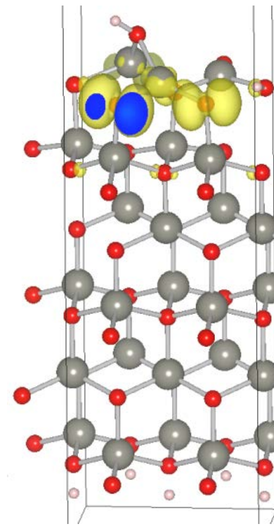
Center for Interface Science: Solar Electric Materials (CISSEM)
EFRC Director: Neal R. Armstrong
Lead Institution: The University of Arizona

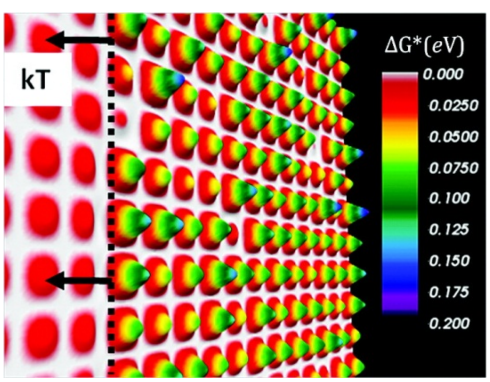
Mission Statement: *To advance the understanding of interface science underlying solar energy conversion technologies based on organic and organic-inorganic hybrid materials; and to inspire, recruit and train future scientists and leaders in the basic science of solar electric energy conversion*.

CISSEM was established in August 2009 as an Energy Frontier Research Center funded by the U.S. DOE, Office of Science, Office of Basic Energy Sciences, through Award Number DE-SC0001084. Under the Directorship of Prof. Neal R. Armstrong, The University of Arizona is teamed with the Georgia Institute of Technology, the National Renewable Energy Laboratory (NREL), Princeton University, and the University of Washington. CISSEM, an integrated multi-investigator five-year $15M program that started in August 2009, is comprised of fourteen principal investigators; with more than sixty graduate students, postdoctoral research associates, scientists, engineers, and staff involved with the center. We combine state-of-the-art facilities, leading researchers, and enthusiastic students to investigate the interface science of solar cell photovoltaics (PVs), building the basic science foundation and training the future energy scientists required to help develop abundant, clean, and economical energy conversion technologies for the 21st century.



Theoretical modeling – Charge distributions corresponding to the valence band maximum for a ZnO (0002) hydroxylated surface containing defects DOI: 10.1021/cm301596x

Interfacial processes are the focus of our collaborative and synergistic efforts. We are focused on understanding, modifying, and controlling the processes that affect efficiency in emerging thin-film PV technologies at nanometer length scales (one nanometer is about 1/100,000 of the width of a human hair). Regions called "interfaces" form where different materials contact each other. The chemical and physical processes that occur at interfaces control the efficiency, lifetime, and manufacturability of thin-film PVs, and must be understood and improved to support the desired growth of PV technologies (at well under $1/watt) and the U.S. renewable energy portfolio.

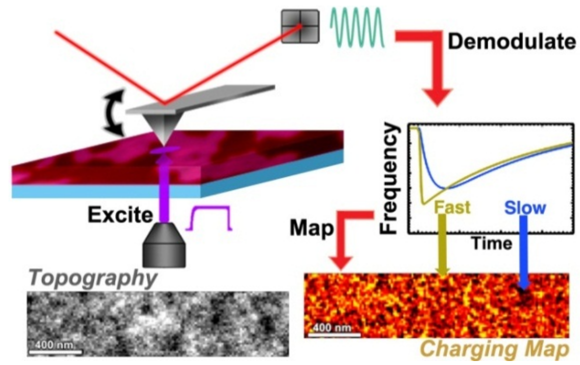


Kinetic Monte Carlo simulations – Free energy of activation (ΔG^*) calculations for electron transfer at the interface between an organic PV active layer and an electrode DOI: 10.1021/jp207471f

For Years 4 and 5, the CISSEM team is pursuing a unifying, vertically-integrated theme, using select combinations of model materials. We will create an understanding of the electronic properties of interfaces between molecular semiconductors and electrical contact or "interlayer materials" that lead to efficient harvesting of electrical charges, and describe their impact on thin-film PV performance. Consistent with our status as an EFRC, this research supports the development of high efficiency, stable, and scalable solar cell energy conversion platforms, and evolves from CISSEM's research activities in Years 1-3. An "interlayer" is a thin (1-50 nanometer) layer of metal oxide or polymer placed adjacent to a contact electrode in a thin- film solar cell. Its composition and structure enhances the efficiency of charge extraction and boosts PV efficiency.

CISSEM is:

- A multi-investigator center addressing the science of interfacial processes that limit efficiencies and lifetimes in emerging solar electric energy conversion technologies, which requires the characterization and control of these processes at nanometer length scales.
- An integrated synergistic EFRC approach to tackle complex problems; combining the technology and expertise of four universities and NREL, the U.S. federal laboratory "dedicated to the research, development, commercialization and deployment of renewable energy and energy efficiency technologies."
- An outstanding training opportunity for future energy scientists and leaders, engaging the unique array of research facilities and expertise at CISSEM's universities and NREL.



Characterization – Schematic of the fast free time-resolved electrostatic force microscopy technique that maps electrical transients at ca. 100-200 nanosecond timescales (1000X faster than comparable methods) with ca. 80 nanometer resolution
DOI: 10.1021/nl203956q

- A research program creating new scientific understandings of the electronic properties of interfaces relevant to many complementary energy conversion systems including other thin-film PV platforms, energy storage systems, photoelectrochemical platforms that create fuels from sunlight, and new thin-film, solid-state lighting technologies.

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Use-inspired discoveries of basic phenomena – Georgia Tech researchers displaying an all-polymeric organic solar cell on a flexible substrate featuring a new polymer-based, electron-collecting electrical contact
DOI: 10.1126/science.1218829

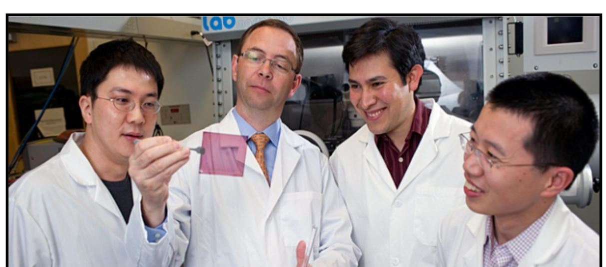

Photo credit: Georgia Institute of Technology