

Fabrication of Organic-inorganic Perovskites for Highly Efficient Solar Cells and Light Emitting Diodes



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The unprecedented worldwide interest in organic-inorganic lead halide-based perovskite ($\text{HC}(\text{NH}_2)_2\text{PbX}_3$ or $\text{CH}_3\text{NH}_3\text{PbX}_3$) solar cells is rooted in its solution process-ability at low temperature as well as its extraordinary device performance. Perovskite thin films can be crystallized via a broad range of solution-based routes, but the quality of the final films varies strongly with small changes in solution composition and the processing parameters. I will highlight the mechanism of perovskite crystallization and discuss ways to judiciously control the crystal nucleation and growth processes during the perovskite film fabrication to achieve a high quality perovskite film. Here I will highlight the influence of a toluene drenching method on hybrid organic-inorganic perovskite ($\text{CH}_3\text{NH}_3\text{PbX}$) films upon three different precursor compositions, $\text{CH}_3\text{NH}_3\text{I}$ (MAI): PbI_2 , 3MAI: PbI_2 and 3MAI: PbCl_2 , and show that the mixed halide precursor (3MAI: PbCl_2) results in the highest quality films with the toluene treatment, including high surface coverage, large grains, long PL lifetimes and high photoluminescence quantum efficiency (PLQE).

I will also discuss the synthesis of perovskite (MAPbX_3) Nano-crystals with broad spectral tuneability. By blending perovskite crystals with different emission wavelengths in a polymer host, we demonstrate the potential to replace conventional phosphors and provide the means to replicate natural white light when excited by a blue GaN LED.

Sandeep Pathak gained his PhD at the University Of Cambridge, U.K. in 2011, working on High Temperature Superconductors with Prof David Cardwell. He joined Clarendon Laboratory (University of Oxford, U.K.) to work with Prof. Henry Snaith as a postdoctoral fellow to work on Dye-Sensitized and Perovskite Solar Cells. He has been working with Prof Snaith on perovskite solar cell except for a brief period when he moved back to Cavendish Laboratory to work with Prof Ullrich Steiner (University of Cambridge, UK). Recently, he has joined Prof. Bulovic's lab at MIT as a visiting Scholar. His current research work predominantly involves fabrication of highly efficient perovskite solar cells and development of new materials for photovoltaic applications.

*This talk is part of the Perovskites Seminar Series organized by Sam Stranks and sponsored by the Center for Excitonics. For more info contact Sam Stranks: stranks@mit.edu