Department of Physics
Condensed Matter Physics
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UNIVERSITY OF OXFORD

CONDENSED MATTER SEMINAR

Thursday 22 November at 2.15pm

"Highly luminescent lead halide perovskite nanocrystals: genesis, properties and applications"

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We review the important differences that exist in the chemistry and physics of colloidal lead halide perovskite nanocrystals (APbX3, NCs, A=Cs+, FA+, FA=formamidinium; X=Cl, Br, I) as compared to conventional semiconductor NCs made of metal pnictides and chalcogenides. We survey the the synthesis methods, optical properties and prospects of these NCs for optoelectronic applications [1, 2, 3].

The absorption spectral, sponaneous and stimulated emission spectra of these NCs are readily tunable over the entire visible spectral region of 400-800 nm by composition as well as by the NC size and shape [4-5]. Post-synthestic chemical transformations of colloidal NCs, such as ion-exchange reactions, provide an avenue to compositional fine tuning or to otherwise inaccessible materials and morphologies [6]. The photoluminescence of these NCs is characterized by narrow emission line-widths of 100 meV (12-45 nm from blue-to-near-infrared), wide color gamut covering up to 140% of the NTSC color standard, high quantum yields of up to 100%. With a new ligand capping strategy utilizing common and inexpensive long-chain zwitterionic molecules such as 3-(N,N-dimethyloctadecylammonio) propanesulfonate, a much better chemical durability can be attained [7]. Cs- and FA-based perovskite NCs are highly promising for luminescence downconversion (bright and narrow emission at 530 and 640 nm; backlighting for displays), for light-emitting diodes and as precursors/inks for perovskite solar cells. In particular, high purity colloids are ideal for further engineering as needed for photochemical/photocatalytic applications. Towards these applications, a unique feature is that perovskite NCs appear to be trap-free without any electronic surface passivaiton, making photogenerated electrons and holes readily available for surface chemical reactions.

References
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