UVSOR Facility

KOSUGI, Nobuhiro	Director
KATOH, Masahiro	Professor
SHIGEMASA, Eiji	Associate Professor
KIMURA, Shin-ichi	Associate Professor
HOSAKA, Masahito	Assistant Professor*
MOCHIHASHI, Akira	Assistant Professor
ITO, Takahiro	Assistant Professor
HIKOSAKA, Yasumasa	Assistant Professor
HORIGOME, Toshio	Technical Associate
NAKAMURA, Eiken	Technical Associate
YAMAZAKI, Jun-ichiro	Technical Associate
HASUMOTO, Masami	Technical Associate
SAKAI, Masahiro	Technical Associate
HAYASHI, Kenji	Technical Associate
KONDO, Naonori	Technical Associate
HAGIWARA, Hisayo	Secretary

Outline of UVSOR

The UVSOR accelerator complex consists of a 15 MeV injector linac, a 600 MeV booster synchrotron, and a 750 MeV storage ring. The magnet lattice of the storage ring is the so-called double-bend achromat. The double RF system is routinely operated for the user beam time, and the lifetime of the electron beam has been improved to around 6 hours at 200 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. Initial beam currents stored under multi-bunch and single-bunch modes are 350 mA and 70 mA, respectively.

Eight bending magnets and three insertion devices are available for utilizing SR. The bending magnet with its radius of 2.2 m provides SR, whose critical energy is 425 eV. After completing the upgrade project, there are 14 beamlines available in total (13 operational, and 1 under construction) at UVSOR, which can be classified into two categories. 9 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 rest of the 5 beamlines 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, 8 EUV and SX stations (one of them is under construction) with a grazing incidence monochromator, 3 VUV stations with a normal incidence monochromator, 1 (far) infrared station equipped with FT interferometers, 1 station with a multi-layer monochromator.

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) as well as 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. In recent five years, the number of beamlines has been reduced from 22 to 14. The upgrade project of the UVSOR storage ring, in which the creation of four new straight sections and the achievement of much smaller emittance (27 nm-rad) were planned in 2002–2003, has been accomplished on schedule. The upgraded storage ring is named UVSOR-II. As seen in Figure 2, the numbers of users and related publications have shown an apparent upward tendency, since 2004.

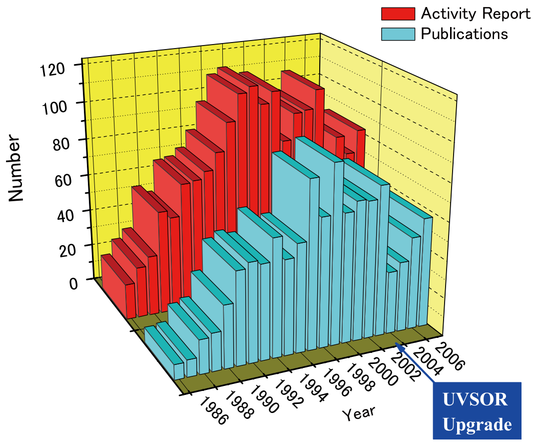

Figure 2. Number of publications resulting from UVSOR work and of users' reports in UVSOR ACTIVITY REPORT.

Highlights of Users' Researches 2006

1) VUV Reflectance Spectroscopy of Strongly Correlated Electron System

J. Fujioka, S. Miyasaka, Y. Tokura *(Univ. Tokyo, Osaka Univ.)*

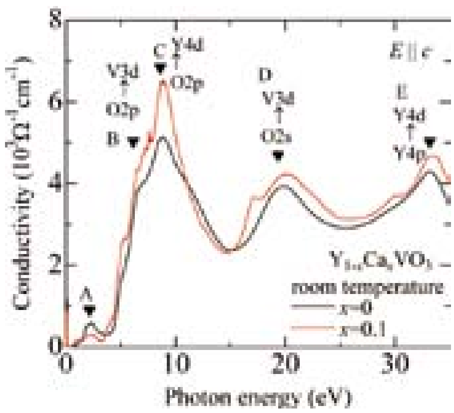

Figure 3. The optical conductivity spectra of $Y_{1-x}Ca_xVO_3$ $x = 0$ (black line) and $x = 0.1$ (red line), respectively.

The spin, orbital and charge degrees of freedom in the correlated electron system have been attracting much attention. The interplay among them leads to the versatile magnetic and/or electronic structure, even though the crystal structure is nearly cubic. The investigation of the electronic structure over wide energy range by the measurements of the reflectivity spectra is indispensable to reveal the spin-orbital-charge coupled phenomena associated with the insulator to metal transition.

We have measured the reflectivity spectra of the several transition metal oxides, including the V, Mn, Fe, Ni, and Cu ions, for an energy range between 4 eV and 35 eV. As an example, we focus on the optical conductivity spectra of the single domain crystals of the perovskite-type vanadium oxide $Y_{1-x}Ca_xVO_3$ as the prototypical Mott-Hubbard insulator, with two valence electrons in the 3*d* orbital of the nominally trivalent V ion with the spin configuration of $S = 1$.

In Figure 3, we show the optical conductivity spectra of $Y_{1-x}Ca_xVO_3$ $x = 0$ and $x = 0.10$ for E // c, which was measured at room temperature. We assigned the peak A around 2 eV to the Mott-gap excitation. A more intense peak (B) is observed around 7 eV, which is assigned to the charge transfer excitation from O2*p* to V3*d* level. Above 7 eV, three peaks (C, D, and E) are observed and we have assigned them to the excitations from O2*p* to Y4*d*, from O2*s* to V3*d*, and from Y4*p* to Y4*d*, respectively.

2) Phase Change of EUV Reflection Multilayer Measured by Total Electron Yields

T. Ejima, T. Harada, A. Yamazaki *(Tohoku Univ.)*

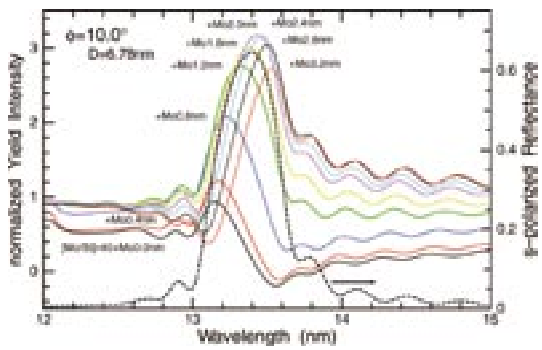

Figure 4. Total electron yield (solid curves) and reflection (broken curve) spectra of Mo/Si multilayers with varying top Mo layer thicknesses.

In the extreme ultraviolet (EUV) wavelength region, normal incidence mirrors are required to have extremely low aberrations. The surface milling method has been proposed for accurate correction of figure errors. It is essential to obtain information regarding the reflection phase in multilayer mirrors. In this study, reflection phase values for multilayer optics were obtained according to the formula derived from the total electron yield intensity and reflection in the multilayer.

Simultaneous reflection and TEY measurements for aperiodic Mo/Si multilayers are shown in Figure 4. In the TEY spectra, the main peak is observed clearly around 13.4 nm and the peak position shifts from 13.2 nm to 13.6 nm as the thickness of the top Mo layer increases. The phase term differences obtained from the reflection and TEY spectra are in accordance with the change in thickness of the top Mo layer. To evaluate the phase information, the present TEY intensity analysis has proved much easier than the Kramers-Kronig analysis of the reflection spectrum.

* Present Address; Nagoya University