DuraMAT
Durable Module Materials Consortium

Yi Cui, Ali Javey, Reinhold Dauskardt & John Benner
Stanford and UC Berkeley Universities

BAPVC Bay Area Photovoltaic Consortium

Supporting university research to develop technology industry will use

Charter

The Bay Area Photovoltaic Consortium (BAPVC) is led by Stanford University and University of California Berkeley. BAPVC is funded by the U.S. Department of Energy with additional support from industry and universities. DOE is providing $27 million over six years (2011–2017) as part of the SunShot Photovoltaic Manufacturing Initiative (PVMI) to provide a source of research funding for all universities across the United States.

BAPVC conducts industry-relevant research and development that will impact high-volume PV manufacturing, produce a highly trained workforce, and speed up commercialization of cutting-edge PV technologies. BAPVC will develop and test innovative new materials, device structures, and fabrication processes necessary to produce cost-effective PV modules in high volumes. The research will advance technologies that bring down manufacturing costs and improve device performance characteristics to facilitate the manufacturing of solar cell modules with a price less than $0.50 per watt, thereby enabling an installed system price of $1 per watt.

Linking University Research with National Laboratory Capabilities

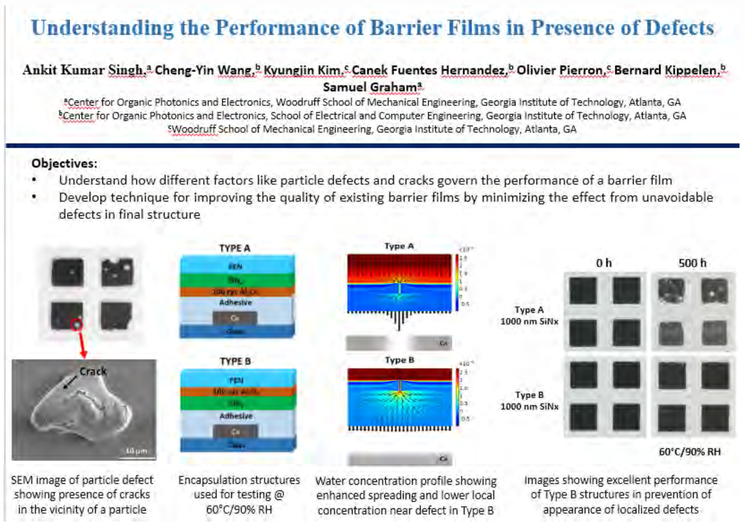
BAPVC will execute its proven 4-step approach to identify, select and fund universities throughout the USA to perform industry-relevant research with a specific focus on characterization and development of advanced module materials.

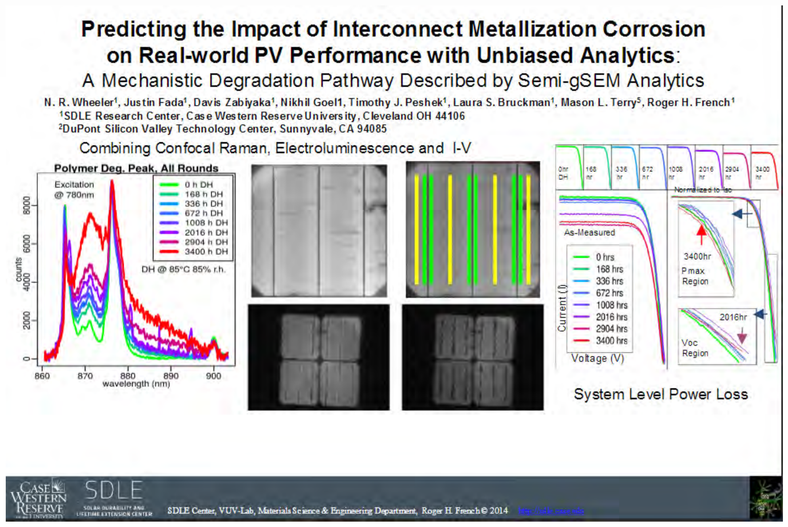
1. Industry and academic jointly assess technology status and discuss opportunities for improvement.
2. Industry develops guidance reflecting their priorities.
3. BAPVC prepares a call for proposals.
4. Proposals are evaluated by industry and academic peer review.

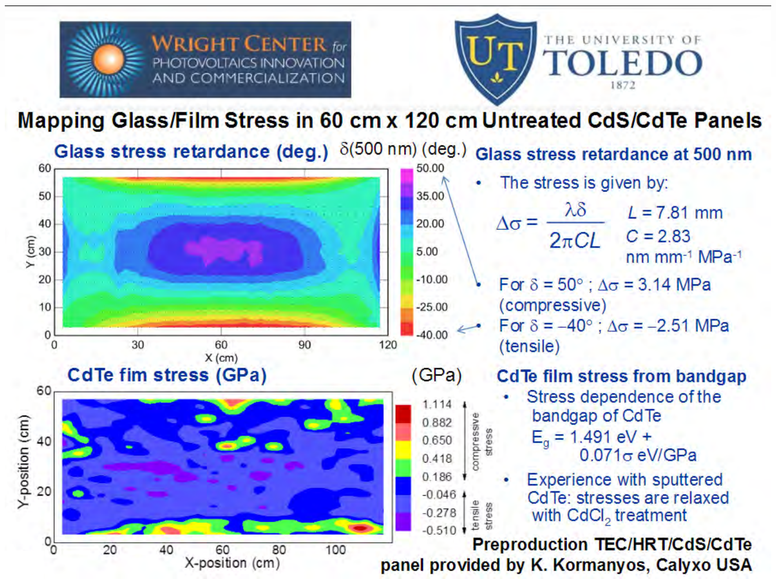
BAPVC's 2016 Fall Meeting held October 3-4, 2016 on campus at Berkeley launched this discussion, as more than a quarter of BAPVC's existing research portfolio is devoted to characterization and development of durable module packaging materials. All BAPVC projects address reliability of technologies under investigation. BAPVC's industry members are now working independently to synthesize ideas and opportunities discussed in the Fall Meeting into specific guidance that will become the scope of interest for a Request for Proposals (RFP) to be released soon. Evaluation engages both industry and academic reviewers to seek the aforementioned benefit of balanced interaction. Five or more new awards, adding to existing projects, will be placed by March 2017.

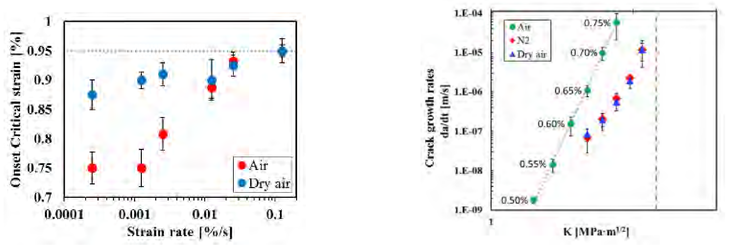
Anticipated 2017 Projects Focused on Module Materials

- High-resolution quantitative accelerated tests and lifetime models linked to field performance. (Dauskardt – Stanford, Carter – UCSC)
- Simple, scalable hybrid barrier and encapsulation systems (Urban – LBNL)
- Adhesion benchmarking of state-of-the-art screen printed metallization and quantify root cause metal failure mechanisms (Dauskardt – Stanford, Reese – NREL, Graham – Georgia Tech)
- Multivariate predictive network modeling of degradation (French – Case Western)
- Through-the-glass optical analysis of stresses (Collins – Toledo)









- Used mechanical testing in order to measure the crack growth rate in SiNx barrier films on PET
- Data show there is a strong environmental impact on crack growth rates vs driving force
- Onset Critical Strain as a design metric does not capture the complexity of subcritical crack growth needed to predict long term performance of barrier films

BAPVC Presentations on Reliability & Module Materials in the Spring Meeting 2016

"Transparent Metal–Organic Framework/Polymer Mixed Matrix Membranes as Water Vapor Barriers for Photovoltaic Cells" Fen Qiu, LBNL

"Increasing the thermomechanical stability of perovskite solar cells" Brian L. Watson, Nick J. Rolston, Kevin A. Bush, Tomas Leijtens, Michael D. McGehee, Reinhold H. Dauskardt

"Adhesion Characterization of PV Module Encapsulation and Backsheet Structures" Jared Tracy Nick Bosco Reinhold Dauskardt

"Linking Degradation Mechanisms into Pathways for PV Modules Under Damp Heat: Using Confocal Raman, Electroluminescence, and IV" Nicholas R. Wheeler, Justin S. Fada, Davis Zabiyaka, Nikhil Goel, Timothy J. Peshek, Laura S. Bruckman, Mason L. Terry, Roger H. French

"Non-linear power degradation detected from massive realworld c-Si PV power plants data" Yang Hu, Timothy Peshek, Mohamed A. Elsaeiti, David Meakin and Roger H. French

"Photothermal Deflection and Fourier Transform Infrared Spectroscopy of Organic PV Materials" Kaitlin Hellier, Renee Sully, Jacob Kermish-Wells, Glenn Alers, Sue A Carter

"Understanding Temperature and Light Degradation of Perovskite Films and Devices" Ghada Abdelmageed, Leila Jewell, Kaitlin Hellier, Lydia Seymour, Mark Tingwald, Frank Bridges, Jin Z. Zhang, and Sue A. Carter

"Polymer Degradation and Aging Under Ultraviolet Exposure" H. Renee Sully, Katie Hellier, Jacob Kermish-Wells

"Transparent Metal-Organic Framework/Polymer Mixed Matrix Membranes as Water Vapor Barriers for Photovoltaic Cells" Fen Qiu, Eun Seon Cho, Youn Jue Bae, Wendy L. Queen, Jeffrey J. Urban

"A Multiscale Opto-Electro-Thermal Reliability Framework for Shadow Degradation, Moisture Ingress, and PID" R. Asadpour, X. Sun, R. Chavali, and M. A. Alam

"Surmounting Barriers to Barriers with Speed and Calibration" Michael Kempe, Talysa Stockert, Arrelaine Dameron, Matthew Reese

"Understanding the performance of Barrier Films in presence of Defects" Ankit Kumar Singh, Cheng-Yin Wang, Kyungjin Kim, Canek Fuentes Hernandez, Olivier Pierron, Bernard Kippelen, Samuel Graham

"An In-line Optical Metrology for Advanced Thin-Film Module Fabrication and Determination of Substrate and Film Stresses" Prakash Koirala, Jian Li, Puja Pradhan, Nikolas Podraza, Robert Collins

BAPVC Presentations on Reliability & Module Materials Fall 2016

"Investigation of Interfacial Delamination in Field and Laboratory Aged PV Modules" Jared Michael Tracy (Dauskardt Group) Stanford

"Next-Generation Robust Perovskite Solar Cells for Improved Stability" Brian L. Watson, Nicholas Rolston, Adam D. Printz, and Reinhold H. Dauskardt

"Investigation of Interfacial Delamination in Field and Laboratory Aged PV Modules" J. Tracy, N. Bosco, and R. Dauskardt

"High Sensitivity Mapping of Stress via Anisotropic Optics for Improved PV Manufacturing" Robert W. Collins, Prakash Koirala, Puja Pradhan, Jian Li, and Nikolas J. Podraza

"Network modeling for rapid optimization of Lifetime, efficiency and CapEx of PERC solar cells" Roger H. French, Timothy J. Peshek, Bryan Huey, Hongping Zhao, Mason L. Terry

"Transparent and Robust Metal-Organic Framework/Polymer Films for Enhanced Water Vapor Blocking" Fen Qiu, Eun Seon Cho, Youn Jue Bae, Aizhao Pan, Wendy Queen and Jeffrey J. Urban