DPhil Project in Condensed Matter Physics

Charge-carrier dynamics in perovskite materials for photovoltaics

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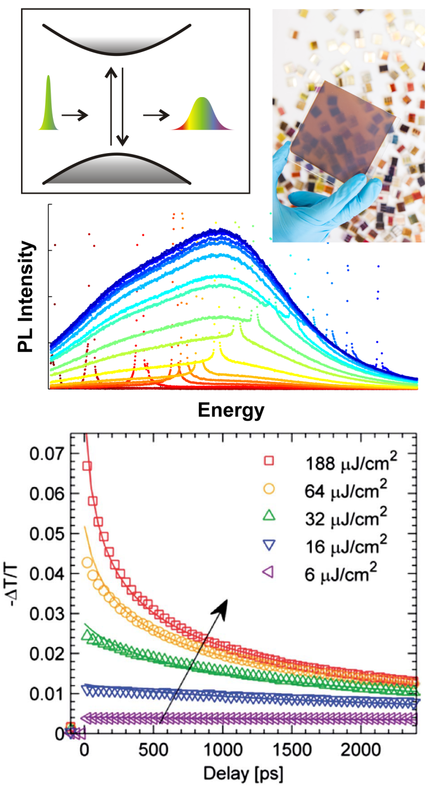

Increasing world needs for electrical power have intensified research into materials suitable for cheap and efficient solar cells. Solution-processed semiconductors offer great benefits in this area, as they can be easily processed into devices allowing cheap production of large-scale solar panels. To the great surprise of the photovoltaics community, a new generation of thin-film photovoltaic cells based on hybrid metal trihalide perovskite absorbers emerged suddenly over the last 2 years which rapidly reached power conversion efficiencies now exceeding 20% as materials control and device protocol improved. The methylammonium lead trihalide perovskite materials employed allow low-cost solution processing in air and absorb broadly across the solar spectrum, making them an exciting new component for low cost clean energy generation. However, this recent remarkable progress in the power conversion efficiency has been achieved mostly by an initially highly successful trial-and-error approach. The broad aim of this project is to develop a clearer understanding of fundamental parameters governing light-to-photocurrent conversion, which now holds the clue to further development of this material class for light-harvesting technologies. Currently, the research community is only starting to understand factors that have already been well established for most other photovoltaic materials, such as charge generation, recombination and diffusion, as well as the influence of basic material parameters such as composition, morphology, trap states and doping. During this project we will advance the efficiencies of these materials by gaining an understanding of fundamental photon-to-charge conversion processes using a combination of ultra-fast and quasi-steady state optical techniques, e.g. photoluminescence upconversion, THz pump-probe spectroscopy photoinduced absorption and photoconductivity. This spectroscopic project will be conducted as part of an active collaboration with other team members working on solar cell materials and device fabrication and development.

See also:

[1] *Stranks, Eperon, Grancini, Menelaou, Alcocer, Leijtens, Herz, Petrozza, and Snaith*, Science **342**, 341 (2013).

[2] *Wehrenfennig, Eperon, Johnston, Snaith, and Herz*, Advanced Materials **26**, 584 (2014).

[3] *Wehrenfennig, Liu, Snaith, Johnston, and Herz*, Energy Environ. Sci. **7**, 2269 (2014).

[4] *Wehrenfennig, Liu, Snaith, Johnston, and Herz*, J. Phys. Chem. Lett. **5**, 1300 (2014).

https://www-herz.physics.ox.ac.uk/research.html