Soft X-ray Spectroscopy of Solid (BL25SU)

1. Introduction

The soft X-ray helical undulator beamline BL25SU was designed and constructed for studies on the electronic states and surface structures of solids. The Electronic Properties of Solids subgroup has been completely supporting the beamline operation.

This beamline was commissioned in February 1998 and opened to the public users on April 1998. This beamline has been successfully operating since then and was shown various exciting results.

2. Light Source and Monochromator

The light source is a twin helical undulator. It has two helical undulators installed in tandem in a 4.5 m straight section. The fundamental radiation covers an energy range from 0.2 to 3 keV.

The downstream undulator can be reversed. If the helicity of the two undulators is set to be opposite, either left or right circularly polarized light can be used when the gap of one undulator is opened.

Figure 1 shows the major optical elements of the BL25SU. The optical system consists of three main parts: the prefocusing mirrors, the monochromator adopting plane gratings with varied line spacing, and the post focusing mirrors. A detailed description of the optical system has been reported in Ref. 1.

The photon energy range from 500 to 1,500 eV is covered by the G_2 grating (central groove spacing of 1/600 mm) with the resolution $E/\Delta E \sim 4{,}000$ in 1998. Further improvements to the system have been going on since early 1999.

3. End Stations

3.1 HRPES Station

High resolution photoemission spectroscopy (HRPES) can be carried out with the GAMMA-SCIENTA SES200 hemispherical analyzer. The sample temperature can be controlled from ~ 20 to 300 K by a cryostat (closed-cycle He refrigerator) and a heater.

Prof. Suga's group (Osaka University) conducted the first experiment done on Ce 3d-4f resonant photoemission at this station. The results are described elsewhere [2]. In brief, the spectra with a total energy resolution of ~ 0.2 eV clearly showed a significant difference in the Ce 4f states between the bulk and surface.

3.2 MCD Station

The magnetic circular dichroism (MCD) of core absorption can be measured at the 2nd experimental station. The total electron yield method is employed for the absorption measurement. A 1.4 T magnetic field is applied to a sample by using two couples of permanent magnet dipoles. The magnetic field is alternatively reversed by setting one of the dipoles on the optical axis with a motor-driven linear feedthrough. Two absorption spectra for evaluating MCD are taken in parallel by reversing the magnetic field at each photon energy. The sample temperature can be controlled from ~ 20 to 300 K by using a cryostat and a heater.

A test measurement on ferromagnetic Nickel showed a clear MCD signal in the 2p absorption region.

One of the first experiments on ordered Pd-Fe alloys at Fe 2p indicated that the contribution of the orbital angular momentum on the Fe site was enhanced by increasing the Pd concentration [3].

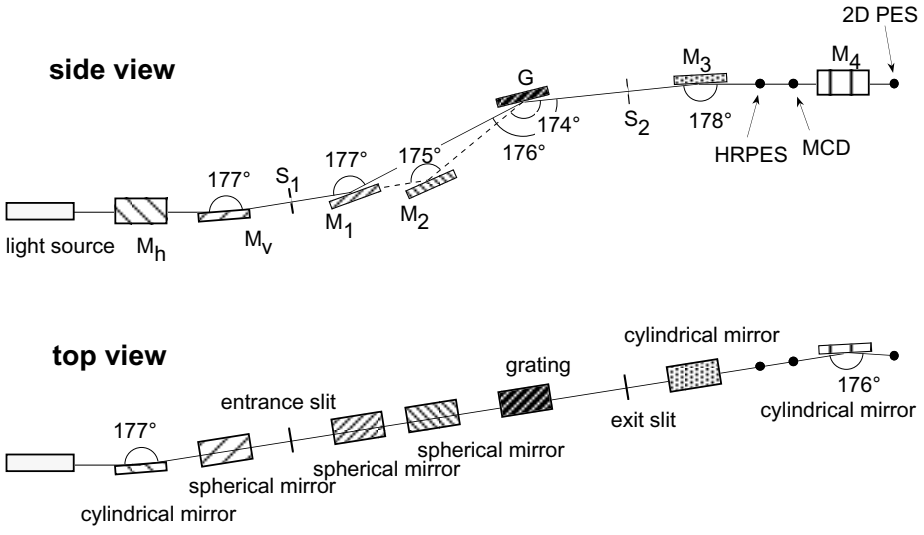

Fig. 1. Schematic layout of BL25SU.

3.3 2D-PES Station

The groups of Prof. Daimon (Nara Institute of Science & Technology) and Prof. Suga tested a 2-dimensional display-type photoelectron analyzer for angle resolved photoemission and photoelectron diffraction experiments using an electron gun. This instrument is located at the 3rd experimental station in Fig. 1.

The first experiment is planned in early 1999.

Samples are introduced from entry air-lock systems in the above three systems.

3.4 The 4th Station

Prof. J. Kirshner (Max-Planck-Institute of Microstructure Physics, Germany) and Prof. Suga cooperated on a study using the space at the end of the beamline (in the rear of the 2D-PES station) from November 1998 to March 1999. They used a PEEM (Photoelectron Emission Microscope) transported from Germany and studied the magnetic and electronic structures of thin film micro and nanostructures using the MCD effect.

References

[1] Y. Saitoh *et al.*, J. Synchrotron Rad. **5** (1998) 542.
[2] A. Sekiyama *et al.*, Solid State Commun. **111** (1999) 373-378.
[3] T. Muro *et al.*, in preparation.