Contribution ID : **100** Type : **Invited Oral**

High resolution and radiation-damage free inverse photoelectron spectroscopy

Tuesday, 14 August 2018 15:30 (45)

Despite the importance, limited information has been available about the unoccupied states of organic semiconductors because of lack of a suitable experimental technique. Inverse photoelectron spectroscopy (IPES) is, in principle, an ideal tool to examine the unoccupied states; the electrons are introduced to the sample surface and the photons emitted due to the radiative transition to unoccupied states are detected, which can be regarded as the time-inversion process of photoelectron spectroscopy (PES). Particularly, to determine quantitatively the energies of the unoccupied states of such systems with large exciton binding energy as organic semiconductors, IPES can be a unique technique. In the previous IPES, however, the sample damage to the molecules was unavoidable owing to the electron bombardment and the energy resolution was limited to 0.5 eV.

In 2012, we developed low-energy inverse photoelectron spectroscopy (LEIPS) [1]. In order to reduce the sample damage, the kinetic energy of incident electron is lowered to less than 5 eV which is a typical damage threshold of the organic materials. By reducing the electron energy, the photons emit in the near-ultraviolet range leading to the improvement of energy resolution for the photon detection using the multilayer bandpass filters. Using LEIPS, the unoccupied states can be examined with the accuracy similar to the occupied states using PES.

This novel technique has been applied to organic semiconductors relevant to organic electronic devices [2] and to the fundamental research of organic semiconductors [3]. In the presentation, after discussing the principle of LEIPS, the recent advances of this technique will be reported.

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Session Classification : Speaker Sessions and Seminars

Track Classification : Vacuum Science and Technology