Light Energy Conversion with Semiconductor Nanostructures: From Quantum Dots to Perovskites.

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Résumé/Abstract

Semiconductor nanostructures with tunable photoresponse can capture the visible and near IR photons quite effectively. By controlling the size and composition one can tune the photoresponse of semiconductor nanostructures in the entire visible region. Assembling these nanostructure assemblies on electrode surfaces in a controlled fashion is an attractive approach for designing next generation solar cells. The key advantage of semiconductor nanostructures lies in designing thin film solar cells with low temperature processing. These advantages significantly decrease the energy payback time since less energy is consumed (and hence a lower carbon footprint) during their manufacture.

The early studies which focused on the synthesis of semiconductor quantum dots and elucidation of charge carrier dynamics have led to the evolution of high efficiency metal halide perovskite solar cells. In the present talk light induced charge carrier generation and transport across interfaces which are important in the operation of solar cells will be discussed. Photoinduced segregation in mixed

halide perovskite has a direct influence on decreasing the solar cell efficiency as segregated I-rich domains serve as charge recombination centers.[5] Recent developments in utilizing semiconductor quantum dots in light energy conversion will be discussed.

Additional Readings

[1] Manser, J. S.; Christians, J. A.; Kamat, P. V., Intriguing Optoelectronic Properties of Metal Halide Perovskites. *Chem. Rev.* **2016,** *116*, 12956–13008.

[2] Kamat, P. V. Semiconductor Surface Chemistry as Holy Grail in Photocatalysis and Photovoltaics. *Acc. Chem. Res.* **2017,** *50*, 527-531.

[3] Brennan, M. C.; Draguta, S., Kamat, P. V.; Kuno M. K. Light-Induced Anion Phase Segregation in Mixed Halide Perovskites ACS Energy Lett., **2018**, 3, 204–213

[4] DuBose, J. T.; Kamat, P. V., Probing Perovskite Photocatalysis. Interfacial Electron Transfer between CsPbBr3 and Ferrocene Redox Couple. The Journal of Physical Chemistry Letters **2019**, 10, 6074-6080.

[5] Kamat, P. V.; Kuno, M., Halide Ion Migration in Perovskite Nanocrystals and Nanostructures. Accounts of Chemical Research **2021**, 54 (3), 520-531.

Bio

Prashant V. Kamat is a Rev. John A. Zahm, C.S.C., Professor of Science in the Department of Chemistry and Biochemistry and Radiation Laboratory at the University of Notre Dame. He is also a Concurrent Professor in the Department of Chemical and Biomolecular Engineering. Professor Kamat has for more than three decades worked to build bridges between physical chemistry and material science to develop advanced nanomaterials that promise cleaner and more efficient light energy conversion. He has published more than 450 scientific papers that have been well recognized by the scientific community Thomson-Reuters has featured him as one of the most cited researchers each year since 2014 (2016 -2020). He is currently serving as the Editor-in-Chief of ACS Energy Letters.