UC San Diego

JACOBS SCHOOL OF ENGINEERING
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"Techniques for Measuring the Mechanical Properties of Organic Semiconductors"

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Abstract: Mechanical flexibility and deformability are at the core of the advantages offered by organic semiconductors. Therefore, an in-depth understanding of the mechanical properties of these materials is crucial to the design of robust organic electronic devices such as solar cells, sensors, and displays. Since these devices are typically fabricated as thin films, on the order of 200 nm, it can be difficult to measure the mechanical properties using traditional techniques such as tensile testing. This thesis examines and compares various methods of testing the mechanical properties of thin films and correlates the molecular structure of organic semiconductors to such properties. A collection of methods known as film-on-elastomer techniques were employed to measure the elastic modulus, yield point, and crack-onset strain in organic semiconductors. These methods were used to show a decrease in the stiffness and an increase in the ductility of small-molecule semiconductors that bear side-chains in the backbone structure. Film-on-elastomer methods were then compared to a technique called the film-on-water method that uses water to support thin films while conducting a tensile test. These methods were used to measure the mechanical properties of poly(3-hexylthiophene) in a range of molecular weight and the results were directly compared. Lastly, a technique known as scratch testing was used for the first time to measure the cohesion and adhesion of semiconducting polymers. The cohesive and adhesive strength were measured as a function of the length of the side chain in poly(3-alkylthiophenes) and molecular weight in poly(3-hexylthiophene).

Biosketch: Daniel Rodriquez Jr received his B.S. (2014) and M.S. (2015) in Nanoengineering from UC San Diego. Prior to attending UC San Diego he served for five years in the US Navy as an information systems technician, 2nd class. His current research in the Lipomi Research Group focuses on studying the mechanical properties of organic semiconductors, metrology for measuring these properties, and skin-wearable sensors for health monitoring.