examined after turning the crystal to 90°. The other boundaries along {111} and {111} were observed and the growth direction of the crystal changed below the boundaries. Some section topographic images also revealed the same results. Therefore, we concluded that a pyramidal single crystal region, enclosed by the boundaries on {111}, {111}, {111} and {111}, remained in the crystal.

Analysis of three dimensional architecture of renal microcirculation

Yasuo Ogawara (1802) 1, Katsukuni Fujimoto (7645) 2, Keiji Umetani (1460) 3, Hiroyuki Tachihara (5312) 1, Fumihiko Kajiyama (6386) 5, Mami Takemoto (6274) 1, Takahisa Asano (7152) 3

1 Dept. of Medical Engineering, Kawasaki Medical School, 2 Dept. of Anatomy, Kawasaki Medical School 3 Life & Environment Div., JASRI, 4 Dept. of Cardiovascular Physiology, Okayama University Graduate School of Medicine and Dentistry, 5 Dept. of Nuclear Medicine, Kawasaki Medical School

We have visualized renal microvascular structure 3-dimensionally and have directly measured individual glomerular volume of the kidney at the early stage of diabetic nephropathy in spontaneous diabetes mellitus (DM) and in age-matched control rats. Using the Osaka Long Evans Tokushima Fatty (OLETF) rats as rats of early stage DM (28weeks) and control rats (Long Evans Tokushima Fatty; LETO) of the same age, the vessels of the left kidney was filled up with contrast media (BaSO4 + India ink + 8% gelatin). A sampled renal column (63-4mm) was used observing two m-CT systems; 8GeV-superphoton m-CT for the highest image quality (3-10μm in resolution) and commercially available m-CT (10 μm in resolution) for data accumulation. The glomerular volumes more than 400 per sample were computed and normalized to body weight. Heterogeneity in glomerular volume distribution was evaluated by coefficient variation (Fig. 1). The glomeruli in OLETF were characterized by irregular stereocircuits, whereas those in LETO were characterized by regular glomerular structure. Highly heterogeneous glomerular volume distribution in DM rat was quantitatively demonstrated using our developed 3D glomerular micro-structural visualizing method. This technique provides a new aspect for the evaluation of global heterogeneity in glomerular remodeling under the chronic renal dysfunction, which may provide more sensitive insights into early complications of diabetic nephropathy.

Fig.1. Histograms of glomerular volume of OLETF diabetic-rat and LETO control-rat.