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The ability of XSTRIP as a detector for the time-resolve DXAFS measurement

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Introduction

XSTRIP is a silicon miscrostrip X-ray detector system developed in Daresbury Laboratory [1], and it has been installed in NW2A beamline of PF-AR. The detail of its composition and fundamental performance were reported at elsewhere [2]. We succeeded in measuring a XAFS spectrum by only one pulse of X-ray at that time, and we have carried out some further DXAFS measurements using the XSTRIP detector to improve the quality of the XAFS spectra by one pulse of X-ray.

Experiments

The DXAFS measurements of Ni foil (5 μm thickness) were carried out at NW2A beamline using an Si(111) bent crystal (Bragg-type) polychromator with the bending radius of 2 m. The bunch revolution signal of 794 kHz at PF-AR was delayed and used as the trigger for starting the XSTRIP scan to synchronize the scan with the X-ray pulse. The delay time between the bunch revolution and the trigger signals was adjusted to get the maximum intensity of X-ray. The XAFS spectra of Ni foil were measured for various accumulation numbers.

Results and Discussion

The XAFS spectra and the EXAFS functions of Ni foil (5 μm thickness) are shown in figure 1 and 2, respectively. The exposure time of the XSTRIP detector was 0.9 μs, corresponding to that only one X-ray pulse irradiated during the one exposure frame. The accumulation number of spectrum a in figure 1 is 1, and it corresponds to the spectrum obtained by only one X-ray pulse. This means that the time-resolution of this spectrum is equivalent to the width of one X-ray pulse (ca. 70-100 ps). The EXAFS functions in figure 2 were extracted from the XAFS spectra smoothed. Although the signal-to-noise (S/N) ratio of spectrum a is insufficient to analyze the EXAFS data, the characteristics to the Ni foil can be clearly observed. The S/N ratio of the spectrum c, whose accumulation number was 9, has been drastically improved and it can be analyzed to obtain the local structure parameters. If a reaction system is reversible or can be repeated at least 10 times, it is possible to perform the time-resolved applications in sub-nano second time region by means of the XSTRIP detector.

This study demonstrates the ability of XSTRIP as a linear detector for the DXAFS measurements. Because a very good spectrum can be obtained for much longer exposure time, such as 100 μs, the XSTRIP detector is very powerful not only for the ultra-fast XAFS measurements but also for conventional DXAFS applications.

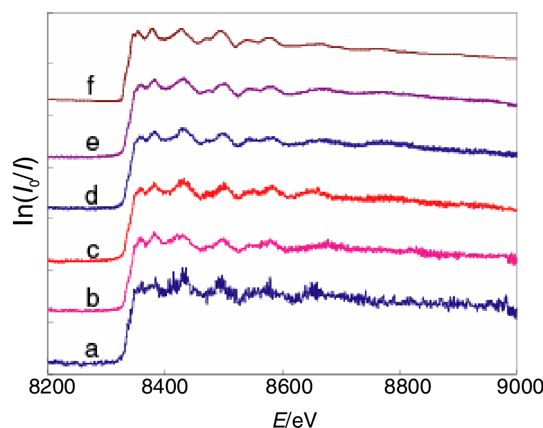

Fig. 1. XAFS spectra of Ni foil (5μm thickness). The exposure time is 0.9 μs, and the accumulation number is 1 (a), 4 (b), 9 (c), 25 (d) and 100 (e). The spectrum f is obtained by conventional step scan measurement.

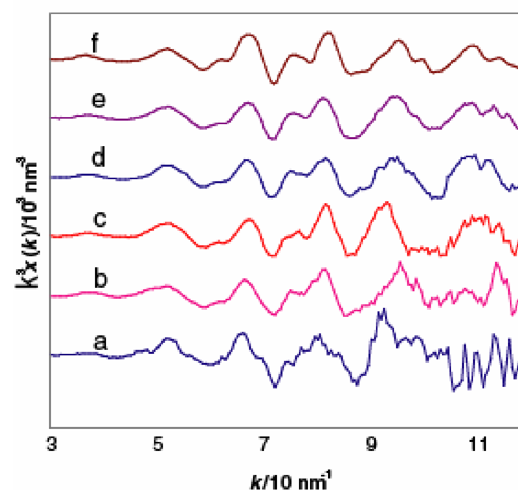

Fig. 2. EXAFS functions of Ni foil (5μm thickness). The abbreviations are the same meanings with Fig. 1. The functions except for f are obtained from the XAFS spectra smoothed.

References

[1] J. Headspith et al., Nucl. Instrum. Methods. Phys. Res. A, 512, 239 (2003).
[2] Y. Niwa et al., Photon Factory Activity Report 2005, #23 part B, 253 (2006).

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