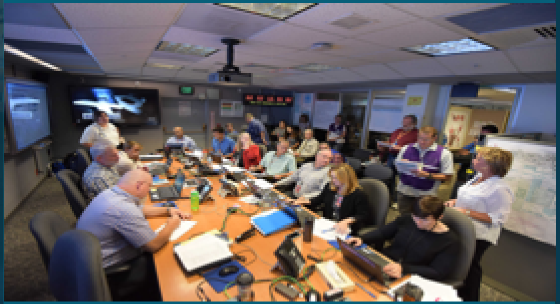
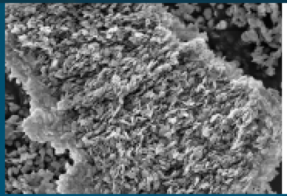
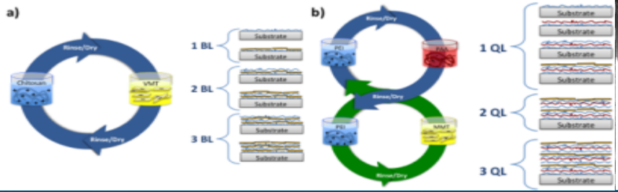
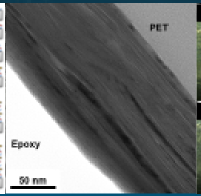
SAND2020-13045PE

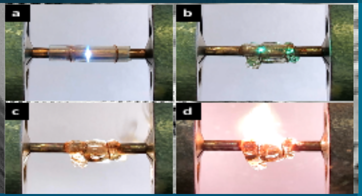
Polymer-Clay Nanocomposites for PV barrier materials











Margaret Gordon, Erik Spoerke, Eric Schindelholtz, Ken Armijo, Rob Sorensen

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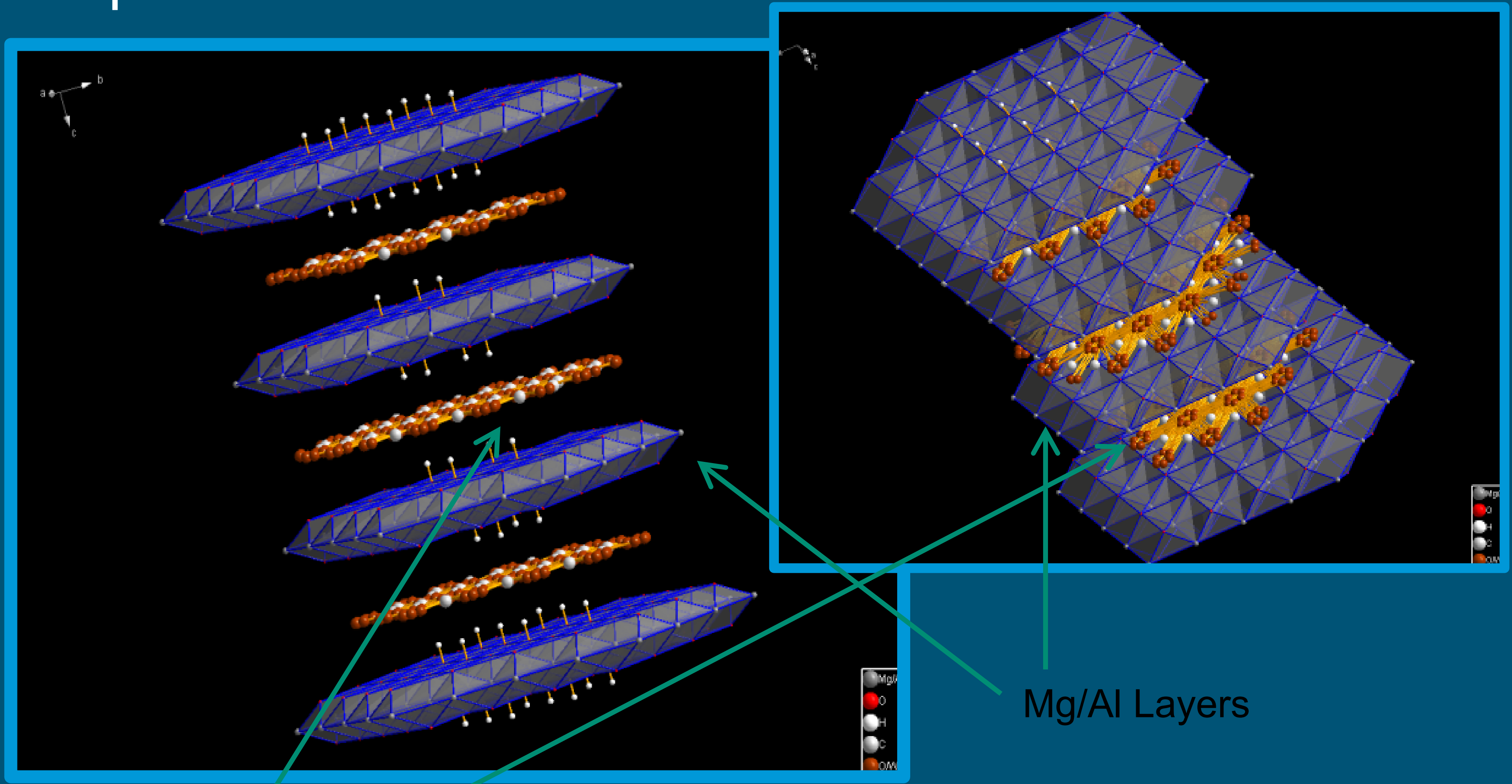
Clay component structure

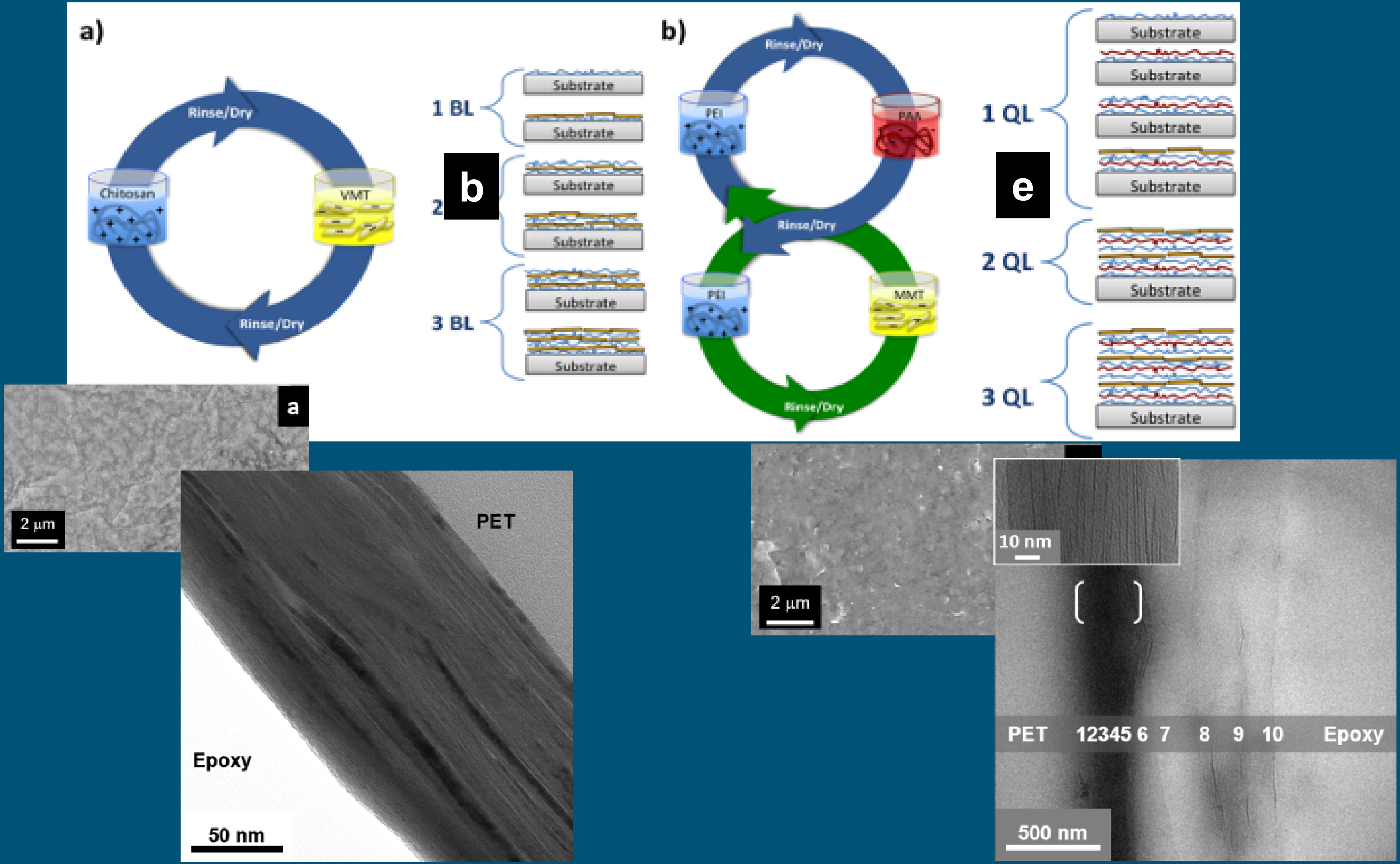


Mg/Al Layers

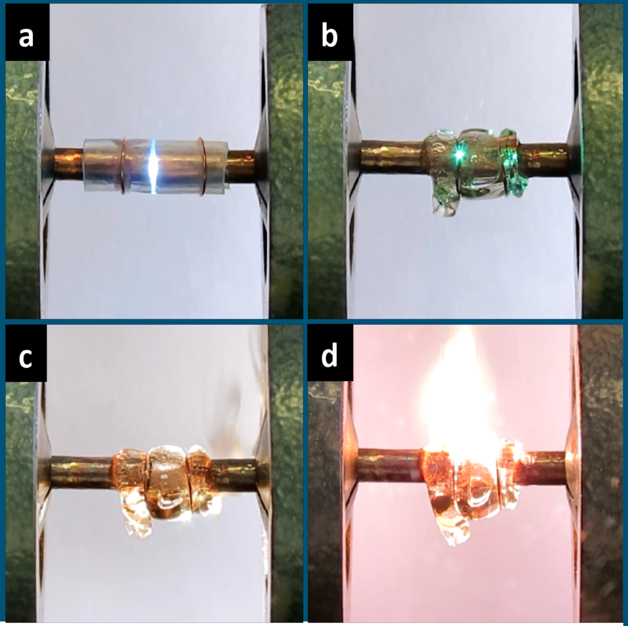
Interspace With Water and CO_3 Counter Anions

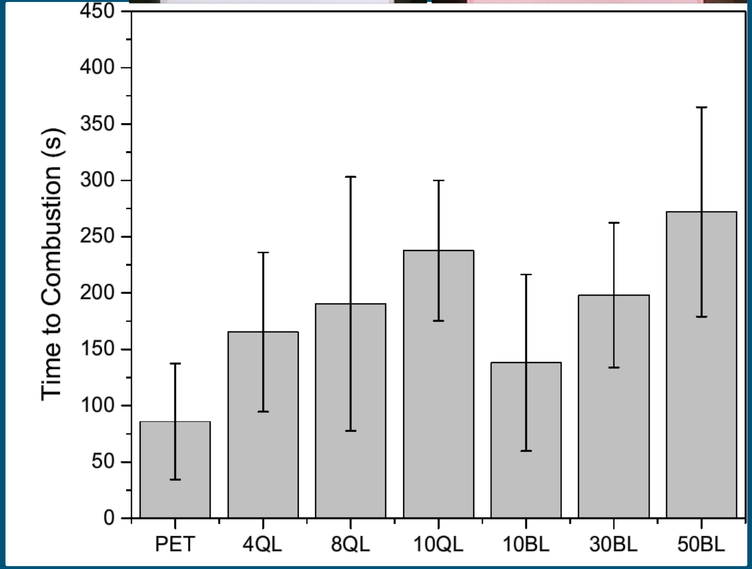
- Layered Structure Reflects Vertical "Stacking"
- Reflects Preferred Horizontal Growth
- Segregation of layers for nanocomposite building
- Aspect ratio control from ~80 nm to ~2 microns

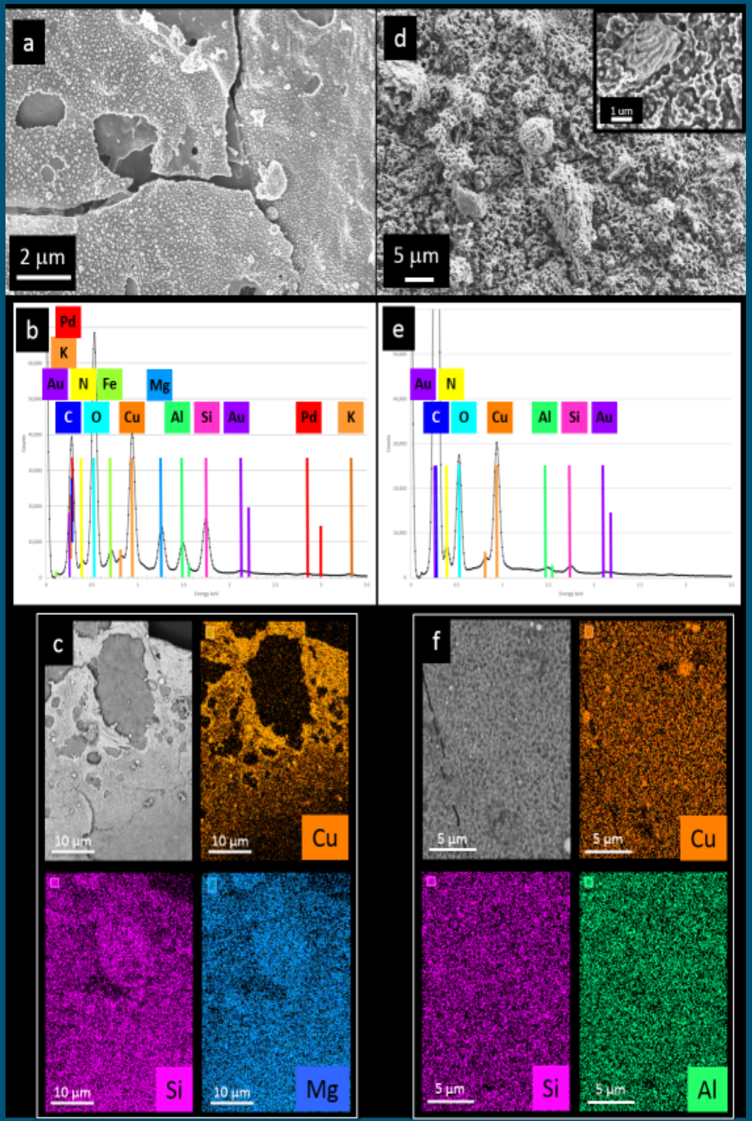
Layer-by-Layer film growth



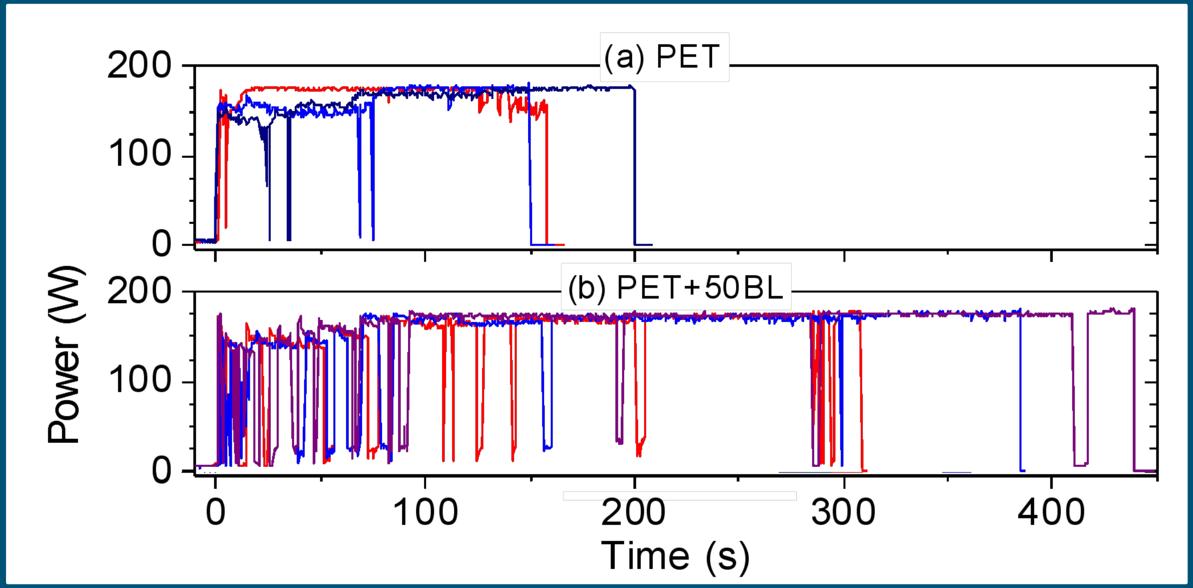
Arc Fault Protection







Arc Fault Extinguishment

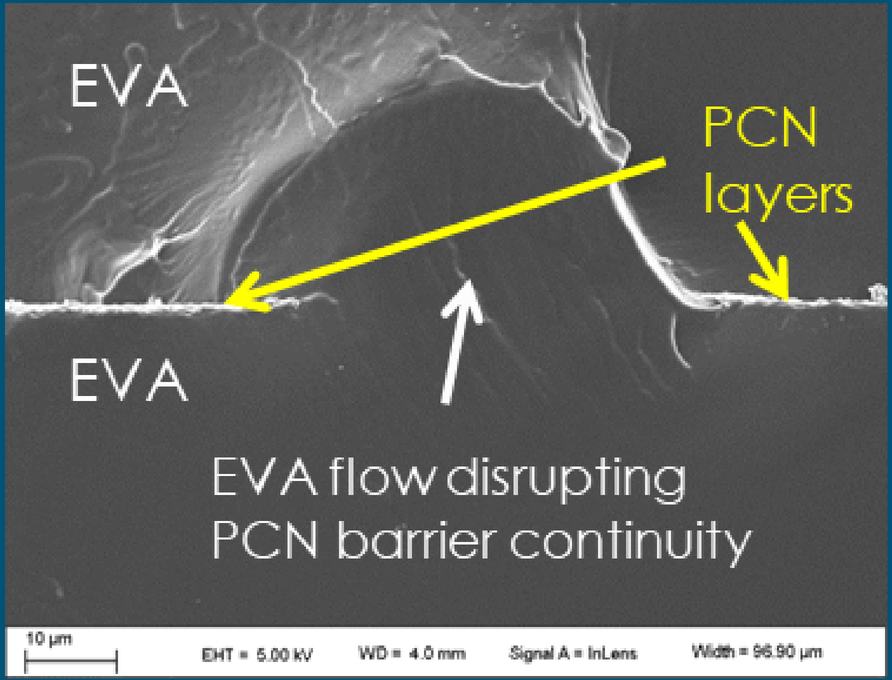


Arc-test data showing arc power over time when exposed to polymer (PET) and PCN-coated polymer sheaths. Experiments run until polymer ignition. Each drop in current signals extinguishment of the arc, requiring restart. Average time to ignition is much longer and the frequency of extinguishing events is MUCH higher in PCN-coated materials.

1) Electrical arcing due to faults in corroded or damaged electronics in a solar cell can lead to ignition of solar components, modules, and local structures (roofs, arrays, etc.)
2) Coated polymer sheaths were exposed to an SNL-developed electrical arc (100-300W), and showed dramatically increased time to ignite coated polymer sheath relative to uncoated controls.
3) In addition to preventing ignition of polymer substrates, also showed ability to extinguish electrical arcs.
4) When coated directly onto PV electrical materials (Tabbing wires), PCNs also showed ability to extinguish arcing between tabbing wire electrodes (simulating broken or damaged wiring in a cell).

PCNs can be applied as a passive, materials-based solution to the hazards of electrical arc-faults. Implications extend beyond photovoltaics into a wide range of power electronics (energy storage, nuclear energy, power transmission, etc.)

Functional integration in a PV system



When two PCN-coated EVA are laminated together, the PCN barrier interface is disrupted by the plastic flow of the EVA polymer.

1) Understanding where to put PCNs in a solar cell is critical to its ultimate utility.

2) PCNs can be effectively coated as a highly transparent, well-adhered film on glass, EVA (encapsulant), electronics (metals, wires, silicon), and backsheet materials (PET-based).

3) PCNs can be deposited on large –scale, using reel-to-reel techniques. We demonstrated successful deposition of 6QL on 60ft of EVA 11 inches wide.

4) As an effective O_2-barrier and a limited water vapor barrier, it may have potential as a barrier coating on backsheet materials. Combining PCNs with better moisture barriers (e.g., ALD-based inorganic coatings), may improve moisture barrier properties.

5) PCNs are not effective as gas barriers when applied to EVA. The laminating process used to seal EVA-encapsulants leads to deformation of the EVA and disruption of the PCN barrier film.

Questions?

Thank you to the team: Erik Spoerke (PI), Eric Schindelholtz, Ken Armijo, Rob Sorensen, and collaborator on related work Professor Jaime Grunlan (Texas A&M University)

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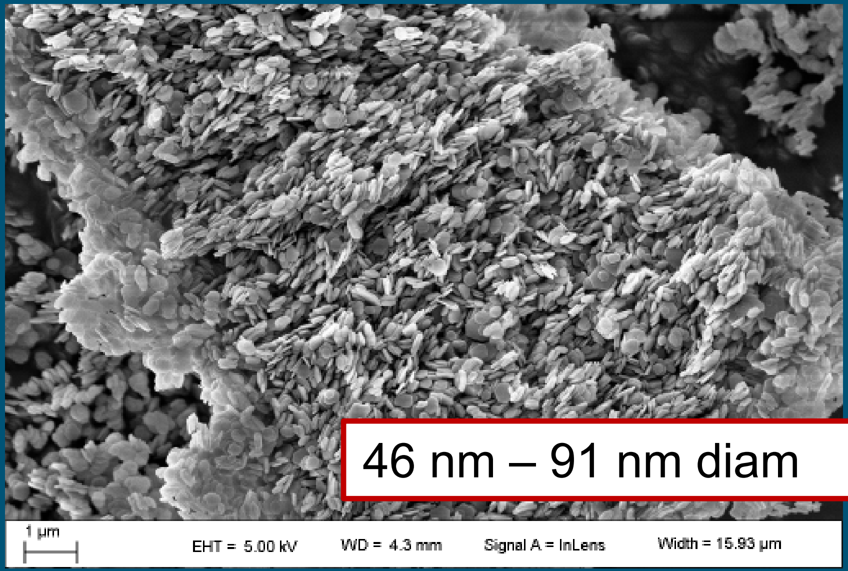
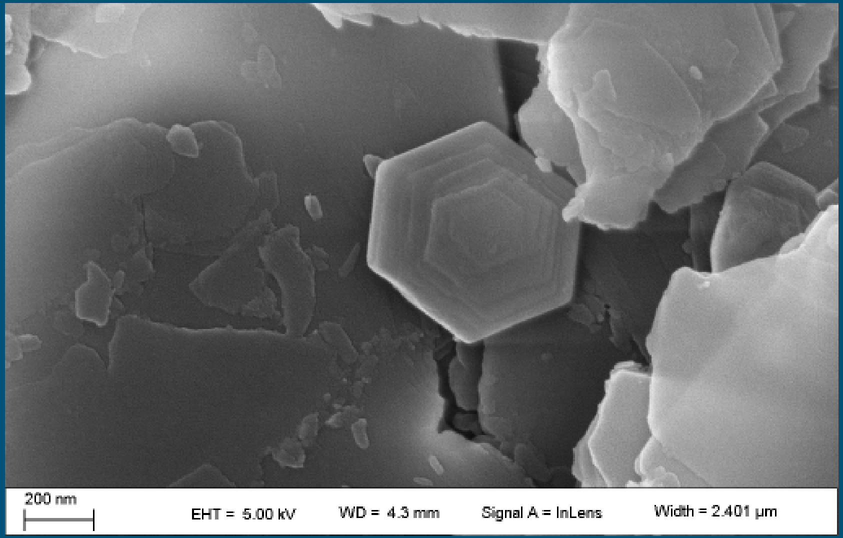
Aspect Ratio Control





Hexagonal Platelets at a Nanoscale