The photophysics of hybrid lead halide perovskites

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Hybrid lead halide perovskites ('perovskites') – such as $CH_3NH_3PbI_3$ – are a family of solution-processible semiconductors first reported in 1978. Since 2012, they have received enormous attention as the active material in solar cells, with record power-conversion efficiencies of over 20% being achieved after only a few years of development. The possibility of distrupting existing solar technologies using abundant materials and simple, low-temperature manufacturing methods has driven rapid advances in our understanding of these materials over the last four years.

While their semiconducting characteristics are reminiscent of direct-bandgap semiconductors such as GaAs, the ionic nature of perovskites results in an intrinsic softness, giving rise to phenomena such as ionic conduction that must be understood and controlled to enable widespread implementation. Furthermore, the bandgap of perovskites is tunable throughout the entire visible spectrum, an attractive feature for use in multi-junction solar, light emitting, and lasing devices.

In this talk I will present an overview of the photophysics of perovskites, with particular focus on the spectroscopic investigations conducted by our group at CNST in Milan. This includes investigations of the relation between microstructure and electronic response,[1,2] the role of excitons,[3] the origin and nature of static and photoinduced trap states,[in preparation] and studies of nanocrystalline and confined structures.[4]

Acknowledgements
My colleagues at CNST, including principal investigator Annamaria Petrozza and director Guglielmo Lanzani. The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement no. 604032 of the MESO project.

References

[1] V. D'Innocenzo, A. R. Srimath Kandada, M. De Bastiani, M. Gandini and A. Petrozza. *J. Am. Chem. Soc.* (2014).
[2] G. Grancini, A. R. Srimath Kandada, J. M. Frost, A. J. Barker, M. De Bastiani, M. Gandini, S. Marras, G. Lanzani, A. Walsh and A. Petrozza. *Nat. Photonics* **9,** 695–701 (2015).
[3] V. D'Innocenzo, G. Grancini, M. J. P. Alcocer, A. R. S. Kandada, S. D. Stranks, M. M. Lee, G. Lanzani, H. J. Snaith and A. Petrozza. *Nat. Commun.* **5,** 1–6 (2014).
[4] Q. A. Akkerman, S. G. Motti, A. R. Srimath Kandada, E. Mosconi, V. D'Innocenzo, G. Bertoni, S. Marras, B. A. Kamino, L. Miranda, F. De Angelis, A. Petrozza, M. Prato and L. Manna. *J. Am. Chem. Soc.* **138,** 1010–1016 (2016).