Impact of atomic structure and dynamics on solar cell performance of metal halide perovskite thin films

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Metal halide perovskites (MHPs) are revolutionizing the solar cell research field - the record power conversion efficiency of MHPs based solar cells has reached 22%, which rivals that of silicon solar cells. This represents the highest efficiency among all solution processable materials and the fastest rate of efficiency improvement in the history of all photovoltaic materials. Based on this trend, MHPs have been called the "next big thing in photovoltaics" and worldwide research efforts have grown explosively.

Despite the impressive solar cell performance demonstrations, the microscopic mechanisms of the high performance and the thin film growth processes of the MHP thin films are still poorly understood. The lack of understanding in these aspects is currently precluding more rational progress toward further increase in efficiency, reliably scaling up the solar cell area and improvement in device stability. In this talk, I will present our recent results on synchrotron based *in-situ* grazing incidence X-ray scattering studies on the MHP thin film formation processes. Our results reveal the sub-processes and mechanisms through which highly preferential crystallographic orientation of MHP films can be formed. We demonstrate methods to controllably tune the direction and degree of the preferential orientation. Impact of the degree of thin film orientation on solar cell performance will be discussed. I will also present our work that employed temperature dependent elastic and quasi-elastic neutron scattering to characterize the atomic structure and dynamics in MHPs. We find that the rotation of organic cations in MHPs play a crucial role in determining the optoelectronic properties as well as structural phase stability.

Bio: Joshua J. Choi received B.E. in Chemical Engineering from Cooper Union and Ph.D. in Applied Physics from Cornell University (Advisor: Tobias Hanrath). He then performed postdoctoral research at the Department of Chemistry, Columbia University (Advisor: Jonathan S. Owen). He joined the faculty of the Department of Chemical Engineering, University of Virginia as an assistant professor starting in August, 2014. He is a recipient of a NASA Early Career Faculty Award (2015).