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Elemental and chemical state depth analysis by combined use of a poly-capillary and a thin wire in a synchrotron X-ray microprobe

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1 Introduction

Non-destructive three-dimensional (3-D) analyses of materials by the X-ray confocal system have been applied to various analytical tasks, such as archeological and cultural heritage specimens, and biological tissues [1]. The X-ray confocal technique has high sensitivity and achieves the depth resolution of 10 – 50 μm. In order to realize a simple 3-D analysis with the higher depth resolution, a thin wire technique was proposed in the previous paper [2]. To enhance the signal intensities and to achieve the high depth resolution, the method which combines the poly-capillary confocal system and the thin wire technique has been developed. In this report, the application to the chemical state analysis by XANES spectra is described [3].

2 Experiment

An inset in Fig.1 (a) shows a schematic representation of the experimental arrangement of the elemental and chemical depth analysis using a thin wire in combination with a poly-capillary. In addition to the conventional confocal poly-capillary system, a thin wire was set close to the sample surface and a slit was inserted in front of the detector. The poly-capillary acts as the one dimensional (vertical) condenser lens for emitted X-rays.

A sample used was a (Fe(III) oxide film)/(PET film)/(evaporated Fe film) layered film. For incident X-rays, the Kirkpatrick-Baez focusing system of 5 μm square beam size was used.

3 Results and Discussion

Fig. 1 (a) shows the Fe K_α intensity profiles from the layered film as a function of sample displacement (depth), measured using the confocal (solid line, Pc) and polycapillary-wire modes (dashed line, Pc/W). The difference profile (chain dotted line, Dif) shows two sharp peaks 21 μm apart: the Fe(III) and evaporated Fe films are at positions indicated as A and B, respectively. The Fe XANES curves were then measured at position A (Fig. 1(b)), using both the confocal and polycapillary-wire modes. The difference in the XANES spectra between the two modes (chain dotted line in Fig. 1(b)) is from the Fe (III) iron alone. The difference spectra in Fig.1(c) agree well with the XANES spectra measured independently from Fe (III) and evaporated Fe films. These results clearly show that the depth resolution of the XANES spectra in X-ray microbeam analysis can be improved by the present technique.

References

[1] K. Janssens et al., Spectrochim. Acta Part B 59 (2004) 1637. [2] A.Iida, X-ray Spectrom.40 (2011) 376 [3] A.Iida, X-ray Spectrom.46 (2017) 225, PFACR2015#33

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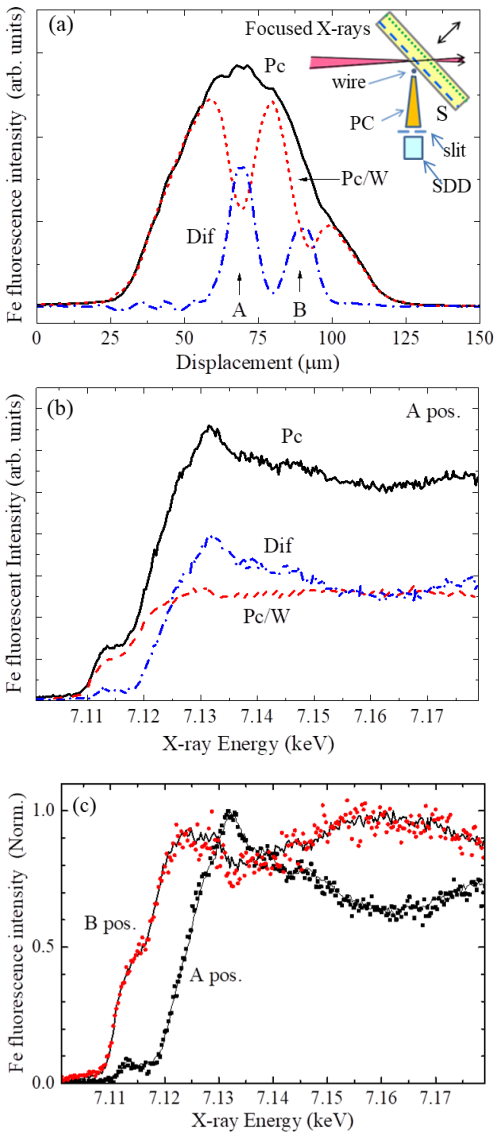

Fig. 1 (a) Fe K_α intensity profiles and their difference along the depth from the layered Fe film. S:sample, PC:poly-capillary. (b) XANES spectra at the A position. (c) Results (dots) compared with reference spectra (solid lines). Pc: with poly-capillary, Pc/W: with poly-capillary and the thin wire, Dif = P − Pc/W.