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Perovskite-Based Solar Cells

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This special series of the *Journal of Photonics for Energy* focuses on the science and technology of the so-called perovskite-based solar cells. These materials have been named for their perovskite crystal structure that adopts an ABX_3 composition, where for example A = formamadinium-FA, methylammonium-MA, Cs, and/or Rb; B = Pb^{2+}, and/or Sn^{2+}; and $X = Cl^-$, Br^-, and/or I^-. These materials have gained a lot of attention due to rapid rise in performance, reaching current record certified efficiencies of 22.1%.[1] In spite of their quickly achieved high efficiencies, there is still much to learn about the synthesis and properties of these materials. Here we display a series of new findings and perspectives on a variety of related topics.

The collection of papers were published in the *Journal of Photonics for Energy*, throughout Volumes 6 and 7:

1. Z. Song et al., "Pathways toward high-performance perovskite solar cells: review of recent advances in organo-metal halide perovskites for photovoltaic applications," *J. Photonics Energy* **6**(2), 022001 (2016) [doi: https://doi.org/10.1117/1.JPE.6.022001].
2. H. Peng et al., "High-performance cadmium sulphide-based planar perovskite solar cell and the cadmium sulphide/perovskite interfaces," *J. Photonics Energy* **6**(2), 022002 (2016) [doi: https://doi.org/10.1117/1.JPE.6.022002].
3. A. Hariz, "Perspectives on organolead halide perovskite photovoltaics," *J. Photonics Energy* **6**(3), 032001 (2016) [doi: https://doi.org/10.1117/1.JPE.6.032001].
4. S. Ananthakumar, J. R. Kumar, and S. M. Babu, "Cesium lead halide ($CsPbX_3$, X = Cl , Br, I) perovskite quantum dots-synthesis, properties, and applications: a review of their present status," *J. Photonics Energy* **6**(4), 042001 (2016) [doi: https://doi.org/10.1117/1.JPE.6.042001].
5. M. Goudarzi and M. Banihashemi, "Simulation of an inverted perovskite solar cell with inorganic electron and hole transfer layers," *J. Photonics Energy* **7**(2), 022001 (2017) [doi: https://doi.org/10.1117/1.JPE.7.022001].
6. R. Szostak et al., "Understanding perovskite formation through the intramolecular exchange method in ambient conditions," *J. Photonics Energy* **7**(2), 022002 (2017) [doi: https://doi.org/10.1117/1.JPE.7.022002].
7. M. Habibi, M.-R. Ahmadian-Yazdi, and M. Eslamian, "Optimization of spray coating for the fabrication of sequentially deposited planar perovskite solar cells," *J. Photonics Energy* **7**(2), 022003 (2017) [doi: https://doi.org/10.1117/1.JPE.7.022003].

Mohamad Goudarzi et al. present a simulation of two different processing methods for the inverted perovskite solar cell geometry and report a drastically different interface defect density between the two preparations. Mehran Habibi et al. describe a spray coating method for sequentially depositing planer perovskite-based solar cells, addressing a critical need for scalable processing methods for these materials. Szostak et al. present a comprehensive study into the intramolecular exchange method for synthesizing perovskite-based $MAPbI_3$ solar absorbers and propose a mechanism for the direct formation of the $MAPbI_3$ film. Haitao Peng et al. explore the potential to replace TiO_2 with CdS as a higher performing electron transport layer of a perovskite-based solar cell, achieving a photoconversion efficiency of 16.1%.

Soosaimanickam Ananthakumar et al. provide a review of the synthesis, properties, and applications for cesium lead halide perovskite quantum dots (QDs). These QDs have higher quantum yield (90%) than any other semiconductor QDs making them a promising candidate for a variety of device applications. Since this report researchers have reported $CsPbI_3$ QD devices with a certified device efficiency of 13.43%,[2] a current QD device record. Alex Hariz and

Zhaoning Song et al. present two perspective views on perovskite-based solar cells and provide commentary on potential pathways to higher performance.

The articles in this special series provide a snapshot of the rapidly advancing field of perovskite-based solar cells. We hope these works provide inspiration for new areas of research while also providing a perspective outlook on this exciting field.

References

1. W. S. Yang et al., "Iodide management in formamidinium-lead-halide — based perovskite layers for efficient solar cells," *Science* **356**(6345), 1376–1379 (2017).
2. E. M. Sanehira et al., "Enhanced mobility $CsPbI_3$ quantum dot arrays for record-efficiency, high-voltage photovoltaic cells," *Sci. Adv.* **3**(10), eaao4204 (2017).

Ana Flavia Nogueira received her PhD degree in chemistry from the University of Campinas (UNICAMP), Campinas, Brazil, in 2001. In 2002, she joined the group of Professor James R. Durrant at Imperial College, London, in a postdoctoral position. Since 2004, she has been an associate professor at UNICAMP. She is also the coordinator of the Laboratory of Nanotechnology and Solar Energy, a leading group in third-generation solar cells in Brazil.

Laura T. Schelhas received her PhD in chemistry from the University of California, Los Angeles (UCLA) in 2013. In 2014, she accepted a postdoctoral position at the Stanford Synchrotron Radiation Lightsource (SSRL) at SLAC National Accelerator Laboratory before becoming staff in 2016. She is currently is an associate staff scientist in the Applied Energy Programs Division at SLAC. Her research focuses on understanding the structure function relationship in both solar absorbers and solar modules materials such as encapsulants, backsheets, and anti-reflective/anti-soiling coatings.