

## **Probing Nanoscale Energy Transport in Organic Semiconductors**

Organic semiconductors are conjugated molecular materials whose facile thin film processing and tunable optoelectronic properties have made them of interest for applications in light-emission, detection, and solar photoconversion. In addition, devices made from organic semiconductors can be integrated with mechanically flexible substrates, enabling novel form and functionality. Indeed, light-emitting devices (i.e. OLEDs) based on these materials have already been widely commercialized in mobile phones, with effort growing for their use in televisions, lighting, and solar energy conversion. Contrasting conventional inorganic semiconductors, the excited state in these materials is a tightly-bound electron-hole pair termed an exciton. As such, the design and performance of organic optoelectronic devices is often dictated by exciton diffusion, confinement, and recombination.

This talk will outline the importance of exciton transport in organic optoelectronic devices, and discuss how exciton diffusion can be probed and engineered. Excitons may be generated either as spin-zero singlets or spin-unity triplets. Singlets are fluorescent, and hence have been widely examined using a battery of spectroscopic techniques. Triplets are typically dark, and have not been studied as extensively. The first part of this talk will describe a solar-cell-based approach we have developed to probe dark exciton transport that is capable of yielding the intrinsic material exciton diffusion length. This method has been applied to small molecule and polymer organic semiconductors as well as to thin films of colloidal quantum dots. We have also used a variant of this technique to probe triplet exciton diffusion in materials capable of exhibiting singlet-fission. The second portion of this talk will examine the transport of interfacial excitons (i.e. charge-transfer states) along electron donor-acceptor interfaces found in organic solar cells and OLEDs. While the migration of these important energetic intermediates is often ignored in device operation, our recent work suggests they can be at least as mobile as their bulk counterparts. We show how this behavior can be engineered, offer insight into the mechanism for energy transfer, and compare the behavior of this state to those found at hybrid organic-inorganic interfaces.

**Department of Physics  
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**Theoretical and  
Applied Physics**

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Science  
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**Wednesday, February 19th**

**4:00 PM**

**Innovation Hall**

**Room E430**

**Refreshments will be available at**

**3:30 PM.**

**In E217**

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## **Short Biography**

Russell J. Holmes is a Professor and the Director of Graduate Studies in the Department of Chemical Engineering and Materials Science at the University of Minnesota (since 2006). He is a Distinguished University Teaching Professor and holds the Ronald L. and Janet A. Christenson Chair in Renewable Energy. His group carries out research in the optoelectronic characterization of organic and hybrid organic-inorganic thin films, as well as the application of these materials in devices for light-emission and solar photoconversion. Recently, emphasis has been placed on developing structure-property relationships governing energy transport, as well as engineering and understanding interfaces in devices. Prof. Holmes completed his B.Sc. (Honours) in Physics at the University of Manitoba in Canada, and his M.A. and Ph.D. in Electrical Engineering at Princeton University. Prof. Holmes recently completed a sabbatical leave at the University of Cambridge, where he was a Leverhulme Trust Visiting Professor and a Visiting Fellow at Clare Hall.