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. It 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 four 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 twelve beam-lines operational at UVSOR, two beam-lines under commissioning, one under construction. The operational beam-lines can be classified into two categories. Nine of them are the so-called "Open beamlines," 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 dedicated to the use of 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, 1 (far) infrared station equipped with FT interferometers.

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 work. 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 fruit of the research activities using SR at UVSOR is published as a UVSOR ACTIVITY REPORT annually. The refereed publications per year count more than 60 since 1996.

Recent Developments of the Facility

In 2011, a new undulator system dedicated for coherent light production was constructed as shown in Figure 2. This new undulator will be used for coherent light generation both in the UV-VUV range and in the THz range. This will be also used for the resonator free electron laser.

In spring, 2012, we had three month shut-down for a reconstruction work towards UVSOR-III. We have replaced all the bending magnets in the storage ring with combined function ones which are capable of producing defocussing fields as well as the dipole fields. A new in-vacuum undulator was installed. This will be used for a scanning transmission X-ray microscope (STXM) beam-line, which is also under construction.

Figure 2. New Undulators installed in 2011. The upper is the variable polarization optical klystron undulator which will be used for coherent light generation. The lower is the in-vacuum undulator for the STXM beam-line.

Reserch Highlight 2011

A New Two-Dimensional Topological Insulator —Successful Formation of a Bilayer Bismuth

Topological insulators are a new state of matter which is gaining increased attention in condensed matter physics. While the bulk is an insulator, they have metallic edge (surface states) and these edge states have similar properties with magnets even though the bulk is not a magnet. There are hopes to develop novel devices utilizing this intriguing property.

In this work,[1)] a way to fabricate a new two-dimensional topological insulator has been found. The remarkable thing about this material is that it is only two-atomic layers (bilayer) thick made of bismuth. While it is not impossible to make such a thin material in the atomic scale (for example, the Noble physics prize in 2010 was awarded to physicists who studied graphene, a single atomic-layer sheet of carbon), it still remains to be a big challenge. The present finding should accelerate researches to further understand the exotic properties of topological insulators as well as for application in atomic-scale devices and quantum computation.

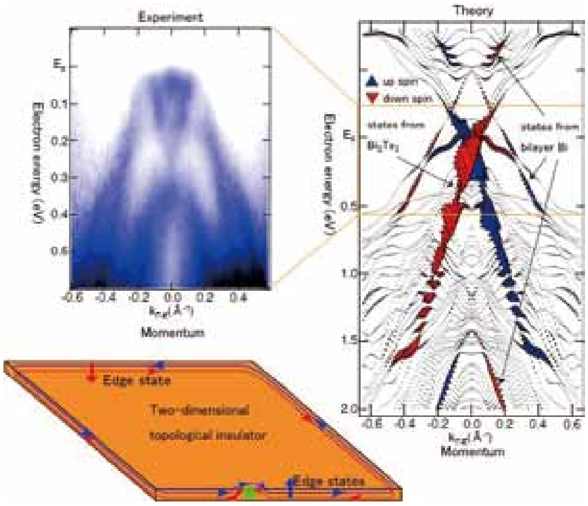

Figure 3. The experimental band dispersion of Bi(111) bilayer on Bi_2Te_3 measured experimentally (left) and its corresponding first-principles calculations (right). The left bottom figure shows the schematic drawing of a two-dimensional topological insulator.

Reference

1) T. Hirahara, G. Bihlmayer, Y. Sakamoto, M. Yamada, **H. Miyazaki**, **S. Kimura**, S. Blugel and S. Hasegawa, *Phys. Rev. Lett.* **107**, 166801 (5 pages) (2011).