

4CF14-2014-020027

Abstract for an Invited Paper  
for the 4CF14 Meeting of  
the American Physical Society

**Development of advanced characterization techniques to resolve fundamental materials and device issues in photovoltaics**  
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Scientists within the National Center for Photovoltaics at the National Renewable Energy Laboratory (NREL) are pursuing critical activities to help accomplish the goal of the U.S. Department of Energy's SunShot Initiative to make large-scale solar energy systems cost-competitive with other energy sources by 2020. To achieve this goal we must increase the efficiency of PV devices while reducing cost and increasing reliability. As technologies mature, fundamental improvements must be driven increasingly by an in-depth understanding of the relationships between device performance and material properties down to the nanoscale. Solar cell efficiency is often determined by the properties and distribution of the defects and impurities that control doping, recombination, and carrier transport in these devices. Advanced measurement capabilities are crucial to understand the distribution and properties of these defects. In this presentation I will discuss ongoing work at NREL to develop advanced characterization methods that will enable PV scientists to resolve the structural, compositional, optical, and electronic properties of these defects and impurities in established and newly developed PV technologies.