Interface Science
- Molecular Aggregates -

http://www.kuicr.kyoto-u.ac.jp/labos/is2/scope_J.html

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Scope of Research

The research at this subdivision is devoted to correlation studies on structures and properties of both natural and artificial molecular aggregates from two main standpoints: photoelectric and dielectric properties. The electronic structure of organic thin films is studied using photoemission and inverse photoemission spectroscopies in connection with the former, and its results are applied to create novel molecular systems with characteristic electronic functions. The latter is concerned with heterogeneous structures in microcapsules, biopolymers, biological membranes and biological cells, and the nonlinearity in their dielectric properties is also studied in relation to molecular motions.

Research Activities (Year 2002)

Presentations

Studies on Solid State Chemistry of Organic Thin films Centering on Observation of Their Electronic Structures, Sato N, The 8th Organic Crystals Symposium (Tokyo, Japan), 27 March.

Electronic Structures of Unoccupied States in Lithium Phthalocyanine Thin Films of Different Polymorphs Studied by IPES, Sato N, Yoshida H, Tsutsumi K, Sumimoto M (Kumamoto U.), Fujimoto H (Kumamoto U.), Sakaki S (Dept. Mol. Eng.), The 11th International Conference on Solid Films and Surfaces (Marseille, France), 8 - 12 June.

Dielectric Imaging of Biological Cells and Tissues by a Scanning Probe, Asami K, 2nd International Conference on Broadband Dielectric Spectroscopy and its Applications (Leipzig, Germany), 2 - 6 September.

Insulator-Conductor Transition in a Hydrated Crystal of Squaric Acid Induced by a High Electric Field, Kita Y, Terao H (U. Tokyo), Sugawara T (U. Tokyo), Sato N, The 2nd International Conference on Broadband Dielectric Spectroscopy and its Applications (Leipzig, Germany), 2 - 6 September.

Grants

Asami K, Manipulation of Single Biological Cells by AC Fields and Their Dielectric Spectroscopy, Grant-in-Aid for Scientific Research (C)(2), 1 April 2002 - 31 March 2004.

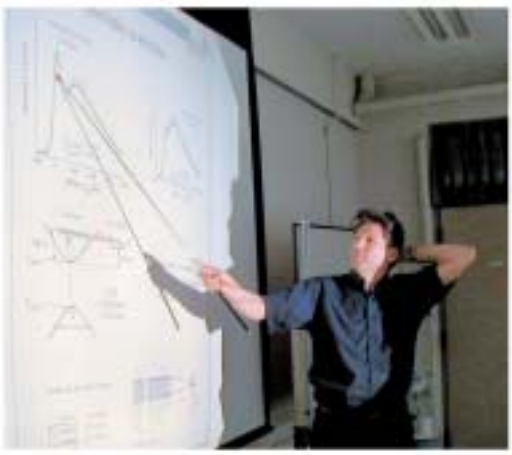
Tsutsumi K, Inverse Photoemission Spectroscopic Study on Contribution of Free Electron Nature to the Electronic Structure of Unoccupied States in Long Chain Alkanes, Grant-in-Aid for JSPS Fellows, 1 April 2002 - 31 March 2003.

Unoccupied electronic states in a hexatriacontane thin film studied by inverse photoemission spectroscopy

The electronic structure of low-lying unoccupied electronic states in a hexatriacontane (n-$C_{36}H_{74}$, HT) thin film was measured using inverse photoemission spectroscopy (IPES). While IPES permits direct observation of the unoccupied DOS, it is essential to avoid radiation damage and/or surface charging for the measurements of organic samples in particular. In this work it was practrically confirmed that the HT thin film is easily degraded by electron irradiation. In order to check these influences we measured IPE spectra with different current densities of incident electrons, and by reducing the current density gradually we finally obtained a reliable IPE spectrum free from radiation effects at the current density bringing about our signal detection limit as shown in Fig. 1(a).

As a result, we have concluded that the only IPE spectrum of HT reported previously by Dudde and Reihl was significantly influenced by the electron bombardment. The observed spectrum shows two distinct features near the vacuum level: they were not resolved in the reported spectrum. The reliable information of DOS for the lowest unoccupied states in HT seems to be first obtained here.

The two features correspond to those so far estimated from other electron spectroscopies, while uncertainty remains in the absolute energy of the IPE spectrum. Our spectrum is further compared with the reported results of theoretical calculations concerning the unoccupied electronic states in long chain alkanes. As a result, we have tentatively assigned the first and the second spectral features to $1b_{1u}$ and $2b_{3u}$ states, respectively, by comparing the intensity ratio for those features with that in the DOS estimated from the reported extended Hückel calculation.



Prof. Dr. Frank Willig from Hahn-Meitner-Institute, Berlin, Germany, gave a stimulating seminar.

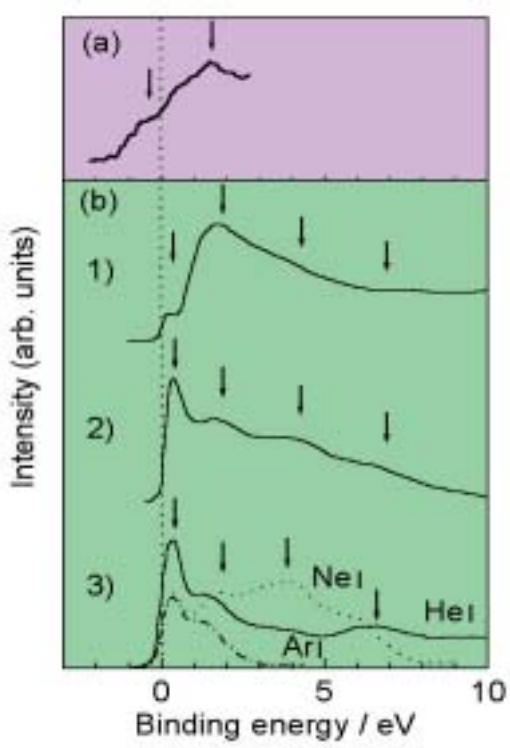


Fig. 1. The most reliable IPE spectrum of an HT thin film (a) obtained at the electron current density of 3.4×10^{-4} A m^{-2}, compared with the spectra regarding the lower unoccupied states of HT thin films obtained by the different electron spectroscopic methods: (b) 1) LEETS, 2) SEES and 3) UPS. Arrows indicate distinct spectral features. UP spectra were measured with different excitation energies indicated beside the respective spectra.

Dielectric imaging of biological cells and tissues using a scanning probe technique

For characterizing structural and electrical properties of biological cells and tissues, a dielectric imaging technique using a scanning fine probe is available. Since dielectric images of cells and tissues are closely related to their morphology, it is important to compare the dielectric images with optical ones directly. In this study, therefore, a scanning dielectric probe unit was assembled on an inverted optical microscope. The scanning probe unit consisted of an X-Y stage controlled by a computer, a fine coaxial probe and a chamber for samples that had an ITO glass electrode at the bottom. Dielectric measurement was made by the three-terminal method that can restrict the measurement to a small area because of eliminating fringing fields. The performance of the system was tested with well-defined nylon and stainless steel meshes in water, and also with epithelia of plant leaves in water, the lateral resolution being around 10 mm using a probe with a Pt wire of 25 mm in diameter.