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

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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 $C_{60(70)-2n}^{z+}$ ($n \geq 1$; z = 1–3). We now intend to apply the above gas phase spectroscopy to functional materials such as carbon nanotubes (CNTs). Additionally we utilize the CNT as catalytic counter electrodes in dye-sensitized solar cells (DSSCs). This research aims at understanding the electron transfer reactions from CNTs both in gas phase and in condensed phase.

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

We observed mass resolved velocity map images of fragments produced by the photodissociation of the fullerenes.[1,2] However we have not obtained a two-dimensional (2D) projection of three-dimensional (3D) velocity distribution of each fragment. We installed a four-element imaging lens which enables us to completely resolve the fragment signals. We thus observed the 2D velocity image of each fragment. The 2D velocity image of C_{58}^{2+} was found to be a convolution of isotropic barycentric velocity distribution of C_{58}^{2+} and anisotropic velocity of C_{60} in the parent molecular beam.

2. Gas Phase Spectroscopy of CNTs

The gas phase spectroscopy used to elucidate the dissociation dynamics of the fullerenes is now applied to the CNT. We have started to design a vacuum chamber for the gas phase spectroscopy of CNTs. Meanwhile we have examined properties and suitable vaporization conditions of CNT samples using AFM and MALDI equipment. We are also seeking for methods for controlling the length of CNT. The gas phase spectroscopy of length selected CNT will allow us to understand properties of the CNTs as functions of their length.

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 found a simple method to produce the CNT counter electrodes with comparable efficiency to Pt electrodes.

References

1) H. Katayanagi and K. Mitsuke, *J. Chem. Phys. (Communication)* **133**, 081101 (4 pages) (2010).
2) H. Katayanagi and K. Mitsuke, *J. Chem. Phys.* **135**, 144307 (8 pages) (2011).