Department of Physics
Condensed Matter Physics
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UNIVERSITY OF OXFORD

CONDENSED MATTER SEMINAR

Thursday 20 January at 14.00

"Bismuth-based solar absorbers: Carrier kinetics and indoor light harvesting"

Prof Robert Hoye
Imperial London

Lead-halide perovskites have emerged as a leading thin film solar absorber over the past decade. This has reinvigorated efforts to discover novel metal-halide semiconductors, particularly those which can address the toxicity and stability challenges faced by the lead-halide materials. Semiconductors based on bismuth have gained particular interest, owing to the electronic and chemical similarities between bismuth and lead cations, as well as the fact that bismuth-based compounds have demonstrated little evidence of toxicity [1]. This talk examines two bismuth-based compounds: Cs2AgBiBr6 and BiOI. These are "perovskite-inspired materials" because Cs2AgBiBr6 maintains the perovskite crystal structure, whilst BiOI replicates key features of the electronic structure of lead-halide perovskites that are thought to be conducive to defect tolerance.

For Cs2AgBiBr6, we examine the role of grain boundaries on carrier and ionic transport. We tune the grain size and use cathodoluminescence mapping to compare the degree of non-radiative recombination at grain boundaries vs. bulk. Through transient current measurements and field-effect transistor measurements, we elucidate the role of grain boundaries on ion migration [2].

For BiOI, we examine its tolerance toward its most common electronic defects through both experiment and computations [3]. By developing an all-inorganic device structure, we achieve external quantum efficiencies up to 80% at 450 nm wavelength, and demonstrate the devices to be stable after several months of storage. Whilst the bandgap of BiOI (1.9 eV) is too wide for outdoor photovoltaics, we show that it is ideally suited to indoor light harvesting, and we demonstrate BiOI indoor photovoltaics that could power carbon nanotube inverters. We finish this talk by discussing the future potential of the wider family of bismuth-based semiconductors for indoor light harvesting to sustainably power the Internet of Things [4].

[1] Nat. Chem., 2010, 2, 336
[2] Li, Senanayak, …, Hoye. Adv. Funct. Mater., 2021, 31, 2104981
[3] Huq, Lee, …, Hoye. Adv. Funct. Mater., 2020, 30, 1909983
[4] Peng, Huq, Mei, …, Hoye, Pecunia. Adv. Energy Mater., 2021, 11, 2002761

Host: Prof Laura Herz
Zoom/ Audrey Wood room