UVSOR Facility

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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 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) 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. 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. The numbers of users and related publications have shown an upward tendency, since 2004.

Highlights of Users' Researches 2008

1) Modification of Gallium Oxide Photocatalyst with Mg Ions

K. Shimura, T. Yoshida, H. Yoshida *(Nagoya Univ.)*

The development of a hydrogen production method from renewable resources and natural energy would be important to realize a sustainable society. Photocatalytic steam reforming of methane (PSRM; $CH_4 + 2H_2O \rightarrow 4H_2 + CO_2$) is an attractive reaction because it has a potential to produce hydrogen from water and biomethane by using solar energy. We applied the Ga_2O_3 photocatalyst for PSRM and examined the loading effect of Mg ions on the structure and the activity of Ga_2O_3.

Mg K-edge XANES spectrum of MgO shows some peaks and Ga L_I-edge XANES of Ga_2O_3 was broad spectrum although both absorption edges are known to appear at 1307 eV (Figure 2 (a) and (f)). The spectra of Mg^{2+}-loaded Ga_2O_3 samples calcined at various temperatures were much different from each other (Figure 2 (b)–(d)). For the sample calcined at 773 K, the spectrum was similar to that of MgO. When the calcination temperature was higher than 1073 K, the spectra were the same as that of $MgGa_2O_4$ spinel. It was suggested that Mg ions would form $MgGa_2O_4$ spinel-like local structure by substituting for Ga ions at tetrahedral site when the calcination temperature was higher than 1073 K. The Mg ions in the bulk would improve the property of the Ga_2O_3 photocatalyst.

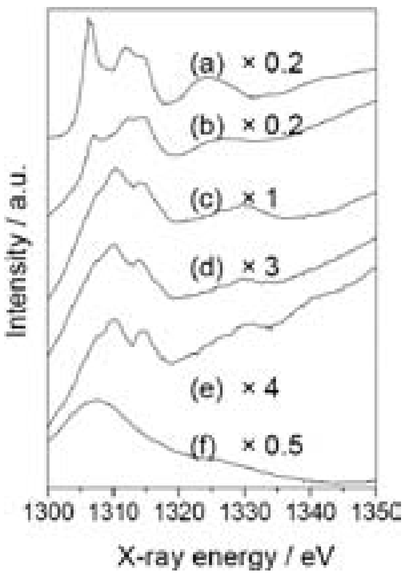

Figure 2. X-ray absorption spectra of (a) MgO, (b)–(d) Mg^{2+}-loaded Ga_2O_3 samples, (e) $MgGa_2O_4$ and (f) Ga_2O_3. Loading amount was 2 mol%. The calcination temperature was (b) 773 K, (c) 1073 K and (d) 1273 K, respectively.

2) Magneto-Optical Kerr Effect in $Nd_2(Mo_{1-x}Nb_x)_2O_7$

S. Iguchi, S. Kumakura, Y. Onose, Y. Tokura *(Univ. of Tokyo)*

The origin of the anomalous Hall effect (AHE) has long been discussed since 1960's in terms of the band effect by Karplus-Luttinger, the spin fluctuation, and the side jump, *etc*. Recent theoretical studies on the AHE due to the Berry phase or the spin-chirality mechanism are the quantum theoretical extension from the traditional perturbative treatment by Karplus-Luttinger, and have revealed the significance of the resonant effect at a small gap in band structure due to some kind of interaction, such as the spin–orbit interaction or the spin chirality. Magneto-optical Kerr effect (MOKE) is an extension of AHE with respect to the energy range. The MOKE measurements for $Nd_2Mo_2O_7$ with spin chirality and $Gd_2Mo_2O_7$ without it have revealed that there is an enhancement in the mid-IR region of the off-diagonal optical conductivity $\sigma_{xy}(\omega)$ originated from the spin chirality.

Figure 3 shows the spectra of the optical conductivity, the real and imaginary components of $\sigma_{xy}(\omega)$ in NMNO at 10 K. The $\sigma_{xx}(\omega)$ shows the correspondent change with the dc conductivity (metallic to insulating with increasing x) without remarkable anomaly such as a peak. In contrast, the characteristic peak structure was observed in the mid-IR range in the $\sigma_{xy}(\omega)$ as well as the continuity to the dc value. Especially, some of the peak-top values are larger than dc ones meaning the resonance effect is intrinsic for the off diagonal conductivity. The shift of the peak to higher energy is considered as the increase in the chemical potential by Nd doping.

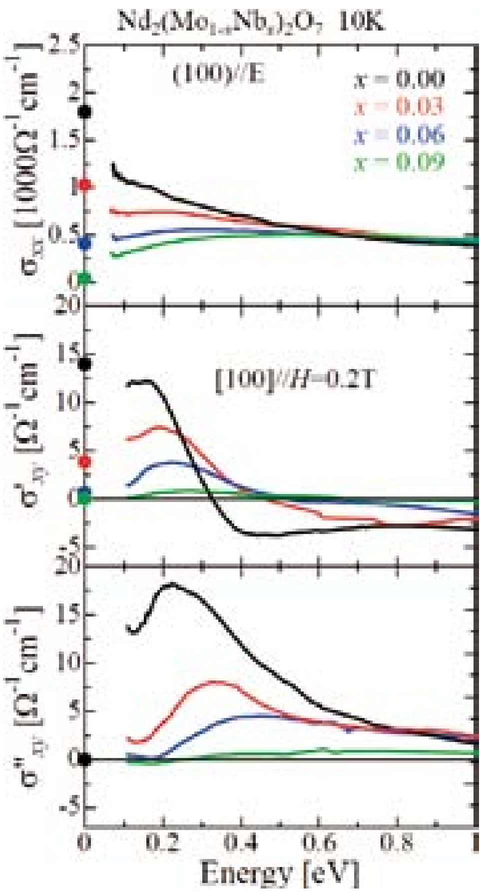

Figure 3. (a) The optical conductivity, (b) the real and (c) the imaginary part of off-diagonal optical conductivity in NMNO at 10 K.

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