

Low Temperature Photoemission Electron Microscope

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Photoemission electron microscopy (PEEM) utilizing magnetic linear or circular dichroism (MLD or MCD) in specific core level spectroscopy provides high resolution and elemental specificity in magnetic domain observation. An additional attractive feature of the PEEM observation by MLD is the possibility to investigate antiferromagnetic domain structure. Even though observation of magnetic domain changes at magnetic transition temperature is an interesting subject, not many PEEM studies have been done at low temperature so far, since sample cooling causes the thermal drift or vibration of the sample that makes the spatial resolution worse. In addition, the requirement of the high adjustability of the sample position and azimuthal rotation for the domain observations by PEEM makes their manipulator complex and difficult to cool down the sample.

In this paper, we report our attempt to develop a low-temperature PEEM apparatus. The system consists of a photoemission electron microscope (STAIB GmbH 350S), a manipulator with Helium cryostat (VG Scienta Ltd.) and ultrahigh vacuum chambers for surface analysis (LEED and Auger), sample preparation (metal evaporators and sample cleaver) and a sample exchange system (load lock system). To achieve a low sample temperature, the sample plate and receptor were modified to improve thermal contact. The manipulator has 5 axes motion (x, y, and z motion and polar and azimuthal rotation). To provide for orthogonal alignment of sample surface and microscope axis, the microscope can be adjusted by tilt motion of the neck of microscope achieved by the flexible support with bellows. In order to reduce the vibration from the cryostat, the sample holder is supported from the backside by an adjustable support. To further minimize thermal drift effect, data acquisition of the image was done for short period and summed up several frames after compensation of the drift by determining possible movement of topographical details. Using the system, achieved lowest temperature was about 78 K. The complete system is mounted on a pneumatic damping system and connected to the synchrotron radiation beamline at BL-13C, 11A, and 19A in the Photon Factory, KEK, Japan.

As an example of the application of this system, we will show some results of magnetic domain observation of $\text{La}_{2-2x}\text{Sr}_{1+2x}\text{Mn}_2\text{O}_7$ ($x=0.30$) at low temperature.