# Enabling Next-Generation Photovoltaics with Switchable Perovskites and Quantum Dot Surface Chemistry

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The landscape of photovoltaics (PV) research has changed dramatically in the last ten years. The cost of traditional monocrystalline silicon module installations has plummeted to rival the cost of US energy generation from non-renewable sources. In parallel, metal halide perovskite (MHP) materials have quickly emerged as a promising new PV technology, reaching power conversion efficiencies as high as 22.1% in just six years of research—a feat that took monocrystalline silicon technology more than thirty years to achieve. Stability of these materials continue to improve, putting MHP technology on the brink of market deployment. However, the economic climate of PV places greater demands MHP PV technology to achieve market penetration, which motivates new strategies for deployment beyond single-junction thin films found in residential rooftops and solar fields. This talk will cover two frontiers of research that address this challenge: 1) Dynamically "switching" perovskite absorber layers from transparent to tinted using solar illumination is presented as proof of concept for the first switchable PV device. The technology is a glimpse into the future of PV deployment in smart buildings that dynamically adapt to weather conditions, transforming buildings from the largest sink of US energy into sources of clean renewable energy. 2) Shrinking MHP materials to the nanoscale regime yield quantum dots (QDs) with properties uniquely suited for tandem PV architectures. Like any nanoscale material, manipulating the QD surface is critical for performance. Current efforts are underway to unravel the complex surface chemistry of the MHP QD materials to allow for efficient absorption of solar photons and extraction of photoexcited carriers to enable PV technologies with efficiencies that exceed the limitations in current technology.

Lance Wheeler received a bachelor of arts degree in Physics from St. John's University in Collegeville, Minnesota in 2009. As a departmental fellow, his graduate work was performed at the University of Minnesota under the

advisement of Professor Uwe Kortshagen, where Wheeler received a Ph.D. in 2014. Within the Center for Advanced Solar Photophysics, a U.S. Department of Energy - Energy Frontier Research Center, his research was dedicated to the development of novel surface chemistries to enable the integration of group IV semiconductor quantum dots into photovoltaic devices. Lance joined the Chemistry & Nanoscience Center at the National Renewable Energy Laboratory in Golden, CO in June of 2014. He has since expanded his research to include perovskite materials, photovoltaic energy generation in switchable glazing, and solar thermochemical fuel production using nanomaterials.

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**Where: EP#252**