Characterization of Subsurface Microstructure and Microcrack for Metallic Materials

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Regarding on the microstructural characterization of steels, electron microscopy has been usually employed. However, the analyses have to be done by thin foil and are invalid for bulk information. Thus the three-dimensional distribution of tiny precipitate and/or microcrack in bulk sample interior has been hardly clarified. The improved resolution of topographic images with hard X-ray is expected for an advanced characterization of steels.

Refraction contrast X-ray imaging has been studied actively. The Hyogo beamline BL24XU of SPring-8 is designed for providing the highly brilliant microbeam and phase contrast imaging. Thus we have applied the imaging method to metallic materials containing cracks or second phases. Training and feasibility examination on utilization of high brilliance X-rays were done.

Experimental was carried out at the branched experimental hutch C of BL24XU equipped with eight figure andulator. The X-ray beam with the energy of 15 keV was monochromatized by the double-crystal monochromator. Two kinds of X-ray beam conditions were used. One was direct monochrome beam. The other was expanded and collimated beam horizontally by using two times 115 (+,-) asymmetric reflections from (001) silicon single crystals.

In order to check the transmission of X-rays in alloys, wedge shape specimens were prepared from bulk materials for Al-12wt%Si alloy, iron, and SUS316 steel. Samples were mounted to the stage with smoothly increasing thickness from about 0 - 5 mm in the horizontal direction. The SUS316 sample involved a fatigue crack which was almost parallel to the horizontal plane. Sample stage was scanned in the vertical direction with various speeds and at various sample thickness. Photographs of those images were taken by X-ray film.

We verified that X-ray images can be obtained even thick iron and steel. Refraction contrast X-ray imaging may be useful to characterize microstructure and defects in metallic materials.