

The Cu2p-edge of superconducting BiSrCu-Oxides studied by resonant Photoelectron Spectroscopy

D. Schmeißer^{1*} and C. Janowitz²

¹Angewandte Physik-Sensorik, BTU Cottbus, Konrad Wachsmann Allee 17, 03046 Cottbus, Germany

²Institut für Physik, Humboldt-Universität zu Berlin, Newtonstr. 15, 12489 Berlin, Germany

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*e-mail: dsch@b-tu.de

We report on a resonant photoemission (resPES) study of $\text{Pb}_{0.4}\text{Bi}_{1.6}\text{Sr}_{2.0}\text{CaCu}_2\text{O}_8$ ((Pb,Bi)-2212) (BISCO) single crystals to unravel the resonant decay mechanisms at the Cu2p absorption edge. The resPES studies on superconducting BISCO are performed at Bessy U49/2. We investigated BISCO single crystals with different hole doping concentrations at temperatures between 300K and 17K. CuO films have been used as a reference.

Here we focus on the resPES data recorded at the Cu2p absorption edge. We find a strong polarization dependence for in-plane and out-of-plane geometries (with respect to the Cu-O plane) in our data which are caused by two independent Auger processes.

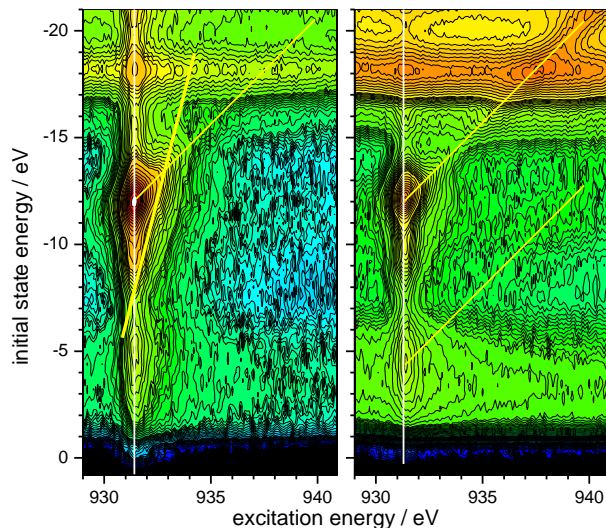


Figure 1: Cu- L_3 edge resonant photoemission profiles recorded in-plane (left) and out-of-plane (right). The thin white and the thick yellow lines mark the 3h-Auger and the Cu-LMM processes, respectively.

At the Cu2p absorption edge the most pronounced intensity is due to the $\text{Cu}3d^8$ satellite (initial state energy around -12eV in figs. 1). The intensity of the valence band states (around -4eV) with a $3d^9$ configuration is much weaker. Very remarkable is the polarization dependence which in Fig.1 is shown for a polarization geometry parallel to the Cu-O plane (in-plane, left panel) and perpendicular to it (out-of-plane, right panel). In these data we identify two Auger processes. One is assigned to involve an in-plane ligand-to-metal CT state

(yellow line, left panel). It originates right at the strong $\text{Cu}3d^8$ satellite and yields to a combined participator and spectator Auger decay with a three-hole (3h) final state [1]. The second Auger process is indicative of a Cu-LMM decay (white line, right panel). It appears only in out-of-plane geometry and involves Sr valence states as well. Fig.2 gives an example for the strong difference for the in plane and the out-of-plane polarization geometries. Here we use the integrated intensities (pIY) of the resPES profiles shown in Figs.1. In the lower panel we show the corresponding data for undoped and maximum doped BISCO samples. We discuss these resPES data in the context of previous assignments of the doping dependence where the shoulder in the main Cu2p absorption signal is used to determine the hole doping concentration [2].

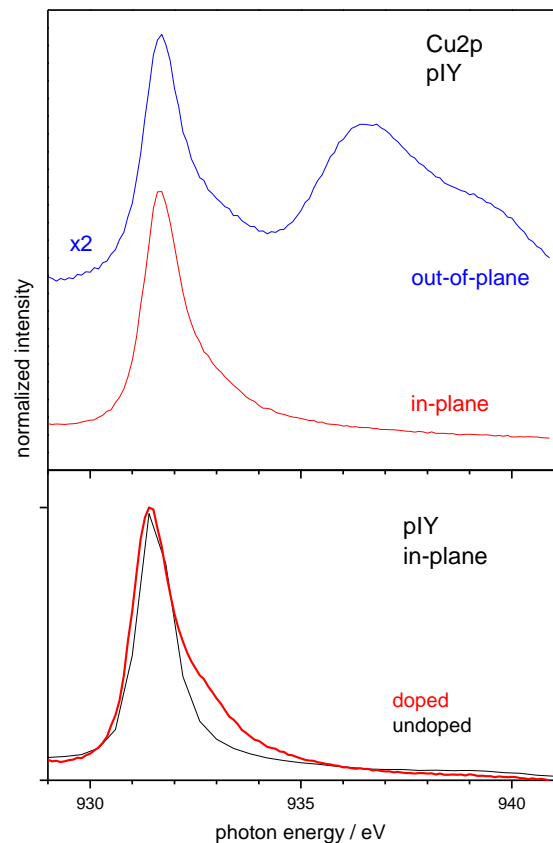


Figure 2: The Cu2p-pIY absorption signal: polarization dependence of the pIY curves of the two wallpapers in Fig.1 (top panel), doping dependence (bottom panel).

Our resPES data enable us to sort the individual resonant mechanisms at the Cu2p edge in more detail than recently anticipated [2]. We discuss our data in the context of the recent discussion about the applicability of the Zhang-Rice model [3].

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