UVSOR Facility

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Outline of UVSOR

After the major upgrade in 2003, UVSOR was renamed to UVSOR-II and became one of the world brightest low energy synchrotron light source. 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. Since July, 2010, the storage ring has been operated for users fully in so-called top-up mode, in which the electron beam intensity is kept almost constant at 300 mA. 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 utilizing SR. The bending magnet with its radius of 2.2 m provides SR with the critical energy is 425 eV. There are 12 beam-lines operational at UVSOR, which can be classified into two categories. 8 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 4 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. Overview of the UVSOR storage ring room.

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 2010

We have started operating the machine in the top-up injection mode for 100% of the users' beam time since the fiscal year 2010, both in the multi- and single-bunch operations. The beam current is kept approximately constant at 300 mA for the multi-bunch mode. As a result, the average beam current increased by about 40%, comparing with that of the previous year, as shown in Figure 2.

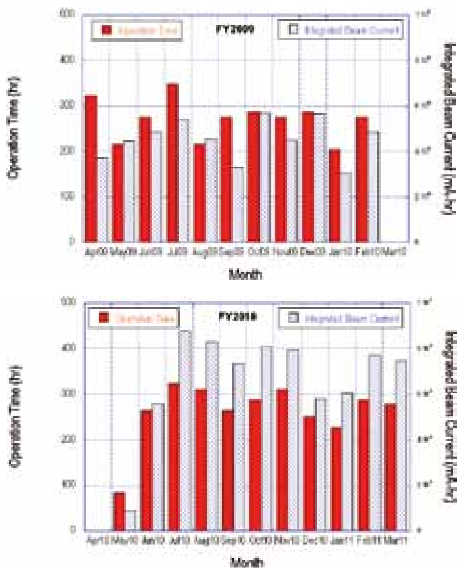

Figure 2. Monthly Statistics of UVSOR Operation. The red bars are for the operation time (hr) and the blue-hatched bars are for the integrated beam current (mA-hr). The increase of the integrated beam current is significant while the operation time did not increase so much, comparing with FY2009 (upper) and FY2010 (lower).

In spring 2010, we have installed a new undulator, which will be used for light source developments under the support of Quantum Beam Technology Program by MEXT. New dedicated beam lines to extract coherent synchrotron radiation in THz and VUV range are under construction. To realize this, two operational beam lines were moved to other sections, and one of them has been completely renewed.

A new upgrade program is in progress, in which all eight bending magnets will be replaced to reduce the emittance more. One new undulator will be installed at the last straight section reserved for an insertion device. A novel EUV micro-spectroscopy beam line will be constructed. This upgrade will be completed in summer 2012. Then, we will call our machine UVSOR-III.

Reserch Highlight 2010

Nodeless Superconducting Gap in $A_xFe_2Se_2$ (A = K, Cs) Revealed by Angle-Resolved Photoemission Spectroscopy

Recently, a new series of iron-based superconductors, $A_xFe_2Se_2$ (A = K, Cs), has been discovered with relatively high transition temperature of ~30 K.[1] Angle-resolve photoemission spectroscopy experiment on $A_xFe_2Se_2$ (A = K, Cs) was conducted at BL7U.[2]

Figure 3 (a) reveals the photo emission intensity map along out-of-plane momentum (k_z) in the ΓZAM plane. The cross-sections of the κ and δ Fermi surfaces clearly show weak dispersion along the k_z direction, indicative of a rather two-dimensional electronic structure. The spectral weight of κ increases from Γ to Z, and a small electron pocket could be clearly observed for the κ band around Z [Fig. 3 (b)]. This gives an electron pocket around Z with its residual spectral weight extending towards Γ. However, we emphasize that the size of the κ pocket is much smaller than that of the δ pocket, which is rather k_z-independent. The experimental Fermi surface topology clearly shows that there is no hole Fermi surface near the zone center, and $A_{0.8}Fe_2Se_2$ is indeed the most heavily electron-doped iron-based superconductor by far.

Our data show that the rather robust superconductivity in such a highly electron-doped iron-based superconductor could mainly rely on the electron Fermi surfaces near M. Thus, the sign change in the $s_{\pm}$ pairing symmetry driven by the inter-band scattering as suggested in many weak coupling theories becomes conceptually irrelevant in describing the superconducting state here. A more conventional s-wave pairing is probably a better description.

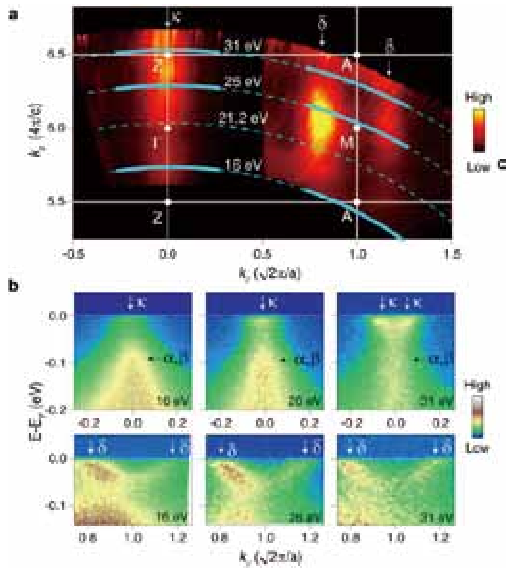

Figure 3. The Fermi surface and band structure as a function of k_z for $K_{0.8}Fe_2Se_2$.

References
1) J. Guo *et al.*, *Phys. Rev. B* **82**, 180520 (2010).
2) Y. Zhang *et al.*, *Nat. Mater.* **10**, 273 (2011).