



Darren Johnson & Stacey York,
co-hosts

Jason D. Azoulay

The University of Southern Mississippi

Friday, April 26, 2019

Seminar at 2:30 pm, 331 KLA

Coffee reception prior at 2:00 pm

Narrow Band Gap Conjugated Polymers for Emergent Electronic Technologies

Research in the field of organic semiconductors has allowed for the development of commercially relevant technologies such as organic thin-film transistors, light-emitting diodes, photovoltaics, sensors, molecular electronics, and biocompatible medical materials. Research efforts in industry and academia remain unabated in areas where energy (in the form of light, electricity or heat) meet a wide variety of molecular and even biological systems. Despite the achievement of significant technological milestones, conformational disorder has complicated the identification of design guidelines to control the bandgap at low energies. Moreover, the synthesis of these materials is constrained by complex multistep synthetic procedures and conventional step-growth polycondensations. Collectively, these features preclude interactions with infrared (IR) light, prevent the study of fundamental physical phenomena, and constrain the design and realization of new optoelectronic and device functionalities.

Through the development of modular synthetic approaches and the extension of molecular conjugation via cross-conjugation, we have demonstrated the capability to systematically control the frontier orbital energetics (separation, position, and alignment), coplanarity of the conjugated backbone, intermolecular interactions, electronic structure, and many interrelated chemical, electronic, and structural factors that affect the degree of electronic correlation. The utility of these materials towards developing a better understanding of pertinent loss processes, understanding the nature of the transient species in light harvesting applications, and the development of new approaches toward IR optoelectronics will be discussed. Such synthetic control has also resulted in novel optical, transport, transient, spin, thermal, and magnetic behavior not previously measured in soft-matter (polymer) systems. This

discontinuity in the structure and dynamics of these materials as the bandgap continues to narrow is a manifestation of increasing electron correlations and, similar to their inorganic counterparts, leads to new emergent properties. Moreover, these materials are multiscale in their characteristic energy, length, and time scales. For example, fundamental excitations span the ultraviolet-visible-IR (intra- and intermolecular excited state transitions), microwave (between different spin states), and beyond. The combination of these unique aspects: modularity, novel physics, and easy manipulation have enabled new optoelectronic and device functionalities that cannot be realized with current semiconductor technologies.

Biography. Dr. Azoulay received his B.Sc. in Chemistry from the U. of Connecticut in 2004. After a short time in industry, he joined the research group of Prof. Guillermo C. Bazan at UC–Santa Barbara and completed his Ph.D. in Chemistry in 2010, with an emphasis on the synthesis and application of late metal catalysts for olefin polymerization. Afterwards, he performed postdoctoral fellowships at the Center for Polymers and Organic Solids at UCSB (2010-11) then Sandia National Labs (2011-14) in electronic and photonic materials research. He joined The Univ. of Southern Mississippi as an Assistant Prof. of Polymer Science and Engineering in 2014. His research group focuses on homogeneous and heterogeneous catalysis; electronic, photonic, and magnetic materials; and multidisciplinary investigations that address large scale objectives in materials development. In 2017, he was awarded 2nd place in the Nokia Bell Labs Prize competition for his work on optoelectronic materials and devices and in 2018 named Nina Bell Suggs Professor.