

FALL 2023

# MSE 690 SEMINAR SERIES

MONDAY, SEPTEMBER 18TH | 3:45PM SEMINAR | ARMS 1010

## “Light-Triggered Ion Movement in Metal Halide Perovskites: Implications for Solar Cell Stability”



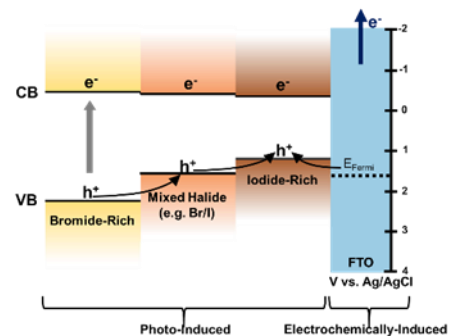
**Biography:** Prashant V. Kamat is a Rev. John A. Zahm, C.S.C., Professor of Science in the Department of Chemistry and Biochemistry and Radiation Laboratory at the University of Notre Dame. He is also a Concurrent Professor in the Department of Chemical and Biomolecular Engineering. Professor Kamat 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 500 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 (2014 -2020). He is a Fellow of ACS, ECS and AAAS. He is also Pravasi Fellow of the Indian National Science Academy. He is currently serving as the Editor-in-Chief of ACS Energy Letters. (URL:Kamatlab.com)

**Abstract:** Radiation Laboratory, Departments of Chemistry & Biochemistry and Chemical & Biomolecular Engineering, University of Notre Dame, Notre Dame, IN 46556

Nanostructured semiconductor materials offer new approaches to develop solar cells with relatively low carbon footprint as compared to silicon based photovoltaic devices. The solution processibility and low temperature processing of these materials significantly decreases the energy required to produce photovoltaic devices. Of particular interest are the metal halide perovskites which have delivered new record-breaking solar cell efficiencies. However, long-term stability of perovskite solar cells remains a hurdle in implementing large panel photovoltaic devices for outdoor applications. Instabilities in perovskites can occur because of both intrinsic and extrinsic changes under light irradiation. For instance, ion migration in perovskite film is one of the factors responsible for deterioration of solar cell performance.

The thermodynamic and redox properties of halide perovskites provide a strong driving force for hole trapping and oxidation of iodide species. When in contact with a non-polar solvent, the migration of iodine species is further extended to expulsion of iodine from the perovskite film. Thus, the mobility of halides and their susceptibility to hole-induced oxidation play a crucial role in determining the long-term stability of metal halide perovskite solar cells. Modification of the perovskite composition through introduction of different cations, halide ions, or introduction of low-dimensional perovskite phases suppress phase segregation. When Ruddlesden-Popper 2D mixed-halide perovskite films with spacer cations such as butylammonium are introduced into three-dimensional (3D) perovskite films, they stabilize them against thermal- and moisture-induced degradation. This improved photostability has led to the incorporation of 2D perovskites into photovoltaic and light emitting display devices. While such passivation of 3D perovskites using 2D perovskites has been reported widely, the stability of the 2D/3D interface during long term solar cell operation is yet to be assessed fully. Thus, suppression of halide ion as well as cation mobility remains a key factor in achieving long term stability and improving efficiency of perovskite solar cells and light emitting devices.



### Suggested Readings:

DuBose, J. T.; Kamat, P. V. Hole Trapping in Halide Perovskites Induces Phase Segregation, *Accounts of Materials Research* 2022, 3, 761-771.

DuBose, J. T.; Kamat, P. V. Energy Versus Electron Transfer: Managing Excited-State Interactions in Perovskite Nanocrystal–Molecular Hybrids, *Chemical Reviews* 2022, 122, 12475–12494.

Chakkamalayath, J.; Hiott, N.; Kamat, P. V. How Stable Is the 2D/3D Interface of Metal Halide Perovskite under Light and Heat? *ACS Energy Letters* 2023, 8, 169-171.