Correlating structure development to performance enhancement in organic semiconductor films

ERIC LIN, DEAN DELONGCHAMP, SHARADHA SAMBASIVAN, DANIEL FISCHER, National Institute of Standards and Technology — Measuring the structural development of organic semiconductor films and correlating it to the electrical characteristics of organic field effect transistors (OFETs) is a critical steppingstone to commercialization. Synchrotron-based Near-Edge X-ray Absorption Fine Structure (NEXAFS) spectroscopy is a powerful tool that can non-destructively reveal the structure and chemistry of thin organic films. The density of bonds involving carbon, nitrogen, oxygen, and fluorine can be quantified, a composition depth profile can be developed for the top (2-10) nm of the film, and bond orientation can be determined. We employ NEXAFS to investigate chemistry, molecular orientation, and defects in thin organic semiconductor films. These quantities are then correlated to OFET performance. Examples will include classical model systems such as pentacene and regioregular poly(3-hexylthiophene), as well as new molecules. Thermal processing-induced increases in molecular orientation will be described. Structure and performance enhancement by hydrophobic substrate modification will be discussed. Finally, the role of the semiconductor chemical structure itself will be considered. NEXAFS provides excellent correlation of processing to structure to performance, illuminating fruitful development vectors for next-generation materials.

Eric Lin
National Institute of Standards and Technology

Date submitted: 30 Nov 2004