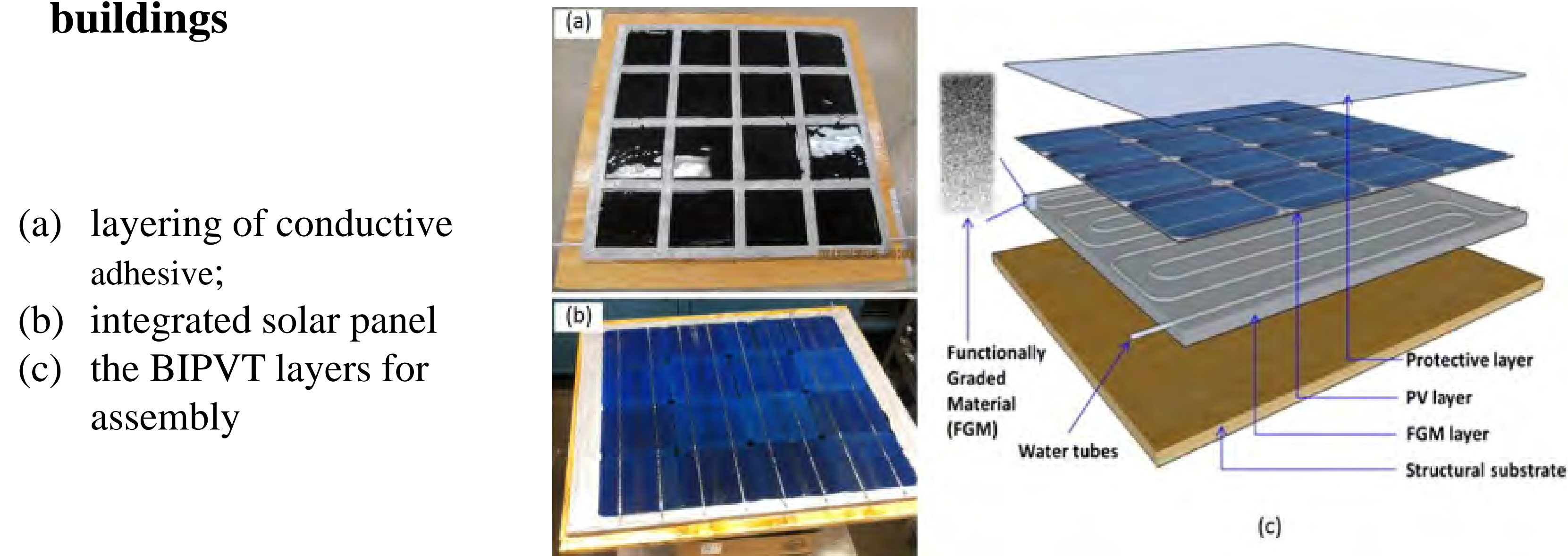
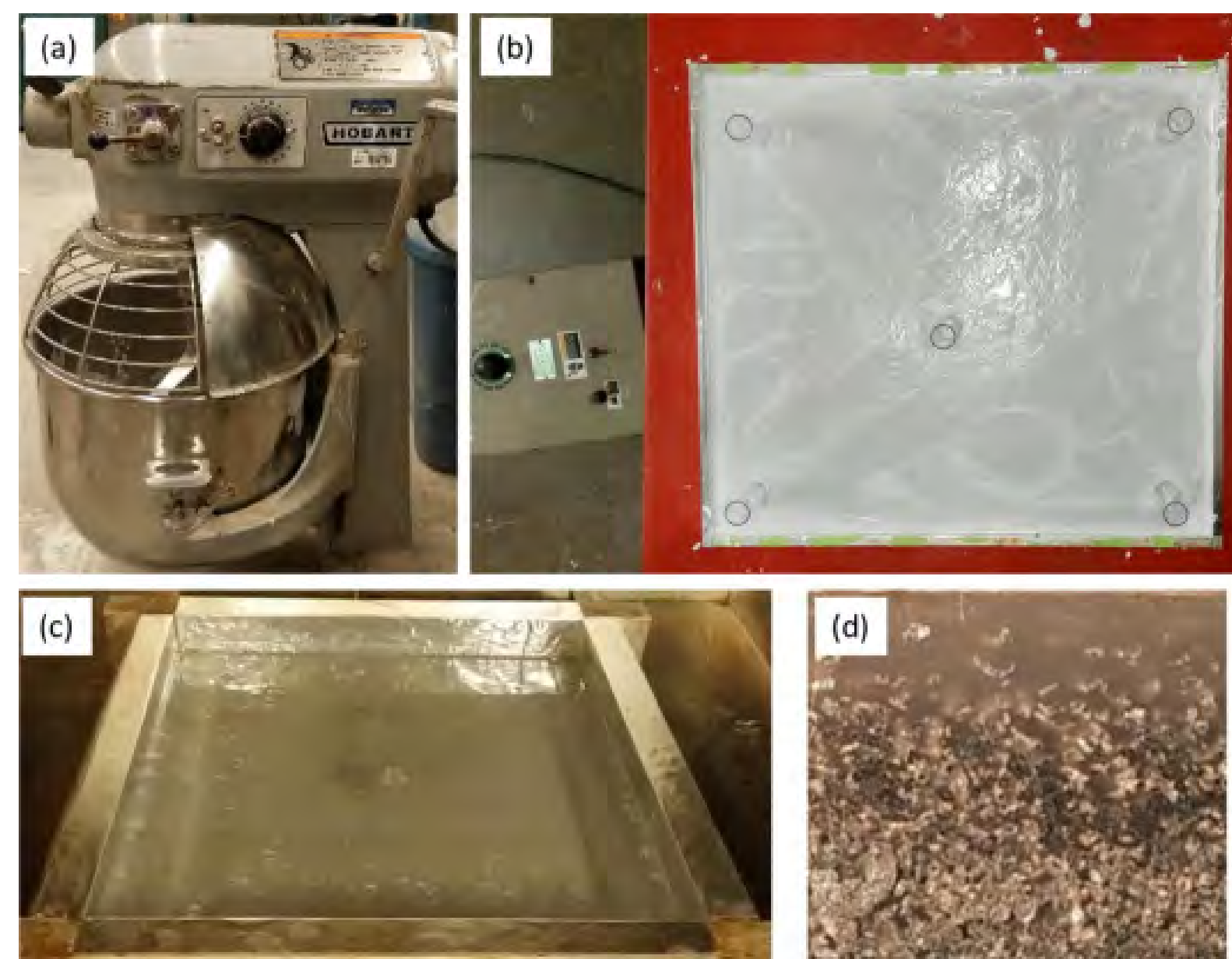


Building-integrated photovoltaic-thermal (BIPVT) solar roof

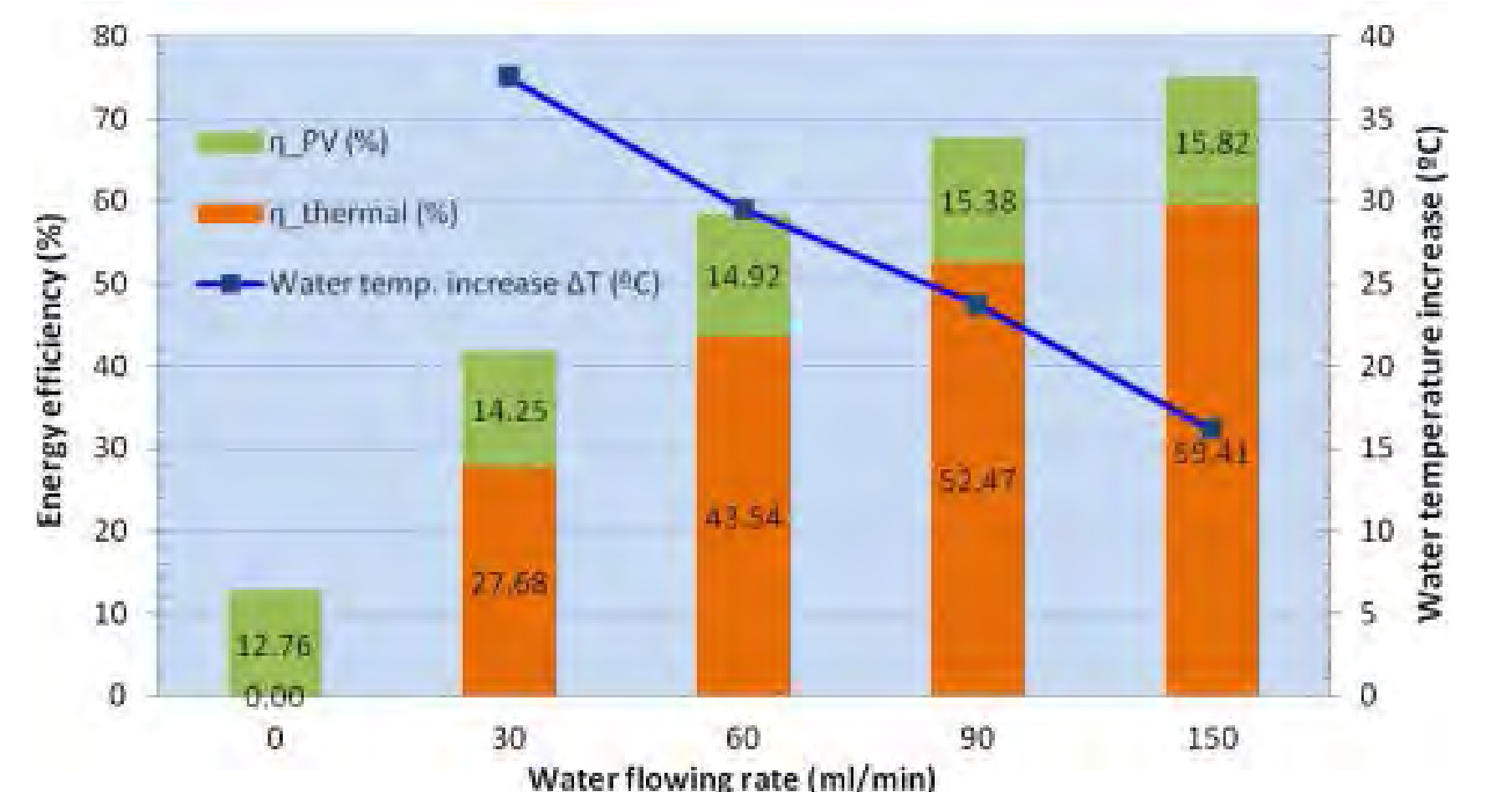
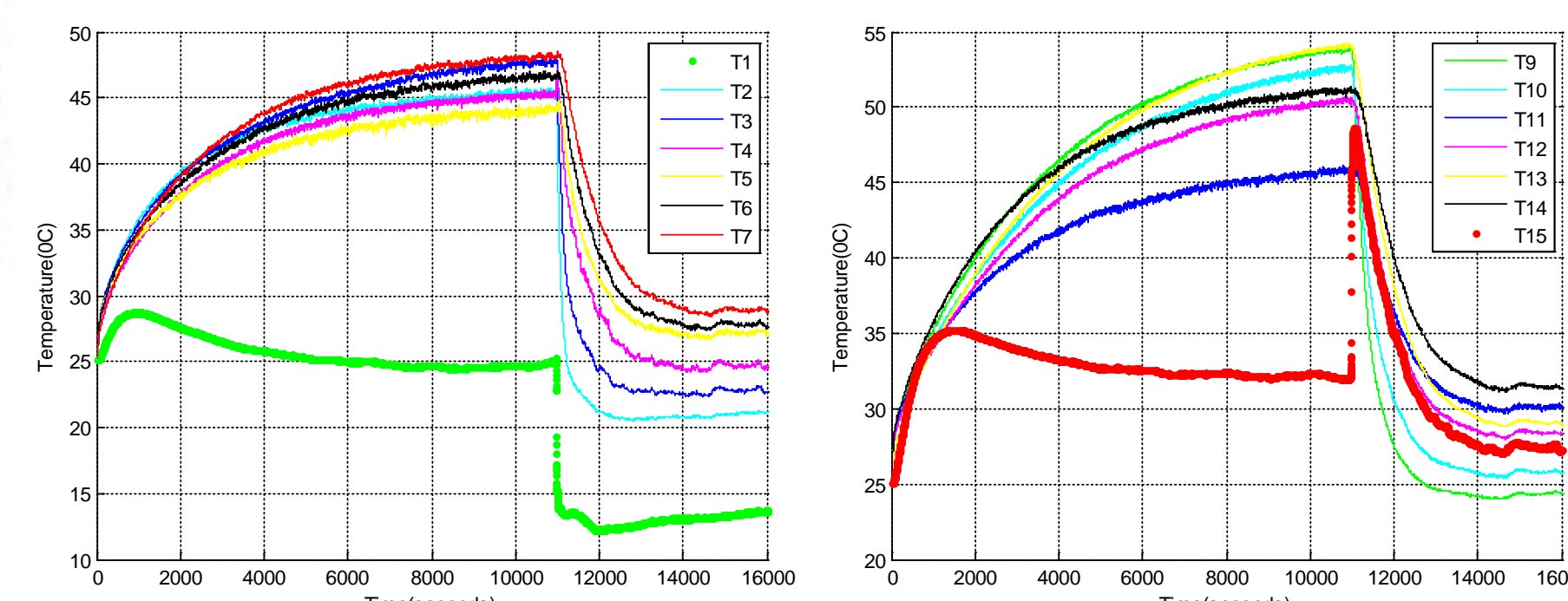
➤ A multi-functional BIPVT solar panel has been developed for energy efficient buildings



➤ A new vibration-sedimentation massive production process has been developed for fabricate a novel functionally graded material.



- (a) mixing of Al particles and HDPE powder with ethanol;
- (b) sedimentation and vibration of mixed suspension;
- (c) degassing of the dried mixture in vacuum oven; and
- (d) cross-section of the cured FGM

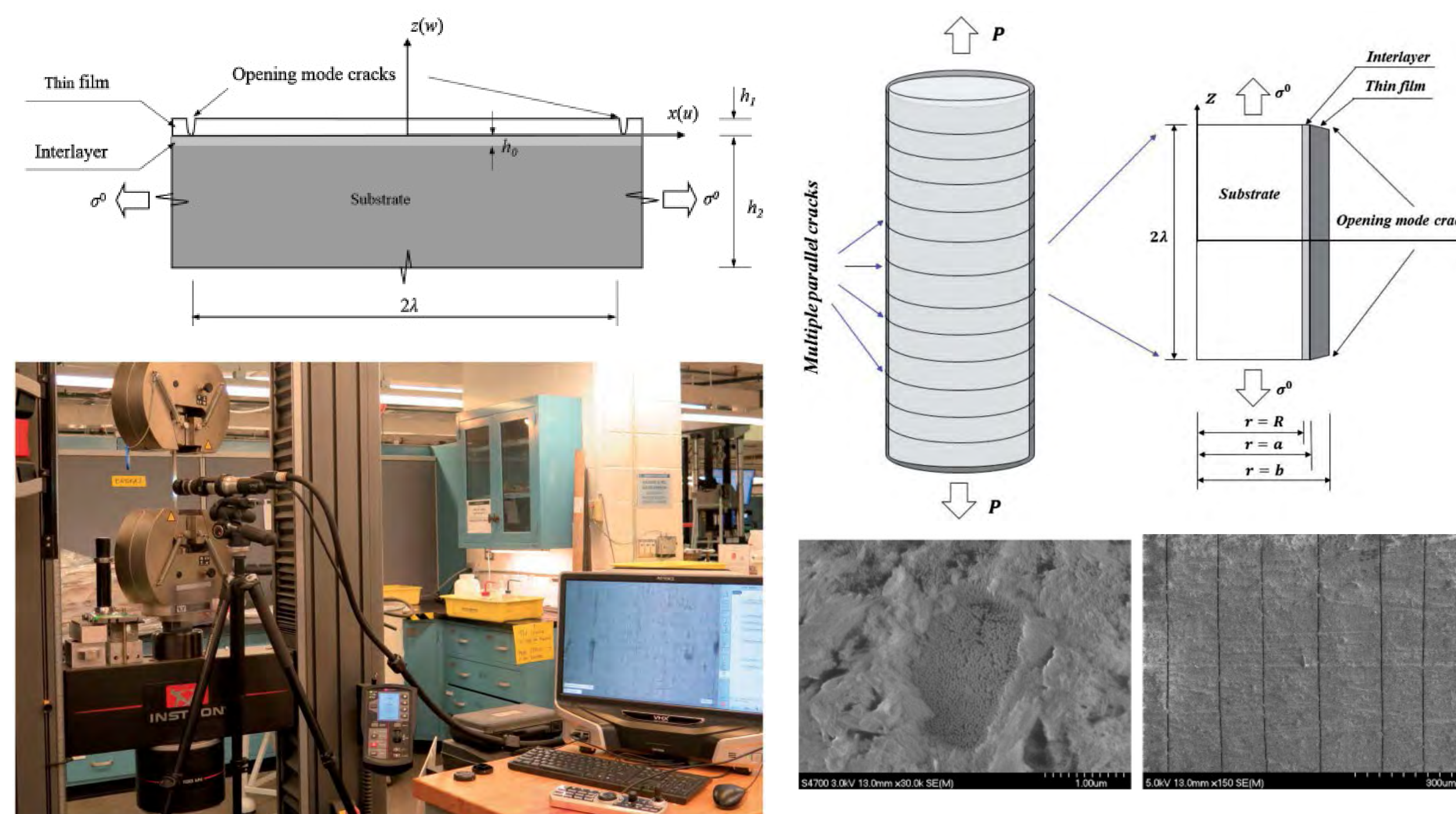


Highlights

- The PV efficiency is enhanced ~24% through temperature control of the panel by water flow.
- The combined electric and thermal efficiency reaches >75% of solar irradiation.

Fracture and delamination analysis of solar panels

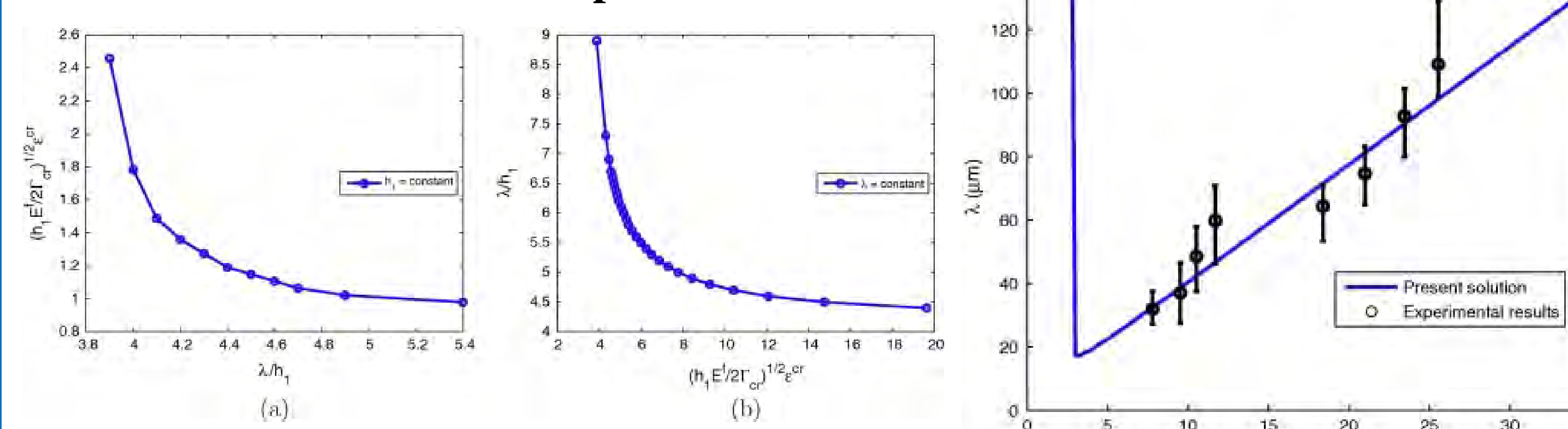
➤ 2D elasto-plastic fracture models for the opening-mode fractures in the coating on ductile solar panel substrate



Fracture testing and in-situ observation

Microstructure investigations

➤ Closed-form solutions and predictions



Fracture spacing development with respect to the external tensile loading: (a) constant coating thickness; and (b) constant crack spacing.

Variance of fracture spacing with respect to coating thickness

Publications

- F.L. Chen, X. He, P.A. Prieto-Muñoz, H.M. Yin, International Journal of Plasticity, 2015.
- X. He, F.L. Chen, H.M. Yin, Journal of Damage Mechanics, 2016 (in press).

Accelerated testing for the long-term performance and environmental impacts of solar panels



Q-Fog accelerated corrosion chamber



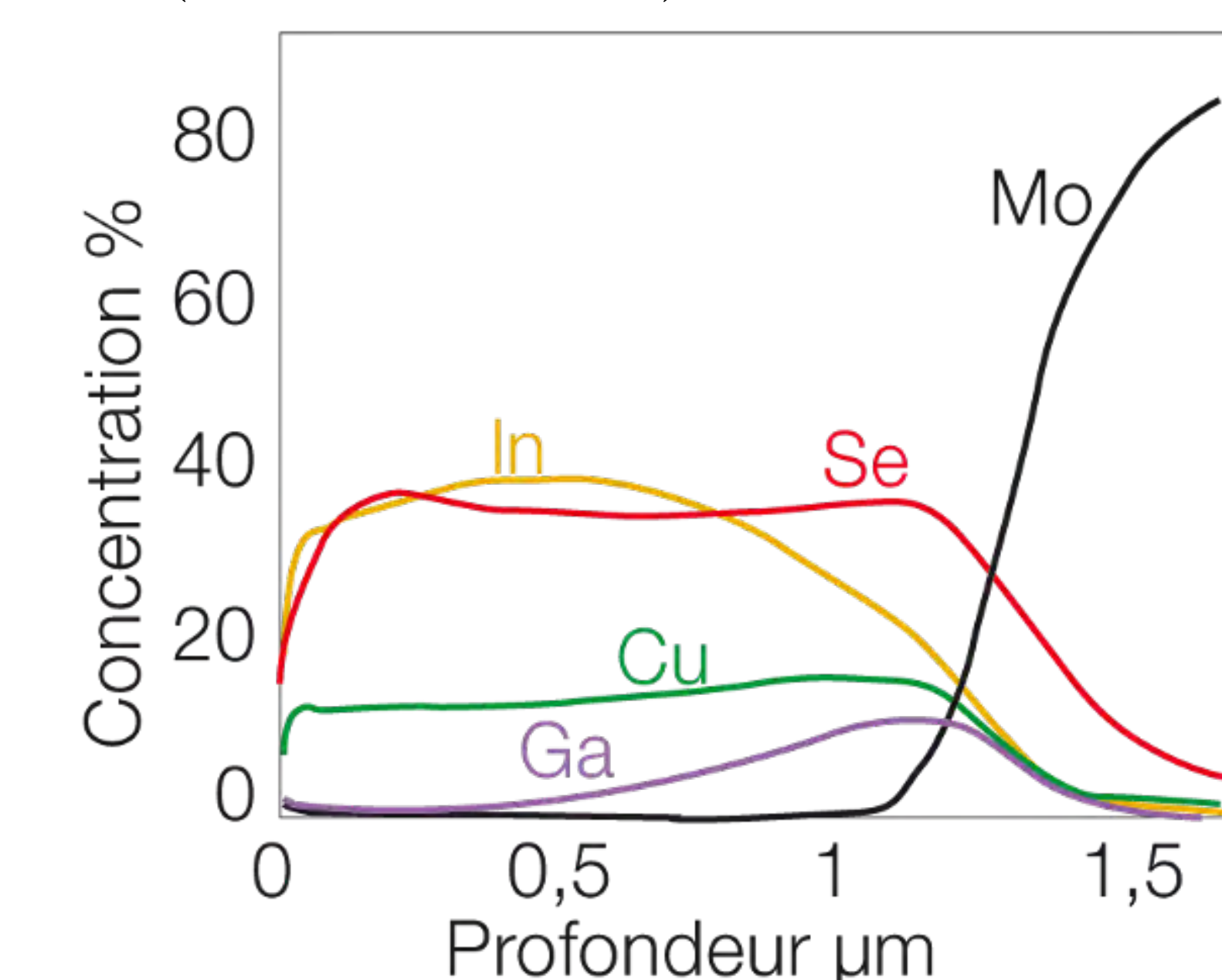
QUV accelerated weathering tester



Multifunctional weathering chamber (under construction)



GD Profiler HR, Measure the oxidation and diffusion of materials during aging and degradation process in the depth direction



Publication

- X. He, D. Hochstein, Q. Ge, W. Ali, F.L. Chen, H.M. Yin, to be presented in Transportation Research Board 2017 Annual Meeting

Projects and Acknowledgements

- NSF CAREER: Energy in sustainable infrastructure – multi-scale/physical approach to a novel hybrid solar roofing panel
- DOE STTR: Hybrid building integrated solar energy system for photovoltaic, thermoelectric and heat utilization, Department of Energy, DE-SC0003347,
- Integrated investigation of polyuria coatings for infrastructure protection, Department of Homeland Security, DHS CU09-1155
- DURIP – Multifunctional Weathering System for Life Cycle Performance Investigation of Emerging Polymer Materials and, Office of Naval Research
- Chain-Structured Strain and Fracture Sensor for Bridge Structural Health Monitoring,, National Science Foundation, CMMI 1301288
- Environmental impacts of RAP, New Jersey Department of Transportation.
- Wear testing using roadway loading parameters, Con Edison Company of New York, Inc.,
- The support from the Henry Mitchell Weitzner Research Fund

Facilities

1. **Environmental chambers and ovens**
 - Sun room with 4KW metal halide global (MHG) lamp
 - Multifunctional environmental chamber
 - Freeze/Thaw Chamber
 - QUV Aging Chamber
 - Large and medium size ovens (27 ft3 and 9 ft3)
 - Vacuum oven (9 ft3)
2. **Material preparation and characterization facility**
 - NETSCH NanoFlash LFA 447
 - Malvern Particle Mastersizer 2000
 - Molds
 - MK Sew (diameter 3 ft)
 - Hot Plates
 - Daytona Driller
 - Machine Shop with various metalworking facilities
3. **Image Processing facilities**
 - Hitachi 4700 Scanning Electron Microscope
 - Zeiss Optical Microscope
 - Digital Image Processing Capabilities
 - Specimen Preparation Facilities
4. **Material micro-mechanical and thermal property test**
 - Gemini II Rheometer
 - Mastersizer 2000 Particle Analyzer
 - Netzsch NanoFlash Thermal Diffusivity Analyzer
 - 3 σ thermal conductivity instrumentation.
5. **Material mechanical test facilities**
 - Southwark Emery 600k Universal Tester
 - Baldwin 200k Universal Tester
 - MTS 220k Dynamic Universal Tester
 - Instron 30k Universal Tester

Publications

- F.L. Chen, X. He, H.M. Yin, Energy and Buildings, 2016.
- F.L. Chen, H.M. Yin, Applied Energy, 2016.

Manufactory collaborator

