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Inorganic-organic hybrid perovskite materials for photovoltaic applications

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Since the perovskite material was first used as a light harvester in a solar cell, the efficiency in the solar cells has skyrocketed from 3.8% to greater than 20%. The materials exhibit beneficial properties for high-performance photovoltaic systems such as a suitable band gap (1.5 - 1.4 eV), high absorption coefficient (104 - 105 cm^{-1}), low exciton binding energy (< 50 meV), and long charge-carrier diffusion length (~175 μm). In addition, these materials exhibit easy crystallization at low-temperature by solution processing, resulting in their low cost. In our pioneering work, the platform consisting of a pillared architecture of a three-dimensional nanocomposite of perovskites fully infiltrating mesoporous TiO_2, resulting in the formation of continuous phases and perovskite domains overlaid with a polymeric hole conductor was proposed for efficient solar cells. Since then, we have rapidly increased from around 12% to over 22% certified efficiency, which is world-record. The unprecedented increase in the PCE can be attributed to the effective integration of the advantageous attributes of the refined bi-continuous architecture, deposition process, and composition of perovskite materials. In this presentation, I will talk about the film morphology through the development of intermediate chemistry retarding the rapid reaction between methylammonium or formamidinium iodide and lead halide (PbI2) for improved perovskite film formation, and the phase stability and bandgap tuning of the perovskite layer through the materials engineering. Furthermore, the development of electron and hole transporting materials for carrier-selective contacting layers will be mentioned.

Research interests: Solar Energy Conversion, Nanostructured Inorganic/Organic Hybrid solar cells, Functional Inorganic-Organic Hybrid Materials, Sol-Gel Process of Inorganic Materials etc.