UVSOR Facility

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Outline of UVSOR

Since the first light in 1983, UVSOR has been successfully operated as one of the major synchrotron light sources in Japan. After the major upgrade of the accelerators in 2003, UVSOR was renamed to UVSOR-II and became one of the world brightest low energy synchrotron light source. In 2012, it was upgraded again and has been renamed to UVSOR-III. The brightness of the electron beam was increased further. Totally, six undulators were installed. The storage ring is operated fully in the top-up mode, in which the electron beam intensity is kept constant.

The UVSOR accelerator complex consists of a 15 MeV injector linac, a 750 MeV booster synchrotron, and a 750 MeV storage ring. The magnet lattice of the storage ring consists of four extended double-bend cells with distributed dispersion function. The storage ring is normally operated under multi-bunch mode with partial filling. The single bunch operation is also conducted about two weeks per year, which provides pulsed synchrotron radiation (SR) for time-resolved experiments.

Eight bending magnets and six undulators are available for providing SR. The bending magnet with its radius of 2.2 m provides SR with the critical energy of 425 eV. There are fifteen beam-lines operational. They can be classified into two categories. Twelve of them are the so-called "Open beam-lines," which are open to scientists of universities and research institutes belonging to the government, public organizations, private enterprises and those of foreign countries. The other three beam-lines are the so-called "In-house beamlines," which are mainly used by the research groups within IMS. We have 1 soft X-rays (SX) station equipped with a double-crystal monochromator, 7 EUV and SX stations with a grazing incidence monochromator, 3 VUV stations with a normal incidence monochromator, 2 (far) infrared station equipped with FT interferometers and 1 beam-line for light source development without monochromator.

Figure 1. UVSOR electron storage ring and synchrotron radiation beam-lines.

Collaborations at UVSOR

Variety of investigations related to molecular/material science is carried out at UVSOR by IMS researchers. In addition, many researchers outside IMS visit UVSOR to conduct their own research works. The number of visiting researchers per year tops about 800, whose affiliations extend to 60 different institutes. International collaboration is also pursued actively and the number of visiting foreign researchers reaches over 80, across 10 countries. UVSOR invites new/continuing proposals for research conducted at the open beamlines twice a year. The proposals from academic and public research organizations (charge-free) and from enterprises (charged) are acceptable. The fruits of the research activities using SR at UVSOR are published as a UVSOR ACTIVITY REPORT annually.

Recent Developments of the Facility

In spring, 2012, we had three month shut-down for a reconstruction work towards UVSOR-III. The storage ring was successfully commissioned in July 2013. Although the operation was less stable for a few months than before, as the result of the fine tunings of the accelerators and of the vacuum conditioning via irradiation of synchrotron radiation, it has been improved gradually.

A scanning transmission X-ray microscope (STXM) beam-line, which was constructed as a part of the UVSOR-III upgrade program, was successfully commissioned.

Another upgrade program has been funded in 2012, in which the BL5U photoemission spectroscopy beam-line would be reconstructed as well as its light source, the variable polarization undulator. The designs were completed and the fabrications were started. The apparatuses will be installed in March 2014.

Figure 2. New STXM beam-line.

Reserch Highlight 2012

Topological insulators have become one of the model systems to study Dirac physics in solids. An essential ingredient in realizing a topological insulator is the parity inversion induced by the strong spin–orbit coupling. From this viewpoint, bismuth (Bi), which is virtually the heaviest non-radioactive element, has been the main building block. Nowadays many Bi alloys are known as topological insulators, although Bi itself is trivial. In these alloys, inhomogeneity may be introduced due to the complicated elemental composition. Therefore, searching for other ways to produce novel topological materials with a simple, well-defined structure, is important.

In this study, we have attempted to change the topological property of Bi by changing its lattice constant. We have fabricated Bi films on Bi_2Te_3 substrates and measured the band dispersion with angle-resolved photoemission spectroscopy. Due to the small in-plane lattice mismatch between Bi and Bi_2Te_3 (~3.6%), Bi can be grown epitaxially on Bi_2Te_3 from 1 BL.[1)] Figure 1(a) shows the band dispersion of a 7 BL Bi film on Bi_2Te_3. Compared to the 7 BL Bi film grown on Si(111)-7×7 [Figure 1(b)], the band dispersion is significantly different near the Γ point. This band dispersion was reproduced by ab inito calculations for a free standing Bi slab when the experimentally obtained lattice parameters were used. Furthermore, by calculating the 3D Z_2 topological for this strained Bi, we have found that the originally trivial Bi becomes nontrivial. Thus it is shown that the topological propertiy of Bi can be changed by inducing a small change in the lattice parameter.[2)]

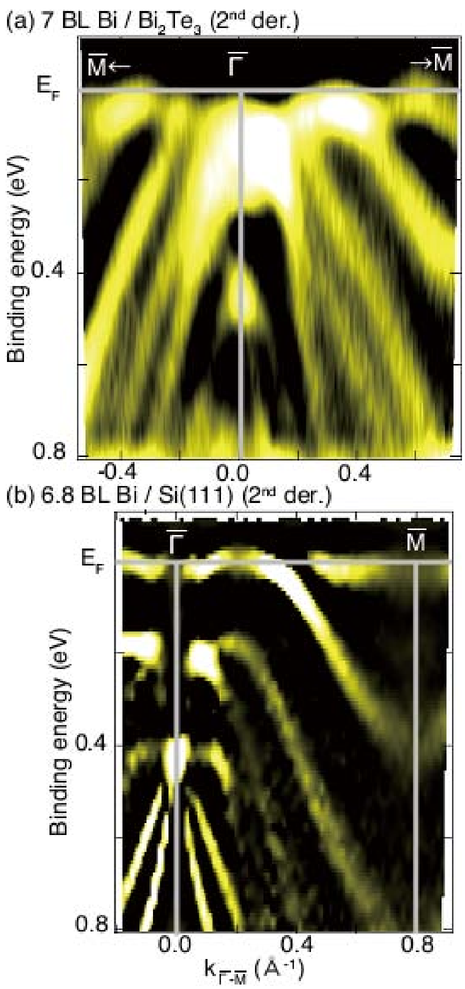

Figure 3. The band disperion of a 7 BL Bi(111) film grown on Bi_2Te_3 (a), and that on Si(111) (b).

References

1) T. Hirahara *et al.*, *Phys. Rev. Lett.* **107**, 166801 (2011).
2) T. Hirahara *et al.*, *Phys. Rev. Lett.* **109**, 227401 (2012).