BL14B2
XAFS II

1. Introduction

BL14B2 is a bending magnet beamline at SPring-8 dedicated to research by industrial users conducting X-ray absorption spectroscopy (XAS) and X-ray imaging measurements. Various measurement systems have been developed to realize easy and high-throughput operations of XAS and X-ray imaging measurements. In FY2022, we introduced voltage–frequency (V–F) converters with high output frequency for XAFS measurements.

2. Introducing V–F converters with high output frequency for XAFS measurements

When we measure the XAFS spectrum for a sample with a large total absorption coefficient (μt), the transmitted X-ray intensity detected in the ion chamber becomes very weak. In the XAFS measurement system, the V–F converter is used to convert the voltage signal, which is output from the ion chamber, into frequency in order to measure X-ray intensity as counts. When an X-ray with small flux is measured using the V–F converter with low output frequency, the linearity of measurement of the X-ray deteriorates because sufficient resolution for converting weak voltage output cannot be ensured. As a result, the measured spectra for samples with large total μt often become steplike. In order to solve this problem, it is required to improve the output frequency of the V–F converter. For this purpose, we introduced V–F converters with an output frequency of 100 MHz TTL, V2F100 (made by Quantum DETECTORS), in this FY. Output frequencies of these converters are 100 times higher than that of N2VF-01 (made by TSUJICON; output frequency of 1 MHz TTL) conventionally used in BL14B2. We evaluated the efficiency of improving the quality of measured spectra by introducing V2F100.

First, we evaluated the linearity of V2F100. Figure 1 indicates the linearity of the measurements of X-ray flux in the ion chamber using V2F100. To change the X-ray flux, a series of Al absorbers with different thicknesses from 0 to 2800 μm are inserted at the upstream side of the ion chamber in the beam path. The data shown in Fig. 1 indicate a dependence of output counts from the V–F converter on the thickness of Al absorbers. The KEITHLEY 428 current amplifier was used for amplifying the output current signal from ion chambers. The photon energy of incident X-ray was 10520 eV. Under this condition, the

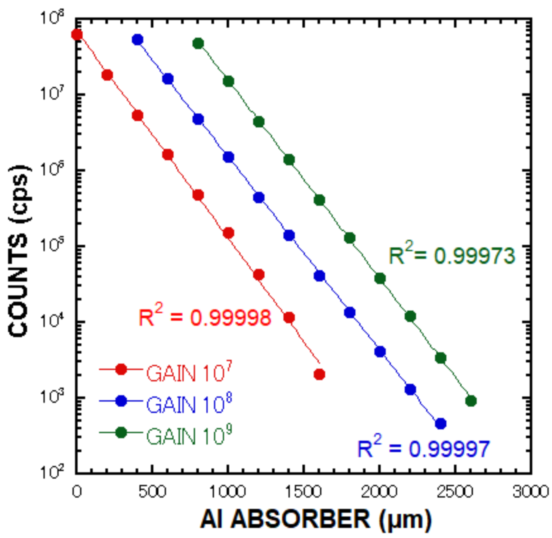

Fig. 1. Linearity of measurements of X-ray flux in ion chamber using V2F100.

transmittance of the Al absorber with a thickness of 400 μm is 0.1. It is found that the output count decreases exponentially over 1000–10000 cps with increasing thickness of the Al absorber. Thus, it is also considered that the linearity of measurements of the X-ray flux using V2F100 is sufficient to measure the XAFS spectrum at BL14B2.

Figures 2(a) and 2(b) show XANES spectra for Zn foil and Zn foil stacked with an Al plate obtained using N2VF-01 (red lines) and V2F100 (blue lines). The thickness of Zn foil is 25 μm (Δμt ~ 4). The Al plate with a thickness of 400 μm was used to attenuate the transmitted X-ray. Each spectrum was measured under the same measurement time and gain of the current amplifier. As you can see in the data of the white line peak of the XANES spectrum for Zn foil stacked with Al plate, whose total μt was large, shown in Fig. 2(b), the XANES spectrum measured by N2VF-01 was steplike because the transmitted X-ray intensity was very weak. On the contrary, that measured using V2F100 was smoother than that measured using N2VF-01. This result indicates that the steplike spectra measured for samples with large total μt were improved by introducing V2F100 with high output frequency.

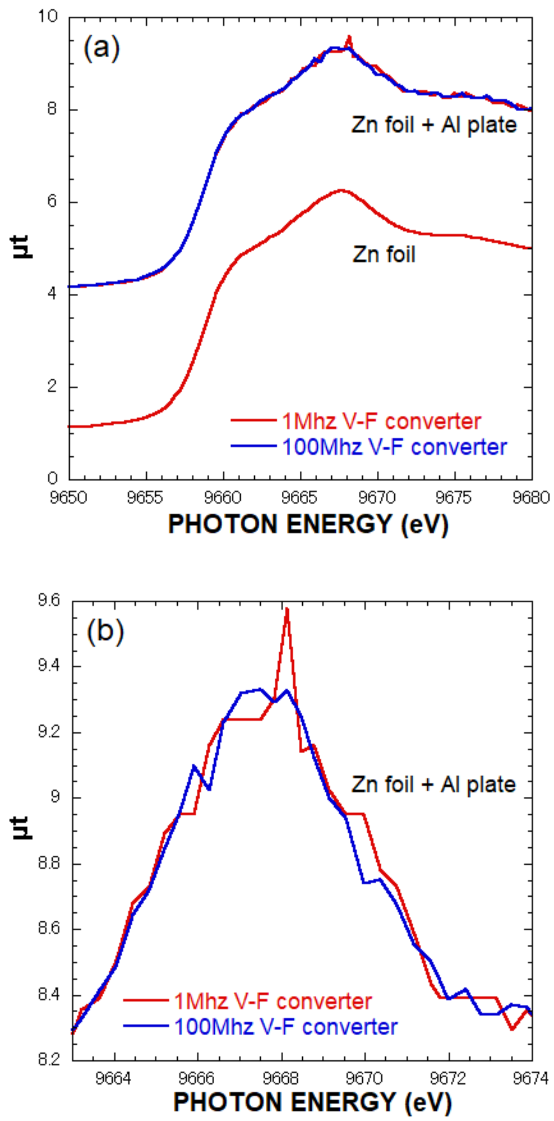

Fig. 2. (a) XANES spectra for Zn foil (lower) and Zn foil stacked with Al plate (upper). (b) Enlargement of white line peak in XANES spectra for Zn foil stacked with Al plate.

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