Enhanced Water-Vapor Blocking for Photovoltaic Cells (PV-6)

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

Scientific Achievement:

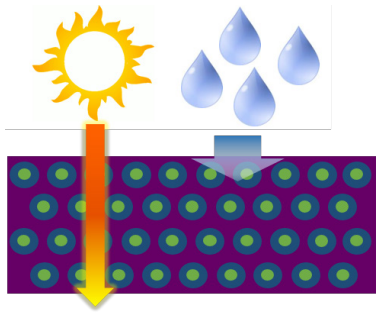
We synthesized a new, hybrid barrier material to protect photovoltaic active layers. It comprises block co-polymer (PS-P2VP) and hygroscopic nanoparticles (MgO). The hybrid structure enhances the barrier properties—hydrophobic polystyrene (PS) layers block most water, and what water makes it through is scavenged by hygroscopic MgO nanoparticles in poly-2-vinylpyridine (P2VP) domains.

Significance and Impact:

The water-vapor transmission rate (WVTR) of all our samples is reduced by ~3,000 times compared to the homopolymer by this strategy, even though a hydrophilic part (P2VP) is added. This is a new approach to improving barrier materials.

Research Details:

- We report a new water-vapor barrier composite material, composed of block co-polymer and hygroscopic nanocrystals. The hygroscopic nanoparticles, dispersed in the block co-polymer matrix, provide obstacles for water-vapor molecules and at the same time act as a reactive species, scavenging water vapor.



	Thickness (nm)	WVTR (g·mil/(m^2·day)
PS-P2VP(S)	523±13	$3.076*10^{-3}$
PS-P2VP(S)-MgO	370±10	$2.118*10^{-3}$
PS-P2VP(L)	517±1	$3.285*10^{-3}$
PS-P2VP(L)-MgO	460±10	$2.845*10^{-3}$
PS (homopolymer)		7.286

Illustrations of block co-polymer (PS-P2VP, purple, navy) and hygroscopic nanocrystal (MgO, green) composite (upper figure) and their WVTR values (lower figure).

Publication: E.S. Cho, C.M. Evans, E.C. Davidson, M.L. Hoarfrost, M.A. Modestino, R.A. Segalman, J.J. Urban, "Enhanced water vapor blocking in transparent hybrid polymer–nanocrystal films," *ACS Macro Lett.* **4**, 70 (2015) [DOI: 10.1021/mz500765y]

Contact: Jeffrey J. Urban (jjurban@lbl.gov)