Combatting Light-Induced Halide Migration in Perovskites for Tandem Solar Cells

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Metal halide perovskites (MHPs) are a class of semiconductor materials which have recently achieved remarkable success in solar cells. With power conversion efficiencies in excess of 26%, solar cells based on polycrystalline perovskite thin films rival existing silicon technologies, and tandem solar cells offer even higher efficiencies.[1-2] Due to the rapid development of the field, much remains to be discovered about the basic physical and chemical properties of perovskite thin films and how these properties determine photovoltaic device efficiency.

MHPs adopt the ABX_3 structure as seen in the figure below, where A is a monovalent organic cation, B is a divalent metal cation, and I is a halide. For tandem solar cells, mixing halide ions allows the band gap of the MHP to be tuned to the 1.75 eV required for photocurrent matching in combination with existing, well-established silicon technology. However, when roughly equal proportions of iodide and bromide are present in a MHP, the material tends to segregate into bromide-rich and iodide-rich regions when exposed to light. This photoinduced halide segregation must be overcome before such MHP tandem cells can be commercialized, but the origin of this phenomenon is not fully understood.

This research project will seek to provide an understanding of the factors that lead to instabilities in mixed halide perovskites, ultimately with the aim of exploiting this knowledge to eliminate the problem and allow for tandem solar cells with long-term photostability. First, mixed halide films will be synthesized according to established methods. Using photoluminescence measurements to track the halide segregation, the project will then establish how the process is influenced by factors including temperature, laser excitation intensity, and applied bias.[3] Another focus of the project will be optical-pump/THz-probe (OPTP) spectroscopy, an ultrafast technique that directly probes mobile charge-carriers and allows for simultaneous determination of the charge-carrier mobility and charge-carrier dynamics on a sub-picosecond timescale.[4] It will also utilize many of the other spectroscopy and microscopy instrumentation at the university including the resources of the Warwick Centre for Ultrafast Spectroscopy (go.warwick.ac.uk/WCUS) and the Spectroscopy and Microscopy Research Technology Platforms. For specific questions regarding the project, please email Rebecca.Milot@warwick.ac.uk or a.d.wright@warwick.ac.uk. More information about the Warwick Ultrafast and THz photonics group can be found on our group website: go.warwick.ac.uk/ultrafast.

References

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4. Lloyd-Hughes, J.; Jeon, T. I., *J. Infrared Millim. Terahertz Waves* **2012,** *33* (9), 871-925.