Kelvin Probe Force Microscopy and Its Application on Electrical Characterization of Organic Solar Cells

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Date: August 16, 2013 (Friday)
Time: 4:30pm – 5:30pm (Tea Reception at 4:15pm)
Venue: Room B6619 (MBE Conference Room), 6/F

Abstract

Kelvin probe force microscope (KPFM), a technique combining atomic force microscope (AFM) and Kelvin probe technology, has evolved into an effective tool to characterize electronic properties of materials and devices. However, there is lack of systematic analysis of its practical aspects such as resolution and sensitivity. In this presentation, I will first present the principle of KPFM and the analysis of resolution and sensitivity of KPFM. Then I will briefly introduce the mechanism of organic solar cells. The most efficient organic solar cell today is made from blending conjugated polymers (donors) and fullerene molecules (acceptors) together to form bulk heterojunctions at nanoscale. Most microscopic characterizations on organic solar cells using AFM are limited to the characterization of nanoscale roughness of the active layer of organic solar cells without providing the phase separation map. We have demonstrated that the phase separation can be identified through the phase image of AFM by further analysis. Carbon nanotubes are often introduced into the active layer of organic solar cells for efficiency enhancement. However, the electrical role of carbon nanotubes is controversial from the literatures. Some assume they are receptors that promote electron transport and others believe they are...
donors that enhance the hole mobility. Using KPFM, we are able to directly observe the charge transfer between carbon nanotubes and organic semiconductors. We have successfully examined the electrical properties of single-walled carbon nanotubes when they are blended with the conjugated polymer poly-3-hexylthiophene (P3HT) and phenyl-C61-butyric acid methylester (PCBM). From this study, we have concluded that single-walled carbon nanotubes work as donors in organic solar cells thus improve the hole transport. This conclusion can be cross-verified by the observation of hole mobility increase after blending carbon nanotubes into the active layers.

About the Speaker

Guangyong Li is currently an Associate Professor in the Department of Electrical and Computer Engineering at the University of Pittsburgh, Pittsburgh, PA. He received the B.S. degree in Mechanical Engineering from Nanjing University of Aeronautics and Astronautics, Nanjing, China, in 1992, the M.S. degree in Control Theory and Applications from Beijing Institute of Control Engineering, China Academy of Space Technology, Beijing, China, in 1999, and the Ph.D. degree in Electrical Engineering from Michigan State University, East Lansing, in 2006. His current research interests include Modeling, Simulation, and Characterization of Solar Cells; Micro/Nano Robotic Systems; Scanning Probe Microscopy; Nanodevices and Biosensors. He has published more than 30 papers in Journals and 70 papers in conference proceedings. Dr. Li and his co-authors received the 2006 IEEE Transactions on Automation Science and Engineering Best Paper Award.

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MBE Seminar 2013-2014/008