Dissociative Photoionization Studies of Fullerenes and Carbon Nanotubes and Their Application to Dye-Sensitized Solar Cells

Department of Photo-Molecular Science
Division of Photo-Molecular Science III

KATAYANAGI, Hideki
Assistant Professor

We have observed the dissociative photoionization of the fullerenes. We studied the mechanisms and kinetics of C_2 release reactions from the fullerenes on the basis of the yield curves and the scattering velocity distributions of the fragments. We now intend to apply the above gas phase spectroscopy to functional materials such as carbon nanotubes (CNTs). Additionally we utilize the CNT to a catalytic counter electrode in dye-sensitized solar cells (DSSCs). This research aims at understanding the electron transfer phenomena from CNTs both in gas phase and in condensed phase.

1. Mass Resolved Velocity Map Imaging of Doubly Charged Photofragments from C_{60} and C_{70}

We have obtained 2D velocity images of the fragments from C_{60} and C_{70}. The 2D velocity images of fragments were found to be convolutions of isotropic center-of-mass velocity acquired by the C_2 emission and anisotropic velocity of C_{60} in the parent molecular beam.

2. Gas Phase Spectroscopy of CNTs

We have started to build a vacuum apparatus for the gas phase spectroscopy of CNTs. With the apparatus we will first perform experiments using the fullerenes and then improve the apparatus to achieve experiments using CNTs.

3. Development and Evaluation of CNT Catalytic Counter Electrodes for DSSCs

To improve photovoltaic energy conversion efficiency of the DSSC, the rate of charge transfer reaction on the counter electrode is important. We prepared the counter electrodes using commercial CNT aqueous dispersions. We have started the impedance spectroscopy of the CNT electrodes in order to elucidate the effect of series resistance of the electrodes on the performance of DSSC.

In-situ Soft X-Ray Spectromicroscopic Study of Chemical and Biological Systems

UVSOR Facility
Division of Beam Physics and Diagnostics Research

OHIGASHI, Takuji
Assistant Professor

We have constructed a scanning transmission X-ray microscope (STXM) beamline in the soft X-ray region at BL4U in the UVSOR-III facility.[1,2] One of the advantages of the STXM is a high tolerance for environments of samples. For example, vacuum is not required for samples and even the samples in water can be observed by using soft X-rays in the water window region (282 ~ 539 eV). This advantage enables the STXM to perform *in-situ* observation easily combined with a long working distance. Hence, we have been developing *in-situ* sample cells for the STXM measurement.

A schematic image of cross section of a liquid flow sample cell is shown in Figure 1. This sample cell uses two silicon nitride membranes of 100 nm thick as windows sealed by two O-rings. Liquid flows between a gap of the two membranes by using a tubing pump. Then, the gap width (*i.e.* thickness of the liquid) can be tuned by the pressure of helium gas in a main STXM chamber. As a test measurement, by changing the liquid from pure water to ethanol simply, their absorption spectra around oxygen 1s were measured (Figure 2). Recently, a window membrane with gold electrodes pettern was developed and *in-situ* measurement of electro-chemistry was performed.

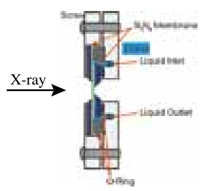

Figure 1. A liquid flow cell in section.

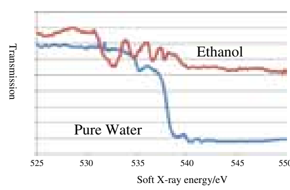

Figure 2. Transmission spectra of pure water and ethanol.

References

1) T. Ohigashi, H. Arai, T. Araki, N. Kondo, E. Shigemasa, A. Ito, N. Kosugi and M. Katoh, *J. Phys.: Conf. Ser.* **463**, 012006 (2013).
2) T. Ohigashi, H. Arai, N. Kondo, M. Sakai, K. Hayashi, E. Shigemasa, A. P. Hitchcock, N. Kosugi and M. Katoh, *UVSOR Activity Report* **40**, 43 (2013).