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Editorial

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The Swift Surge of Perovskite Photovoltaics

The breakthrough early 1990s dye sensitization of mesoscopic TiO_2 films along with a regenerative iodide redox couple led to the explosive growth of dye-sensitized solar cell (DSC) research. The pioneering work of Grätzel and colleagues also made it possible to develop a solid-state DSSC with spiro-oMETAD as the hole conductor and thus replace the liquid electrolyte in the cell. Research efforts of Konenkamp and others further initiated the search for the "extremely thin absorber" (ETA) nanostructured solar cell, using TiO_2 as the electron conductor, an inorganic absorber, and a hole conductor. Another major research thrust was by Weller, Kamat, Zaban, Nozik, Hodes, and others, who employed inorganic quantum dots (e.g., CdS and CdSe) as sensitizers. While discussing developments in sensitized solar cells, it is important to note the contributions of early visionaries like Gerischer, Sutin, and Bard, who were first to establish the concepts of sensitization using dye molecules and semiconductor nanostructures.

The efforts to develop solid-state solar cells initiated effervescent activity around 2010 when efficiencies of 5% were attained with Sb_2S_3 inorganic sensitizers and organic hole conductors. However, the efficiencies of inorganic semiconductor-sensitized solar cells lagged behind those achieved with the liquid junction DSCs. This stalemate took a major leap in late 2012 when a relatively less known organometal halide perovskite, $CH_3NH_3PbI_3$ (Figure 1), emerged as the light harvester delivering efficiencies about 10%. Recent reports of efficiencies of 12−15% have led to make the bold prediction of the "*Next Big Thing in Photovoltaics*". The rise of the perovskite solar cell started with the initial report of Miyasaka's group, which went unnoticed until the work of Nam-Gyu Park, Grätzel, and co-workers reported a power conversion efficiency exceeding 9% and a report of Snaith's group achieving efficiencies of 10% appeared. By replacing TiO_2 with an Al_2O_3 mesostructure, it was possible to demonstrate the ambipolar property of the perovskite material. Further refinements in the materials processing and cell design have now led to the success of achieving certified efficiencies of 14%.

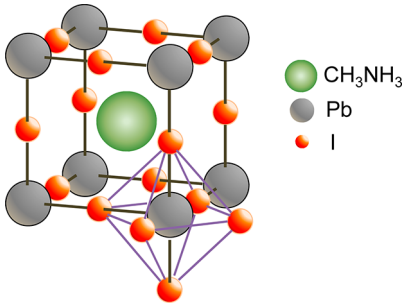

Figure 1. Structure of $CH_3NH_3PbI_3$ perovskite (reproduced with permission from *J. Phys. Chem. Lett.*, (Park, 2013)).

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Nam-Gyu Park, who has been at the center of perovskite solar cell research, has now presented the evolution of the field, explaining how the efficiencies have raised from the point of view of materials design to device making. His perspective in this issue of *J. Phys. Chem. Lett.* discusses the crucial details of the perovskite solar cell components, the different configurations, and the properties of the absorber. By analyzing feasible development of the photocurrent and photovoltage, attaining perovskite solar cells with 20% efficiency may be reached in the near future. Basic understanding of the excited-state dynamics, charge separation, and charge transport in these thin films will be the key in achieving this goal. A few early investigations addressing the issues of high open-circuit voltage and the effect of hole conductors already appeared in the earlier issues of *J. Phys. Chem. Lett.* It is certain that many new research efforts and technological advances related to pervoskite will dominate in the coming years.

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Notes

Views expressed in this Editorial are those of the author and not necessarily the views of the ACS.

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