Stable Perovskite Solar Cells Fabricated Under Humid Ambient Conditions (PV-3)

A joint India-U.S. research consortium funded under the *Joint Clean Energy Research & Development Center (JCERDC)*

Scientific Achievement:

We developed a method to fabricate highly stable perovskite solar cells under high relative humidity (50%), without any encapsulation. A typical solar cell retains 80% of maximum efficiency after 1,200 hours (Fig. 1) and the material is stable for more than 2,500 hours.

Significance and Impact:

The method developed in this paper can make feasible the large-scale fabrication and application of perovskite solar cells.

Research Details:

- Stability of perovskite solar cells was improved by an optimized P3HT hole-transporting layer, optimized mesoporous TiO_2 layer, and small amount of tetraethyl orthosilicate (TEOS) as an additive to the perovskite material.
- In TEOS-doped device, water molecules from air that penetrate the P3HT covering layer react with TEOS, forming SiO_2 and ethanol. Ethanol evaporates from the device, leaving the SiO_2 at the grain boundaries. SiO_2 physically passivates the grain boundaries, thus forming an *in-situ* protection layer to prevent further infiltration of water though the most vulnerable grain boundaries (Fig. 2).

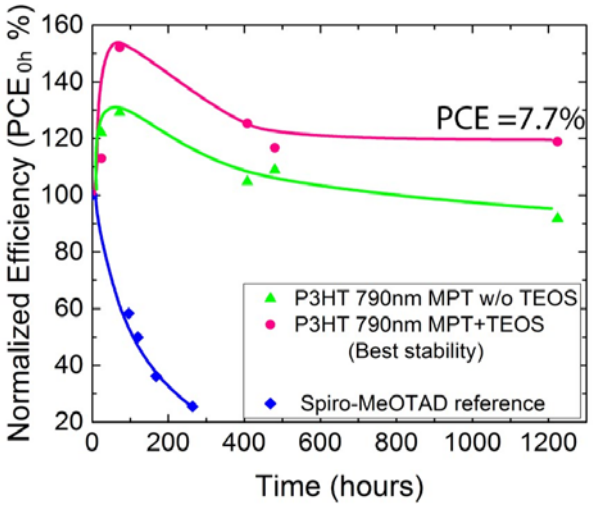

Fig. 1. Long-term stability among the TEOS-doped device, undoped device, and spiro-MeOTAD reference device.

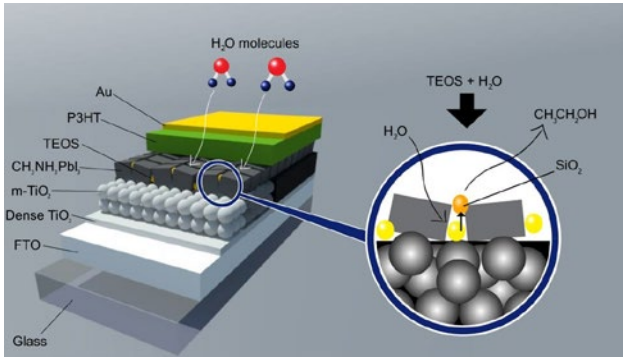

Fig. 2. Mechanism of the TEOS activity in the perovskite layer.

Publication(s): B.A. de Carvalho, S. Kavadiya, S. Huang, D.M. Niedzwiedzki, P. Biswas, "Highly stable perovskite solar cells fabricated under humid ambient conditions," *IEEE Journal of Photovoltaics* (2017)
DOI: 10.1109/JPHOTOV.2016.2642639

Contact: Pratim Biswas (*pbiswas@wustl.edu*)