Chemistry Departmental Seminar

Lead-free Perovskite-Inspired Materials for Indoor Photovoltaics

Thursday 26th November 11:00 – 12:00

Dr. Robert Hoye - Imperial College London

Dr. Robert Hoye leads the Energy Materials & Devices Group in the Department of Materials at Imperial College London, which focuses on the development of thin film semiconductors for clean energy conversion. Dr. Hoye completed his PhD at the University of Cambridge before becoming a Postdoctoral Research Associate at MIT. In 2016 he returned to the University of Cambridge as a College Research Fellow. From 2018, he took up the Royal Academy of Engineering Research Fellowship, initially at Cambridge, before moving to Imperial College as a Lecturer in January 2020.

Although halide perovskites have taken the photovoltaics field by storm, concerns over the toxic and easily accessible lead ontent have prompted a search for lead-free althernatives. However, perovskite-inspired materials have not matched the performance of lead-halide perovskites, and this is partly due to the wide band gaps of the materials, often in the range of 1.7-2.1 eV. These wide band gaps are, however, suitable for harvesting the indoor light spectrum, which spans mostly over the visible wavelength range and does not have strong irradiance in the infrared wavelength region. Indoor photovoltaics IPV) have the potential to play an important role in powering small, autonomous devices used indoors whch are part of the exponentially expanding Internet of Things ecosystem.
This talk firstly explores the application of two perovskite-inspired materials, bismuth oxyiodide (BiOI) and cesium antimony iodide-chloride ($Cs_3Sb_2(I,Cl)_9$), for IPV. We demonstrate that IPVs made from both materials are sufficient to power inverters. Furthermore, we show that the optically-limited efficiency of these materials, as well as a wide range of other materials in the broader perovskite-inspired materials family, have potential to outperform the industry-standard for IPV, hydrogenated amorphous silicon [1]. In the second part of this talk, we examine another perovskite-inspired material which is limited by its wide band gap: $Cs_2AgBiBr_6$ double perovskite. We show that the band gap can be lowered through alloying with Sb, and that mixed alloys of $Cs_2Ag(Sb_xBi_{1-x})Br_6$ have smaller band gaps than either of the pure compounds. Through detailed optical measurements and computations, we identify the source of this large band gap bowing to be due to the Type II band alignment between $Cs_2AgBiBr_6$ and $Cs_2AgSbBr_6$, as well as non-linear mixing between the atomic orbitals of Bi and Sb [2].

References

[1] Peng, Huq, Mei, …, Hoye, Pecunia. *Adv. Energy Mater.*, **2020**, Early View, 2002761. DOI: 10.1002/aenm.202002761
[2] Li, Kavanagh, …, Hoye. *J. Mater. Chem. A*, **2020**, *8*, 21780