

Spin-state and metal-insulator transitions studied by bulk-sensitive photoemission.

L.H. Tjeng, T. Koethe, C. Schüßler-Langeheine, Z. Hu, J. Gegner, H. Roth,
C.-F. Chang, M.W. Haverkort,
*II. Physikalisches Institut, University of Cologne, Zùlpicherstr. 77,
50937 Cologne, Germany*

N.B. Brookes, F. Venturini,
*European Synchrotron Radiation Facility, BP 220,
38043 Grenoble Cedex, France*

O. Tjernberg,
Royal Institute of Technology, Electrum 229, S-16440 Kista, Sweden

and G. Panaccione
*Lab. TASC S.S. 14 Km 163.5, in AREA Science Park,
34012 Basovizza (Trieste)*

It has been demonstrated by the Laubschat/Kaindl [1] and the Suga groups [2] that photoemission studies on rare-earth Kondo systems using ultra violet light do not provide spectra which could be considered as representative for the bulk material. This is caused by the surface sensitivity of this technique, which turns out to be quite problematic for the investigation of especially strongly correlated or narrow band materials, including the transition metal oxides [3]. This in turn is related to the natural tendency of these class of systems to have the electronic structure of the surface to be substantially different from that of the bulk due to differences in coordination number of the atoms at the surface in comparison with the bulk. These problems are likely to be most acute for those systems which are close to an instability, e.g. showing various phase transitions, since the conditions for these to occur are not met in the surface region as probed in ultra-violet photoemission.

Recently we have studied the spin-state transitions in LaCoO_3 and $\text{GdBaCo}_2\text{Co}_{0.5}$ as well as the metal-insulator transitions in VO_2 and Ti_2O_3 single crystals using soft-x-rays instead of ultra-violet light in order to increase the probing depth and discovered that the results are spectacularly different from the data published so far. Experiments using 6 keV photons are also used to obtain in a reliable manner the coherent and incoherent excitations in these materials.

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[1] C. Laubschat et al., Phys. Rev. Lett. 65, 1639 (1990).

[2] A. Sekiyama et al., Nature 403, 396 (2000).

[3] A. Sekiyama et al., Phys. Rev. Lett. 93, 156402 (2004).