MONASH University

Monash Centre for Electron Microscopy

Seminar

Light-Conversion Mechanisms in Metal Halide Perovskites for Photovoltaics

THURSDAY 4 APRIL, 2019

11.00am – 12.00noon

Lecture Theatre S12, 16 Rainforest Walk, Monash Clayton Campus

Professor Laura Herz

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Abstract:

Organic-inorganic metal halide perovskites have emerged as attractive materials for solar cells with power-conversion efficiencies now reaching 23%. This seminar will examine the fundamental photochemical and photophysical processes that have enabled these materials to be such efficient light-harvesters and charge collectors.

As photovoltaic power conversion efficiencies of single-junction cells approach the Shockley-Queisser limit, the recombination and mobility of charge-carriers will be limited only by intrinsic properties. We demonstrate that at the intrinsic limit, the mobility of charge-carriers is predominantly governed by interaction of carriers with optical vibrations of the lead halide lattice (Fröhlich interaction)[1]. Therefore, predictions of maximum attainable mobilities can be made from easily accessible parameters, such as LO phonon frequencies and limits of the dielectric function.[2]

In the absence of trap-mediated charge recombination, bi-molecular (band-to-band) recombination will dominate the charge-carrier losses near the Shockley-Queisser limit. We show that in methylammonium lead triiodide perovskite, such processes can be fully explained as the inverse of absorption,[3] and exhibit a dynamic that is heavily influences by photon reabsorption inside the material.[4]

[1] Wright, A. D.; Verdi, C.; Milot, R. L.; Eperon, G. E.; Pérez-Osorio, M. A.; Snaith, H. J.; Giustino, F.; Johnston, M. B.; Herz, L. M. Nature Communications 2016, 7, 11755

[2] Herz, L. M. ACS Energy Lett. 2017, 2, 1539 & JPC Letters 2018, 9, 6863

[3] Davies, C. L.; Filip, M. R.; Patel, J. B.; Crothers, T. W.; Verdi, C.; Wright, A. D.; Milot, R. L.; Giustino, F.; Johnston, M. B.; L. M. Herz, Nature Communications 2018, 9, 293

[4] Crothers, T. W.; Milot, R. L.; Patel, J. B.; Parrott, E. S.; Schlipf, J.; Müller-Buschbaum, P.; Johnston, M. B.; Herz, L. M. Nano Lett. 2017, 17, 5782

The Presenter:

Laura Herz is a Professor of Physics at the University of Oxford where she directs the Semiconductors Group at the Clarendon Laboratory. She received her PhD in Physics from the University of Cambridge in 2002 and was a Research Fellow at St John's College Cambridge from 2001 – 2003, after which she moved to a faculty position at Oxford Physics. Professor Herz has published more than 150 peer-reviewed research articles (20000 citations, h-index 55 – Google Scholar March 2019) and is currently listed by Clarivate Analytics/Web of Science as a Highly Cited Researcher. Her research interests lie in the area of organic, inorganic and hybrid semiconductors, including aspects such as photophysical and nano-scale effects, self-assembly, charge-carrier dynamics, energy-transfer and light-harvesting for solar energy conversion. Recently, she was awarded the Nevill Mott Medal and Prize by the Institute of Physics and the Friedrich-Wilhelm-Bessel Award of the Alexander von Humboldt Foundation. She is a Fellow of the Royal Society of Chemistry, the Institute of Physics, and University College Oxford.

Convenor: Professor Joanne Etheridge

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