Materials Physics

The research of NSRRC users is continuously progressing towards the frontiers of synchrotron-based spectroscopy in condensed-matter physics. As epitomized below, this section highlights examples of cutting-edge subjects on electronic and magnetic properties of complex materials with X-ray absorption, scattering and photoemission.

Chang *et al*. from L. H. Tjeng's group of Cologne University, using Co-$L_{2,3}$ and O-K X-ray absorption spectroscopy, present their observation of charge ordering in $La_{1.5}Sr_{0.5}CoO_4$ involved with high spin Co^{2+} and low spin Co^{3+} ions. This work proffers evidence for the spin-blockade phenomenon as a source for the extremely insulating nature of the $La_{2-x}Sr_xCoO_4$ series. They also infer that the spin blockade mechanism is active and that there is a strong coupling between the local Co-O distance and the charge/spin state of the ions. The crystal field scheme for the Co^{3+} ion caused by the tetragonal distortion makes the conduction band extremely narrow.

Another interesting work on oxides is the study of novel electronic structure of a highly strained oxide interface. With angle-resolved photoemission spectroscopy, Xie *et al*. from D. L. Feng's group of Fudan Univesity revealed various interfacial electronic properties that have never been observed in oxide interfaces before. The relation between strain and charge transfer across the oxide interface is illustrated from a microscopic level. They found that the large strain in the rocksalt layer induces a large electron transfer to the less strained CoO_2 layer in the misfit oxide $Bi_2Ba_{1.3}K_{0.6}Co_{2.1}O_{7.94}$. Xie *et al*. also discovered a novel interfacial enhancement of electron-phonon interactions. These properties depict a detailed microscopic picture of various important processes that could occur at oxide interfaces in general.

The research group led by D. J. Huang (NSRRC) has continuously been devoted to multiferroics. Okamoto *et al*. report their recent work on spin handedness of conical-spiral magnetic order in multiferroic $CoCr_2O_4$. With measurements of resonant magnetic scattering of circularly polarized soft X-ray, they revealed the mechanism of an unusual multiferroic transition associated with conical-spiral magnetic order. Okamoto *et al*. demonstrate that resonant soft X-ray magnetic scattering is a powerful experimental technique for studying multiferroic transitions of frustrated magnets. Their results particularly illustrate the evolutions of the scattering intensity and wave vector of magnetic ordering about the temperature of multiferroic transitions, elucidating the intricate coupling between magnetism and ferroelectricity.