

IET National Travel Award Report 2024

Dr Krishanu Dey

Postdoctoral researcher, Department of Physics & Junior Research Fellow, Worcester College University of Oxford Parks Road, Oxford OX1 3PU, United Kingdom

In July 2024, I was fortunate to be selected for one of the IET National Travel Awards to attend and present my work in the UK Semiconductors 2024 conference held during 8-9 July at the Sheffield Hallam University in Sheffield. Organized annually by the Institute of Physics (Semiconductor Physics Group), this is UK's annual conference in semiconductor research. As such, the conference this year was a great success with a record number of over 300 delegates and 41 exhibitors. The technical program consisted of 8 different symposiums, focusing on a range of topics including physics in semiconductors, optical devices, electronic devices, semiconductor materials and nanostructures, perovskites, wide bandgap semiconductors and 2D materials among others. In addition to the regular sessions of talks for each symposium, there were talks providing an update on the UK Semiconductor Strategy and introducing the new Innovation and Knowledge Centres (IKCs): the CORNERSTONE Photonics Innovation Centre for silicon photonics and the REWIRE IKC for next generation semiconductor power devices using wide and ultra-wide bandgap semiconductors.

In this conference, I delivered an oral presentation entitled "Suppression of Ion Migration and Compositional Instabilities in Mixed Lead-Tin Halide Perovskite Materials and Devices", which was based on my PhD research conducted at the world-leading Optoelectronics group at the Cavendish Laboratory, University of Cambridge. Despite the meteoric rise in the development of a variety of perovskite electronic and optoelectronic devices, the phenomenon of ion migration remains a common and longstanding Achilles' heel limiting their performance and operational stability. In particular, ionic screening of the applied gate potential especially near room temperature reduces the gate modulation of carriers in the semiconducting channel of lead (Pb) perovskite field effect transistors (PeFETs), resulting in inferior carrier mobilities and non-idealities in device characteristics. Similarly, ionic movements under light and/or bias have been shown to result in current-voltage hysteresis, open circuit voltage gain and short circuit current losses in operating Pb perovskite solar cells (PSCs). In my work, I showed that alloying Pb with Sn significantly suppresses the ionic transport in both PeFETs and PSCs using a range of electrical measurements, supported by density functional theory calculations. As a consequence of this, we also demonstrated reliable hysteresis-free p-type PeTFTs with high mobility reaching 5.4 cm²/Vs, which is one of the highest reported mobilities for 3D perovskite thin films. Moreover, due to the minimal influence of ionic migration under operation, we established FETs as a powerful platform to study the inherent physics of long-range charge transport and shallow traps for doped perovskite semiconductors. In terms of solar cells, we conducted scan-rate dependent J-V measurements and temperature-dependent impedance spectroscopy measurements to demonstrate that substituting lead with tin greatly suppresses the ion migration in halide perovskite optoelectronic devices. Finally, I also presented our work on the beneficial role of tin substitution on arresting the photoinduced halide segregation in mixed-halide perovskites.

Besides my talk, attending this conference was an excellent opportunity for scientists and engineers within the UK to discuss the latest developments in the field and build connections. As a relatively new postdoctoral researcher, I very much enjoyed networking with my peers during the poster sessions and tea and lunch breaks over those 2 days. Overall, this trip was really fruitful and enjoyable and therefore I wholeheartedly thank the IET for awarding me with a prestigious travel grant. I very much appreciate the support from IET over the last two years and I hope to continue working with them for times to come.



Photo: Krishanu Dey delivering his oral presentation



Photo: Networking during the poster session and coffee break