**Controlling thin film organic and metal halide perovskite crystallinity and morphology to gain a better understanding of devices**

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**Abstract:**
In this seminar, we will focus on our recent work on two different thin film systems – metal halide perovskites and organic semiconductors.

For organic semiconductors, through proper control of processing, we are able to realize pinhole free films with grains of up to 500 μm in extent. We will show our efforts to understand their formation and epitaxy of like and unlike adlayers. These materials are allowing us to examine some of the intrinsic properties of organic photovoltaics and provide a glimpse into interesting phenomena, such as highly delocalized charge transfer states at crystalline heterojunctions.

Hybrid inorganic-organic perovskite materials, most commonly methylammonium lead triiodide ($MAPbI_3$), have garnered significant interest in the thin film optoelectronics community due to their outstanding optical and electrical properties. With certified photovoltaic efficiencies exceeding 20%, hybrid perovskites are already competitive with well-established technologies like poly-Si and CIGS. However, solution processed perovskites commonly suffer from poor thin film quality, reproducibility, stability, and scalability. Our work has determined that the fabrication of $MAPbI_3$ thin films displays all of the hallmarks of sol-gel processing. We directly correlate experimental observations with basic sol-gel theory to elucidate the critical steps and specifically target these steps to improve the quality of spin coated thin films, realizing films with roughness on the order of a few nm that allow us to demonstrate world-class (~10% EQE) light emitting devices.

**Brief bio:**
Barry Rand earned a BE in electrical engineering from The Cooper Union in 2001. Then he received MA and PhD degrees in electrical engineering from Princeton University, in 2003 and 2007, respectively. From 2007 to 2013, he was at imec in Leuven, Belgium, ultimately as a principal scientist, researching the understanding, optimization, and manufacturability of thin-film solar cells. Since 2013, he is an assistant professor in the Department of Electrical Engineering and Andlinger Center for Energy and the Environment at Princeton University. Prof. Rand's research interests highlight the border between electrical engineering, materials science, chemistry, and applied physics, covering electronic and optoelectronic thin-films and devices, devices composed of nanostructured media, and plasmonics. He has authored more than 80 refereed journal publications, has 19 issued US patents, and has received the 3M Nontenured Faculty Award (2014), DuPont Young Professor

Award (2015), DARPA Young Faculty Award (2015), and ONR Young Investigator Program Award (2016).