Department of Physics
Condensed Matter Physics
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UNIVERSITY OF OXFORD

CONDENSED MATTER SPECIAL SEMINAR

Thursday 26 September at 2.15pm

"Molecular Doping for Organic and Hybrid Semiconductors: Challenges and Opportunities"

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Molecular doping is an effective tool to enhance bulk conductivity, increase carrier injection and de-activate electron or hole traps in organic molecular and polymer semiconductors. Considerable effort has therefore been directed toward the synthesis of powerful and stable p-type and n-type molecular dopants over the past decade.[1,2] This talk reviews a range of molecular redox agents used in organic electronics, with focus on strong reductants and oxidants for organic semiconductors with low electron affinity (EA) and large ionization energy (IE), respectively. In particular, we look at air-stable dimers, e.g. [RuCp*Mes]2, formed of 19-electron organometallic sandwich compounds able to reduce organic semiconductors with EA well below 3 eV.[3] We also look at powerful single-electron molecular oxidants, e.g. F6-TCNNQ and CN6-CP, with EA larger than 5.6 eV. The second part of the talk focuses on three applications of some these dopants at organic and perovskite surfaces and interfaces: (i) n-doping of electron injection and transport materials (POPy2 and F8BT, EA < 2.7 eV) used in green or blue OLEDs; (ii) surface n-doping of single-layer graphene, resulting in a reduction of its work function to ~2.6 eV, and enabling electron injection in POPy2 (EA = 2.2 eV) [4]; and (iii) the use of these molecular dopants as probes and modifier agents of surface gap states occupation and band bending at metal halide perovskite surfaces.

[1] Stephen Barlow, Seth R. Marder, Xin Lin, Fengyu Zhang and Antoine Kahn, Electrical Doping of Organic Semiconductors with Molecular Oxidants and Reductants, Handbook of Conducting Polymers (2019)
[2] Guo Song, Sang Bok Kim, Swagat Mohapatra, Yabing Qi, Tissa Sajoto, Antoine Kahn, Seth R. Marder, Stephen Barlow, n-Doping of Organic Electronic Materials Using Air-Stable Organometallics, Adv. Mat. 24, 699 (2012)
[3] Xin Lin, Berthold Wegner, Kyung M. Lee, Michael A. Fusella, Fengyu Zhang, Karttikay Moudgil, Barry P. Rand, Stephen Barlow, Seth R. Marder, Norbert Koch and Antoine Kahn, Beating the Thermodynamic Limit: Photo-Activation of n-Doping in Organic Semiconductors, Nature Materials 16, 1209 (2017)
[4] Fengyu Zhang, Chen Klein, Elena Longhi, Stephen Barlow, Seth R. Marder, Gabby Sarusi and Antoine Kahn, Molecular reductant-induced control of a graphene-organic interface for electron injection, Chem. Mat. (2019) DOI: 10.1021/acs.chemmater.9b00566

Host: Pabitra Nayak

Audrey Wood Room, Clarendon Building