

## LOCAL STRESS MEASUREMENTS OF SINGLE CRYSTAL USING SYNCHROTRON RADIATION

Hiroshi SUZUKI\*, Koichi AKITA\*, Yasuo YOSHIOKA\*\* and Hiroshi MISAWA\*

\*Dept. of Mech. Engg., Tokyo Metropolitan University, JAPAN

\*\*Dept. of Energy Sci. & Engg., Musashi Institute of Technology, JAPAN

The stress analysis on single crystal is required for the evaluation of the reliability of microdevices, e.g. electric device, micromachine, microsensor and so on. It is also applicable to measure the stresses in one grain of polycrystalline material. In these cases, it is necessary to measure the stresses in a local area less than 100  $\mu\text{m}$  in diameter.

X-rays from synchrotron radiation source (SR) is suitable for the stress measurement in a local area of single crystal because of optional wavelength with high brightness and parallel beam in comparison with the conventional X-rays. In this study, a system, which has a position-sensitive proportional counter, was developed to measure the local stresses in the silicon specimens of single crystal. We used the SR system at the Photon Factory (PF) of the High Energy Accelerator Research Organization in Tsukuba, Japan as the X-ray source. At first, applied stresses were measured under the bending load. A collimator of 50  $\mu\text{m}$  in diameter was used for obtaining microbeam X-rays and an irradiated diameter was 40  $\mu\text{m}$  on the surface of specimen. Three kinds of hkl diffraction were selected by adjusting the wavelength and each diffraction was measured during swinging the specimen to obtain a measurable profile of diffraction angle. The stresses measured agreed well with the applied stresses. And we confirmed the possibility of the stress measurement of single crystal by using the SR.

The distribution of stress in the vicinity of a circular hole of  $\phi 400 \mu\text{m}$  on a surface of single crystal silicon specimen was secondly measured using a  $\phi 30 \mu\text{m}$  collimator. Five stresses were measured at intervals of approximately 50  $\mu\text{m}$  from the edge of the circular hole. The measured stress distribution agreed with the analytical result by the finite element method. These results indicate that the stresses in a local region such as 30  $\mu\text{m}$  in diameter are measurable by using the SR as compared with the use of conventional x-rays.