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The Robert W. Courter Seminar Series

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ZOOM: https://lsu.zoom.us/meeting/register/tJApd-mhqzssHNAtbx8xlujIXfCf28JLgcJB

Semiconductor physics of 2D organic-inorganic perovskites

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Organic-inorganic two-dimensional halide perovskites (2DPKs) are soft semiconductors formed by combining organic and inorganic moieties, which self-assemble in solution to form highly ordered periodic stacks. They exhibit a large compositional and structural phase space, which has led to novel and emergent physical properties. In this talk today, I will describe two exciting results. First we overcome a long-standing challenge in 2D perovskites of realizing phase pure thin -films. Briefly, we demonstrate a scalable approach involving dissolution of single-phase crystalline powders with homogeneous perovskite layer thickness in desired solvents, to fabricate 2D perovskite thin-films with high phase purity. In-situ characterizations reveal the presence of sub-micron-sized seeds in solution that preserve the memory of the dissolved single-crystals, and dictates nucleation and growth of grains with identical layer thickness of the perovskite layers in thin-films. Photovoltaic devices fabricated with such films, yields an efficiency of 17.1% and 1.20V open-circuit voltage, while preserving 97.5% of their peak-performance after 800 hours under illumination without any external thermal management. Second, we report sunlight-activated anisotropic lattice contraction in 2D perovskites, which is reversible and strongly dependent of both the nature of the interlayer organics and the details of the structure. Our theory suggests that light-generated charge accumulation results in the build-up of a bulk compressive strain, which induces a continuous lattice contraction over minutes. In-situ structural measurements on photovoltaic devices directly correlate the light-induced lattice contraction to an increase in the photovoltaic efficiency of Dion-Jacobson 2D perovskite solar cells from 13.8% to 16.4%.

* Dr. Aditya Mohite is an Associate Professor in the Department of Chemical and Biomolecular Engineering at Rice University and directs an energy and optoelectronic devices lab working on understanding structure-function properties in materials with the aim of controlling charge and energy flow across. His research philosophy is applying creative and “out-of-the-box” approaches to solve fundamental scientific bottlenecks and they utilize the knowledge to demonstrate technologically relevant performance in devices that is on par or exceeds the current state-of-the-art devices. He has published 150 peer reviewed papers in journals such as Science, Nature, Nature Materials, Nature Nanotechnology, Nano Letters, ACS Nano, Chemical Society Reviews, Applied Physics Letters and Advanced Materials amongst others. He has also delivered more than 90 invited talks.