Program in Polymers and Soft Matter

SEMINAR

Prof. Darren J. Lipomi

Department of NanoEngineering
University of California/San Diego

"Mechanical properties of semiconducting polymers for energy and virtual touch"

Summary

Mechanical deformability underpins many of the advantages of organic semiconductors in applications from flexible solar cells to wearable devices for healthcare and virtual touch. The mechanical properties of these materials are, however, diverse, and the molecular characteristics that permit charge transport can render the materials stiff and brittle. In this talk, I describe the ways in which molecular structure and solid-state packing structure govern the mechanical properties of organic semiconductors, especially of π-conjugated polymers. In particular, I describe how low modulus, good adhesion, and absolute extensibility prior to fracture enable robust performance, along with mechanical "imperceptibility" if worn on the skin. The discussion focuses on the mechanisms by which mechanical energy is either stored (i.e., elastically) or dissipated (i.e., by plastic deformation or fracture). Mechanical energy is mediated at the level of both the molecular structure (determined by synthesis) and solid-state packing structure (determined by processing techniques). Development of metrological methods are critical for the accurate determination of the mechanical properties of thin films of materials for which only small quantities are available from laboratory-scale synthesis. We often find that the interplay between the semiconducting polymer and the substrate influence the mechanical properties and the fracture behavior. Computational molecular dynamics simulations have been particularly helpful in predicting the molecular mechanisms responsible for deformation. The talk concludes with applications of organic semiconductor devices in which every component is intrinsically stretchable or highly flexible. Applications of these materials are in devices for portable solar energy and in wearable devices for virtual touch in virtual and augmented reality.

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University of California/San Diego

"Mechanical Properties of Semiconducting Polymers for Energy and Virtual Touch"

Summary

Mechanical deformability underpins many of the advantages of organic semiconductors in applications from flexible solar cells to wearable devices for healthcare and virtual touch. The mechanical properties of these materials are, however, diverse, and the molecular characteristics that permit charge transport can render the materials stiff and brittle. In this talk, I describe the ways in which molecular structure and solid-state packing structure govern the mechanical properties of organic semiconductors, especially of π-conjugated polymers. In particular, I describe how low modulus, good adhesion, and absolute extensibility prior to fracture enable robust performance, along with mechanical "imperceptibility" if worn on the skin. The discussion focuses on the mechanisms by which mechanical energy is either stored (i.e., elastically) or dissipated (i.e., by plastic deformation or fracture). Mechanical energy is mediated at the level of both the molecular structure (determined by synthesis) and solid-state packing structure (determined by processing techniques). Development of metrological methods are critical for the accurate determination of the mechanical properties of thin films of materials for which only small quantities are available from laboratory-scale synthesis. We often find that the interplay between the semiconducting polymer and the substrate influence the mechanical properties and the fracture behavior. Computational molecular dynamics simulations have been particularly helpful in predicting the molecular mechanisms responsible for deformation. The talk concludes with applications of organic semiconductor devices in which every component is intrinsically stretchable or highly flexible. Applications of these materials are in devices for portable solar energy and in wearable devices for virtual touch in virtual and augmented reality.

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