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Doping in Organic Semiconductors: Impact of Trap Filling on Interface Control and Charge Carrier Mobility

Professor Antoine Kahn

Princeton University

Date & Time: October 1st (Mon), 2012, 13：00 - 14:00

Place: Meeting Room 2 (33B2), 3rd Floor, Engineering Bldg #2, The University of Tokyo

Abstract: This talk focuses on electronic states tailing in the gap of organic semiconductors and their passivation via doping. These states are known to have a significant influence on the electrical and electronic properties of thin films and, consequently, on the performance of devices. States that are deep in the gap act as undesirable carrier traps in charge transport, and affect both interface energetic and carrier mobility. We show the controlled passivation of acceptor tail states in fullerene C_{60} by the addition of a small number of electrons introduced by molecular n-doping. By extending doping to unprecedented ultra-low concentrations (molar ratio = $2x10^{-4}$ vs. 10^{-2}-10^{-1} usually used in organic electronics), we demonstrate the controlled progressive filling of the traps with charges released by the dopants, and examine the resulting changes in Fermi level position, conductivity, activation energy and mobility in the electron hopping process in C_{60} films. A clear transition in carrier transport is found when the dopant concentration reaches the trap density (~$9x10^{18}$ cm^{-3}), with most traps filled. The passivation of the traps leads to an increase in the effective electron mobility in C_{60} by more than three orders of magnitude, reaching 0.21 cm^2/V.s. Numerical simulations utilizing kinetic Monte Carlo method confirm an exponential tail of trap states and are in excellent agreement with the experimental data.

Biography: Professor Antoine Kahn received his PhD Degree from Princeton University in 1978. He is Professor of Electrical Engineering and Undergraduate Departmental Representative, Princeton University. His research programs center on the electronic, chemical, structural and electrical properties of materials relevant to thin-film electronic devices. His research interests span a range of semiconductor materials (elemental and compounds), but my current research focuses on organic molecular and polymer semiconductors, metals and metal oxides, and dielectrics developed for applications in organic and molecular electronics. His group is particularly interested in engineering materials and interfaces that improve the performance of organic light-emitting diodes (OLEDs), field effect transistors (OFETs), organic photovoltaic cells (OPVs), and other thin-film devices applicable to large-area, flexible electronics.

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