NSERC CREATE **TOP-SET** Un programme *FONCER* du CRSNG

Séminaire

Le lundi 25 septembre 2023, 13h
ARC 233 et MS Teams
Le séminaire se déroulera en anglais.

Seminar

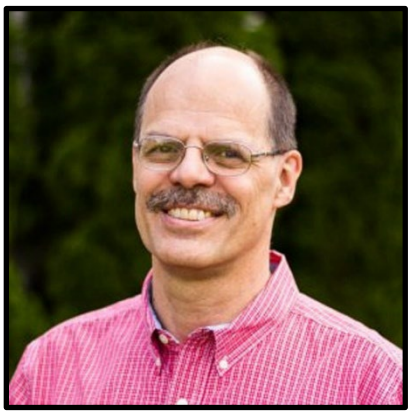
Monday, September 25, 2023, 1 p.m.
ARC 233 and MS Teams

Morphological and Mechanical Stability of Non-Fullerene Organic Solar Cells

Harald Ade, North Carolina State University

Abstract: Organic solar cells (OSCs) are one of the most promising cost-effective options for utilizing solar energy in high energy-per-weight or semi-transparent applications. Recently, the OSC field has been revolutionized through synthesis and processing advances, primarily through the development of numerous novel non-fullerene small molecular acceptors (NFA) with efficiencies now reaching >19% when paired with suitable donor polymers. The device stability and mechanical durability of these non-fullerene OSCs have received less attention and developing devices with high performance, long-term morphological stability, and mechanical robustness remains challenging, particularly if the material choice is restricted by roll-to-roll and benign solvent processing requirements and desirable ductility requirements. Yet, morphological and mechanical stability is a prerequisite for OSC commercialization. Here, we discuss our current understanding of the phase behavior of OSC donor:acceptor mixtures and the relation of phase behavior and the underlying hetero- and homo-molecule interactions to performance, processing needs (e.g., kinetic quenches), and morphological and mechanical stability. Characterization methods range from SIMS and DSC measurements to delineate phase diagrams and miscibility to x-ray scattering to determine critical morphology parameters and molecule packing and dynamic mechanical analysis (DMA) to assess specifically the hetero-interactions. The results presented and their ongoing evolution are intended to uncover fundamental molecular structure-function relationships that would allow predictive guidance on how desired properties can be targeted by specific chemical design. Comparative studies show that the molecular hetero-interactions between the donor and NFA are not always the geometric mean of the homo-interactions. This underscores the limited success often encountered when Hanson Solubility Parameters and surface energies are used to estimate molecular interactions. We will also present a vignette detailing some work at NCSU regarding the integration of organic photovoltaics into greenhouses [1-4].

[1] "Achieving net zero energy greenhouses by integrating semitransparent organic solar cells", E Ravishankar, RE Booth, C Saravitz, H Sederoff, HW Ade, BT O'Connor, Joule 4, 490-506 (2020)
[2] "Balancing crop production and energy harvesting in organic solar-powered greenhouses", E Ravishankar, M Charles, Y Xiong, R Henry, J Swift, J Rech, J Calero, et al. Cell Reports Physical Science 2, 100381 (2021)
[3] "Organic solar powered greenhouse performance optimization and global economic opportunity", E Ravishankar, RE Booth, JA Hollingsworth, H Ade, H Sederoff, et al. Energy & Environmental Science 15, 1659-1671(2021)
[4] "Beyond energy balance in agrivoltaic food production: Emergent crop traits from color selective solar cells", M Charles, B Edwards, E Ravishankar, J Calero, R Henry, J Rech, et al, bioRxiv (2022) doi: https://doi.org/10.1101/2022.03.10.482833



Bio: A graduate of Stony Brook University, Harald Ade has been a faculty member at NCSU since Nov. 1992, rising through the ranks to Full Professor by 2001, and been named Distinguished Professor of Physics in 2014 and Goodnight Innovation Distinguished Professor in 2017. He has had an active and continually funded research program and served as Director of Graduate Program in Physics from 2006-2013. Recognitions include R&D100 Award, NSF Young Investigator Award, APS Fellow, AAAS Fellow, Alumni Outstanding Research Award (twice, NCSU), Holladay Medal (NCSU), K. F. J. Heinrich Award, and Shirley Price for Outstanding Science and Halbach Award of Innovative Instrumentation (both at the Advanced Light Source). He is a Clarivate Analytics Highly Cited Researcher in the field of Materials Science since 2017, based in large part of his development of soft-ray

resonant scattering methods and it use in organic electronics. Some of his external engagements include serving on the Scientific Advisory Committee of the Advanced Light Source (2011- 2019) and the BESSY-II Synchrotron Facility in Berlin, Germany (2006-2009), as well as the Scientific Advisory Council of the Helmholtz Zentrum Berlin, Germany (2009 – 2012). He has conceived and coordinates interdisciplinary efforts at NCSU across the Carbon and Organic Electronics Laboratories (ORaCEL) and the Carbon Electronics Cluster as part of the NCSU Chancellor Faculty Excellence Program. He is Chair of the 15th International Symposium on Functional π-electron Systems (Fπ -15).

TOP-SET est un programme de formation FONCER du CRSNG en puissance optoélectronique ayant pour but de façonner une cohorte de personnel hautement qualifié détenant des connaissances approfondies en systèmes optoélectroniques pour joindre les rangs d'équipes de recherche et développement.

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NSERC CREATE Training in Optoelectronics for Power: from Science and Engineering to Technology (**TOP-SET**) is a training program that aims to form a cohort of highly qualified personnel with comprehensive understanding of optoelectronic systems, capable of joining advanced R&D teams.

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