BAPVC Thrust: Encapsulation and Reliability

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Key Challenges

A key challenge for PV module and system reliability is the fact that many of the mechanisms of observed degradation modes are not well understood. This thrust seeks to identify and characterize degradation mechanisms, facilitate the design and standardization of accelerated testing protocols, and provide the fundamentals for the design of improved PV materials and product designs. In particular, we will: (1) characterize the stability and reliability of PV materials and interfaces, including barrier-films and encapsulants; and (2) develop an understanding of the coupled thermo-mechanical, electro-chemical, and photo-chemical degradation mechanisms that determine the reliability and operational lifetimes of PV technologies.

Existing Projects in our Thrust

- *Reliability and Operational Lifetimes for BAPVC Technologies,* Reinhold Dauskardt (Stanford)
- *PV Module Performance & Lifetime Prediction: Inserting New Technologies Without Lifetime Penalty,* Roger French (Case Western)
- *Novel polymer-nanocrystal composite barrier layers*, Rachel Segalman, Jeffrey Urban (Berkeley)
- *Tailoring Electrostatic Interactions to Produce Hybrid Barrier Films for Photovoltaics*, Bernard Kippelen, Samuel Graham (Georgia Tech)

Potential New Areas of Interest

1. Expansion of current work to characterize, model and predict coupled thermo-mechanical and photo-chemical degradation processes in PV technologies to include electro-chemical processes like those responsible for *potential induced degradation (PID)*.
2. *Increased interaction with other thrusts* to support reliability and degradation characterization and modeling with particular interests in emerging perovskite, ultra-thin silicon, CdTe and InP PV, along with transparent conductors.
3. Development of *multi-layer thin-film mechanics and degradation models* for cell, interconnect, and encapsulant interfaces in PV module packaging technologies, both cell-based and monolithically-integrated.
4. Connecting these models with *detailed transport models* for photons, electrons, phonons, and ions in a hierarchical fashion, in order to predict other failure modes.
5. *Analysis and development of a database* of thermo-mechanical, electro-chemical, and photo-chemical degradation properties of materials for benchmarking BAPVC innovations, to guide field testing, and inform computer simulations.
6. Refinement and redesign of standardized reliability testing capabilities for the broader BAPVC community, re-designing testing for field exposed samples, and calibration/validation of kinetic degradation models and lifetime prediction procedures using in-service and field-exposed data.