Materials Science :

To investigate the electronic and magnetic structures of various kinds of materials spectroscopic and scattering experiments are being conducted at the beamlines. Because relatively high-energy photons with a high-energy-resolution are used for spectroscopy research at SPring-8, the intrinsic bulk and buried interface properties can be precisely investigated. A recent trend is measurements in operand (i.e., studies for device materials under operating conditions, such as when a bias voltage and magnetic field are applied). Hard-X-ray photoemission spectroscopy (at BL15XU, BL29XU, BL46XU and BL47XU) (i.e., so-called HAXPES) provides bulk and interface information about materials. Recently, HAXPES studies at BL09XU have started. In the present chapter, recent achievements regarding the electronic and magnetic proprieties of materials are discussed.

Y. Yamashita *et al.* applied HAXPES at BL15XU to study the interface states of silicon under a bias voltage.

F. Bonel *et al.* showed the X-ray magnetic circular dichroism (XMCD) results for an electric field-driven chemical reaction at the buried FeCo/MgO interface. Experiments were performed at BL25SU, and the results shed a new light on the voltage-control of magnetism. Several mechanisms (charge accumulation or oxidoreduction) lead to magnetoelectric functionalities in solid-state devices.

Electronic & Magnetic Properties

The new soft X-ray beamline BL07LSU, which is operated by The University of Tokyo, has began started to produce promising results using time-resolved photoemission, three-dimensional nano-photoemission, and soft-X-ray emission spectroscopies. Using a soft-X-ray emission spectrometer, an energy resolution over $E/\Delta E \sim 10000$ has been achieved, and the electronic structures of polymer electrolyte fuel cells under operating conditions were reported by H. Niwa *et al.*

In addition, the activity from BL12XU, which operated by the National Synchrotron Radiation Research Center in Taiwan, has been fruitful. A. Severing *et al.* performed non-resonant inelastic scattering (NIXS) experiments on the heavy fermion compound, $CeCu_2Si_2$. By comparing the experimental data with theoretical simulations, they succeeded to determine the orbital orientation of the 4*f* ground state.

Other scattering methods are also actively utilized. K. Ohgushi performed resonant X-ray diffraction measurements at beamline BL19LXU for post-perovskite iridate, $CaIrO_3$. They argued that a quantum compass interaction occurs between the spins in $CaIrO_3$. M. Ito succeeded to introduced a rather bulk sensitive spin and orbital magnetization loops using magnetic Compton scattering. Their experiments were conducted at BL08W, and this method may be complementary to the XMCD method.

These pioneering results will significantly contribute to advancing the field of materials science.

Toyohiko Kinoshita