ESRF

Experiment title:
Spin-resolved Auger spectroscopy on solid materials using circularly-polarized soft x-ray radiation

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HC 56 2

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Report:

The aim of our experiment was to study the L_3VV Auger process Auger process at Cu and some additional (paramagnetic) 3d-materials by means of spin resolved Auger spectroscopy .The essential question with Cu is to what extent the spin-spin coupling can be described in the framework of the atomic multiplet model mostly applied for the Cu Auger line shape [1,2]. In our apparatus the circularly polarized light passes a 90° spherical electron spectrometer and hits the target at normal incidence. Electrons emitted inside a cone of about + 1° around the surface normal are decelerated by a four-element electrostatic lens to the pass energy of 100eV, deflected and energy-analyzed by the spectrometer and accelerated into a retarding Mott polarimeter for spin polarization analysis. At the pass energy of 100eV the energy resolution of the spectrometer is <1 eV, the detection efficiency of the Mott polarirneter is $I/I_0 \approx 10^{-3}$ and its polarization sensitivity S_{eff} about –0.23. This apparatus has been successfully used many times at BEESY at photon energies < 80eV.

Two problems arose during the ESRF beamtime:

- A high field magnet at the neighboring beamline BL12A was operated at +2T and –2T. At the position of our apparatus it caused stray fields varying by 1/3 of the earth field and affecting the electron traces. We handled this problem by controlling the two critical field components simultaneously.
- The high retardation of about 800eV necessary for studying L_3VV Auger electrons from Cu, e.g., required new power supplies for the spectrometer. One of these supplies,

delivered immediatly prior to the beamtime, was coupling AC noise on the spectrometer reference potential. This resulted in the peaks appearing twice in the spectra separated by about 6eV. Although we recognized the discrepancy between our spectra and spectra in literature (measured at other geometries) and checked possible sources of it, we could not identify the fault and decided to measure spin resolved Cu L_3VV Auger electron spectra in their present form.

Fig. 1 shows the distorted spin-resolved Cu L_3VV Auger spectrum measured at the ESRF. Besides all the problem with the spectrum the following results are obvious:

- In the main Auger peak, mostly assigned to a $^1G_4$ multiplet configuration [1 ,2], the partial intensity I_ of electrons with spin antiparallel to the photon helicity is significantly preferred. The spin polarization P is about $-20\% \pm 3.5\%$
- On the low kinetic energy side of the main peak a small peak only appears in the partial intensity I_+ of electrons with spin parallel to the photon helicity superposed by a flat partial intensity I_. From its separation of about 5.5eV from the main peak and its lower intensity we identify this peak as the peak mostly assigned to a $^1S_0$ multiplet configuration. As in our measurement, this peak is present only in I+, it has a spin polarization opposite to the $^1G_4$ peak, although in both peaks singlet coupling should be present.
- At a kinetic energy of 100eV below the data presented in the inelastic background we have measured spin polarization of-1 **2%* 5%** which is nearly the average of the spin polarization across the main peak. This is a hint to energy loss by electron - electron scattering.

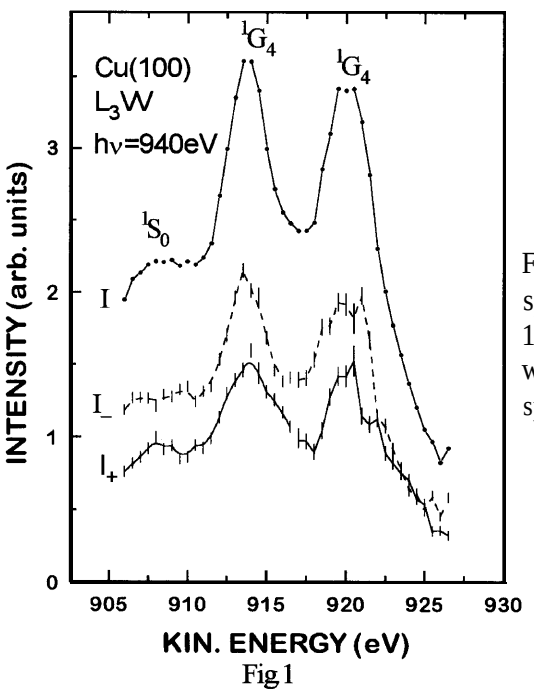

Fig 1

Fig. 1: Distorted spin resolved L_3VV Auger spectrum measured at hv=940eV at Cu(l 00). 1, and I _ give the partial electron intensity with spin parallel and antiparallel to the photon spin, respectively.

[1] E.J. McGuire, Phys. Rev. A 17, 182 (1978)

[2] H.Haak, G.A. Sawatzky and T.D. Thomas, Phys. Rev. Lett. 41, 1825 (1978)