Physics Colloquium

Thursday, September 27, 2018 at 4:10PM in Lewis Lab. 316

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"Singlet Exciton Fission: Toward Molecular Packing Guidelines for Efficient Triplet Harvesting"

Singlet fission is a process unique to molecular photophysics that splits one spin-singlet exciton into two spin-triplet excitons. Incorporated into a solar cell, it has the potential to boost efficiencies beyond the single-junction Shockley-Quiesser limit of 31%. For the process to be practically relevant, however, the currently limited set of efficient materials available needs to be expanded considerably. To this end, much work has been done to establish guidelines for optimal chromophore structure and packing. Because singlet fission is a multi-step process, involving the formation, separation, and decoherence of a spin-correlated triplet pair intermediate, progress toward developing molecular packing guidelines has been slow and complicated. Most work, for example, has focused on better understanding and optimizing only the first step of the process, i.e., triplet pair formation. In this talk, I will discuss our efforts to develop molecular packing guidelines that simultaneously promote high triplet pair yields and long lifetimes—both essential parameters for efficient triplet harvesting. I will first describe our work elucidating the mechanism of singlet fission in solids (i.e., nanoparticles and films) of pentacene derivatives using transient absorption spectroscopy, which has brought renewed attention to two critically overlooked steps, namely, triplet pair separation and decay. I will then present several examples illustrating how molecular packing in various crystalline and amorphous-phase pentacene derivative solids simultaneously governs the yield and lifetime of triplet pairs, which in turn control overall triplet yields. This work represents an important advance toward establishing molecular packing guidelines for efficient triplet harvesting.

Dr. Ryan Pensack received his B.A. in chemistry from Rutgers–Newark University in 2006. For a portion of this time, he worked in the group of Prof. Richard Mendelsohn. Ryan earned his Ph.D. in chemistry from Penn State University in 2012 working under the direction of Prof. John Asbury. He worked as a postdoctoral research associate in the group of Prof. Gregory Scholes until 2017, first at the University of Toronto and subsequently at Princeton University. He is currently a staff scientist at Boise State University in the Nanoscale Materials and Device Group led by Profs. Bill Knowlton and Bernard Yurke. His primary areas of expertise and research interests include ultrafast and multidimensional optical spectroscopy, the structure and dynamics of molecular and semiconductor excitons, and nanoscale materials for energy and computing applications.