A NEW TECHNIQUE FOR THREE-DIMENSIONAL INTERNAL STRUCTURE ANALYSIS IN METALLIC MATERIALS: COHERENT X-RAY DIFFRACTION MICROSCOPY

Yukio TAKAHASHI[1], Yoshinori NISHINO[2], Tetsuya ISHIKAWA[2], and Eiichiro MATSUBARA[2]

[1]Osaka University, Yamada-oka, Suita, Osaka 565-0871, Japan
[2]RIKEN SPring-8 Center, Kouto, Sayo, Sayo, Hyogo 679-5148, Japan
[3]Kyoto University, Yoshida, Sakyo, Kyoto 606-8501, Japan

Coherent x-ray diffraction microscopy[1)] (CXDM) is a novel technique for reconstructing a two-dimensional projection image, using an oversampled Fraunhofer diffraction profile. A three-dimensional (3D) image can also be reconstructed from coherent x-ray diffraction patterns at different sample orientations. After the first demonstration of CXDM by Miao *et al*., several applications of CXDM have been reported. CXDM has a great potential as a new technique for structural studies of metallic materials because it is not only a non-destructive method but also applicable to a sample of micrometer thickness. At present, the best image resolution that has been achieved is less than 50 nm for the 3D image. For example, precipitates in some aluminum alloys in practical use exhibiting sufficient strength with adequate toughness are a few tens of nanometers in size. CXDM is thus exactly suited for study of a 3D exact configuration of precipitates in a micrometer alloy sample. In the present study, the validity of CXDM for this kind of observation has been demonstrated in an age-hardened aluminum alloy in practical use. The measurement was carried out at BL29XUL in SPring-8, Harima, Japan. As the result of data analysis, the internal structure and the shape of the aluminum alloy particle were three-dimensionally visualized[2)]. Both the shape and size of an S-phase precipitate were evaluated on the assumption that the high-electron density region in the particle corresponds to the S-phase. This is the important result toward in-situ observation of formation of internal structures in metallic materials on the nano-meso-scale by CXDM with x-ray free electron lasers.

1) J. Miao, P. Charalambous, J. Kirz, and D. Sayer, Nature 400, 342 (1999).
2)Y. Takahashi, Y. Nishino, T. Ishikawa, and E. Matsubara, to be submitted to APL.