Lifetime-broadening-suppressed polarized-XANES spectroscopy of $La_{2-x}Sr_xCuO_4$

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In spite of extensive spectroscopic studies, including XANES, the electronic structure in the p-type superconductors $La_{2-x}Sr_xCuO_4$, in particular for x> ~0.2, is still not fully understood. This is partially due to the limited energy-resolution in XANES spectra by the lifetime broadening.

In order to overcome this limitation, resonant inelastic x-ray scattering (RIXS) can be used.[1)] In this cycle, RIXS measurements have been performed for a single crystal of $La_{2-x}Sr_xCuO_4$ with Sr-concentration gradient with the polarization of ε//c-axis and ε⊥c at BL39XU. In the experiments, employed was a high-sensitivity spectrometer with high-resolution, which was developed in a previous proposal (2002B0475-NX-np).

The results obtained are partially shown in Fig.1. Clear anisotropy was found for the RIXS spectra (Fig.1a). The lifetime broadening-suppressed (LBS) Cu K-XANES profiles were determined through the fitting procedure to the RIXS spectra,[1)] and are plotted in Fig.1b. The LBS-XANES profiles show sharper features than conventional ones, as is expected, suggesting the possibility to chase changes of the electronic states in $La_{2-x}Sr_xCuO_4$ for Sr-doping by the present method. Analyses are still in progress.

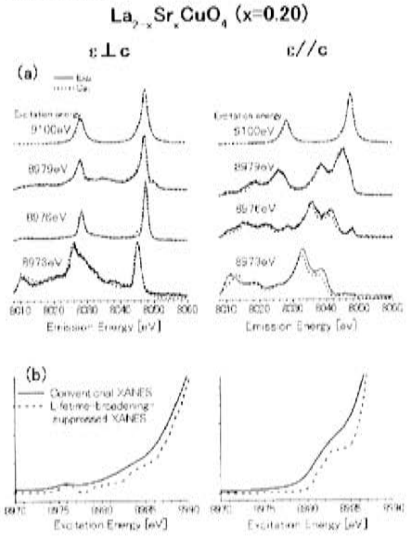

Fig. 1 (a) RIXS and (b) LBS-XANES spectra of $La_{1.8}Sr_{0.2}CuO_4$ for ε⊥c and ε//c.

1) H.Hayashi et al, Phys. Rev. 68, 45122 (2003).

Development of a scanning XMCD microprobe at BL39XU

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A scanning XMCD microprobe has been developed at BL39XU. This equipment is based on a micro-focusing method utilizing a Kirkpatrick-Baez(KB) mirror and the X-ray helicity switching technique using a diamond phase retarder installed in BL39XU. KB mirror consists of a set of two mirrors for vertical(v) and horizontal(h) focus. The mirrors are made of Si, and highly refined by the Elastic Emission Machining(EEM)[1-3]. The mirror surfaces are uncoated. The focal lengths are (v)300 mm and (h)150 mm, and the glancing angles are (v)1.4 mrad and (h)1.8 mrad. The length of both mirrors are 100 mm, hence the effective aperture size is (v)140 × (h)180 μm^2.

The focal beam profiles measured by numerical-differential of the knife-edge scans are shown in Fig. 1. The beam size, which is defined as FWHM of beam profile, was (v)1.2 × (h)1.0 μm^2, and the photon flux in the focal spot, estimated using an ion chamber, was 1.8 × 10^9 photons/s/100 mA. In comparison with the previous study(No. J03B39XU-0500N), broadening of the tail of the focal spot, which lowers contrast of image, was remarkably reduced. This improvement is due to suppression of the slope error on the mirror surfaces by the EEM, instead of usual NC machining which was applied to the previous mirror.

Figure 2 shows an XMCD image of a CoCrPtB hard disk medium taken at Pt-L_3 edge(11.56 keV). The sample was artificially in-plane magnetized with stripe patterns. The beam with the size (v)1.4 × (h)1.8 μm^2 and the photon flux 5.2 × 10^{10} photons/s/100 mA was used in this scan. As a result, the stripes of 2.4 μm width was successfully resolved.

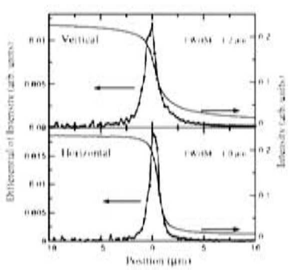

Fig. 1: Intensity profiles of knife-edge scans(solid lines) and their differential curves(circles).

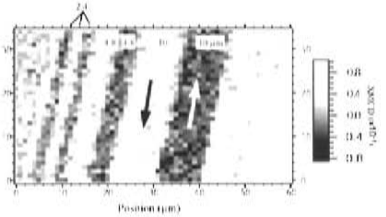

Fig. 2: An XMCD image of artificial magnetization patterns written on a CoCrPtB film, taken at Pt-L_3 edge. In the image, numerals indicate the width of the stripe patterns, and the arrows are the direction of magnetization.

[1] K. Yamauchi et al.
Rev. Sci. Instrum. **73** (2002) 1028.
[2] K. Yamauchi et al.
Rev. Sci. Instrum. **74** (2003) 1549.
[3] K. Yamauchi et al.
Jpn. J. Appl. Phys. **42** (2003) 7129.