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Hybrid SEMINAR SERIES

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Seminar Presentation: 2:00pm – 3:00pm PDT
SME 248

"From the Katana, Swiss Chocolates to Organic Semiconductors — Phase Diagrams Applied to Photovoltaic Devices"

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Abstract:
In the past decade, significant progress has been made in the fabrication of polymer-based devices, such as organic light-emitting diodes (OLEDs), organic field-effect transistors (OFETs) and organic photovoltaics (OPVs), predominantly due to important improvements of existing materials and the creation of a wealth of novel compounds. Many challenges, however, still exist: from achieving reliable device fabrication, increasing the device stability and, more fundamentally, gaining a complete understanding how structural features over all length scales affect important optoelectronic and photophysical processes in such polymers, including charge transport, charge generation, and general photovoltaic processes. Here we demonstrate how classical polymer science tools can be used to elucidate the structure development of semiconducting polymers from the liquid phase, how such knowledge can be exploited to manipulate their phase transformations and solid-state order and, in turn, their electronic features and device performances. More specifically, we will illustrate how rules that explain the mechanical properties of the Katana and distinguishes good from lesser tasty chocolates can be applied to organic semiconductors to manipulate their properties and, hence, and their consequent performance when used as active layers in organic optoelectronic devices, with focus here on organic organic photovoltaic cells. Moreover, we discuss how the relatively new fast-calorimetry technique, that can measure samples at rates of up to 5,000 °C/s, can be used for the identification of thermodynamic transitions of donor polymers (e.g., PCDTBT) and acceptor molecules commonly used in the organic solar cell area. Examples are provided how the change in glass transition temperature of PCDTBT can be used to track polymer degradation upon light exposure. In short, we will demonstrate how thermal analysis can be exploited to obtain important structural information of organic solar cell materials (and beyond!), and processing guidelines can, in turn, be established towards materials of specific optical or electrical characteristics, and improved materials design for organic photovoltaic blends.

Biosketch:
Natalie Stingelin is a Full Professor at the Georgia Institute of Technology and Chair of the School of School of Materials Science & Engineering. She hold prior positions at Imperial College London, UK, at Queen Mary University of London, UK; the Philips Research Laboratories in Eindhoven, The Netherlands; the Cavendish Laboratories, University of Cambridge, UK; and the Swiss Federal Institute of Technology (ETH) Zürich, Switzerland. She is the Director of Georgia Tech's Center of Organic Electronics and Photonics, and was elected a 2021 Fellow of the U.S. National Academy of Inventors, a 2019 Fellow of the Materials Research Society; and is a Fellow of the Royal Society of Chemistry since 2012. Her research interests encompass the broad area of functional polymer materials, polymer physics, organic electronics & photonics, and bioelectronics.