Soft x-ray resonant scattering from antiferromagnetic chromium

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Introduction

The chromium ground state has been intensively studied by x-ray and neutron scattering due to its complex origin and distinct signature in momentum-resolved scattering experiments. It is well-known that, in addition to spin density waves, charge/strain density waves are also present in the ground state. In order to establish or disprove a connection to the spin and charge ordered states of more complex materials, a soft x-ray scattering study of antiferromagnetic chromium has been carried out at NSLS undulator beamline X1B.

Methods and Materials

The resonant soft x-ray scattering measurements were made in a ten-axis UHV diffractometer. Details of the experimental setup are described in Ref. [1]. The chromium single crystal was cut with the (001) direction oriented normal to the surface plane.

Results

The fluorescence yield at the chromium $L_{3,2}$ edges (red) and the Kramers-Kronig transform of the absorption data (blue) are shown in Fig. 1.

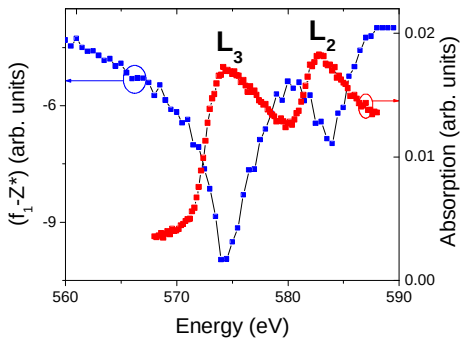

Fig. 1.

Soft x-ray scattering measurements around the wavevector of the charge/strain modulation $\mathbf{Q}_{25\,K}$ = (0, 0, 0.095) showed large resonant enhancements (Fig. 2). Large enhancements were observed for both longitudinally and transversely polarized spin waves. The resonance profile at the L_3 edge is asymmetric with a more rapid decrease on the high-energy side due to self-absorption (Fig. 2).

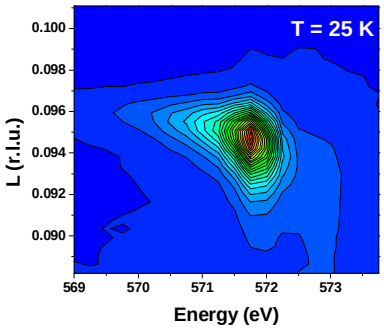

Fig. 2.

Refraction at the crystal surface causes a strong change of the scattering vector with energy near the Cr L_3 edge (Fig. 3). The inset shows the dependence on energy of the superlattice reflection in $La_{1.875}Ba_{0.125}CuO_4$ (LBCO) near the Cu L_3 edge. In contrast to chromium, the scattering vector does not vary significantly over the Cu L_3 resonance profile, due to the much lower density of Cu atoms in the LBCO crystalline matrix.

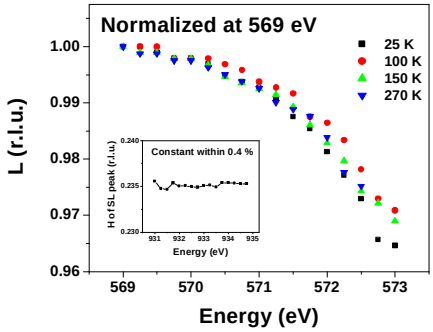

Fig. 3.

Acknowledgements

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[1] P. Abbamonte, A. Rusydi, S. Smadici, G. D. Gu, G. A. Sawatzky, D. L. Feng, Nature Physics **1**, 155 (2005).