Standardizing perovskite aging measurements

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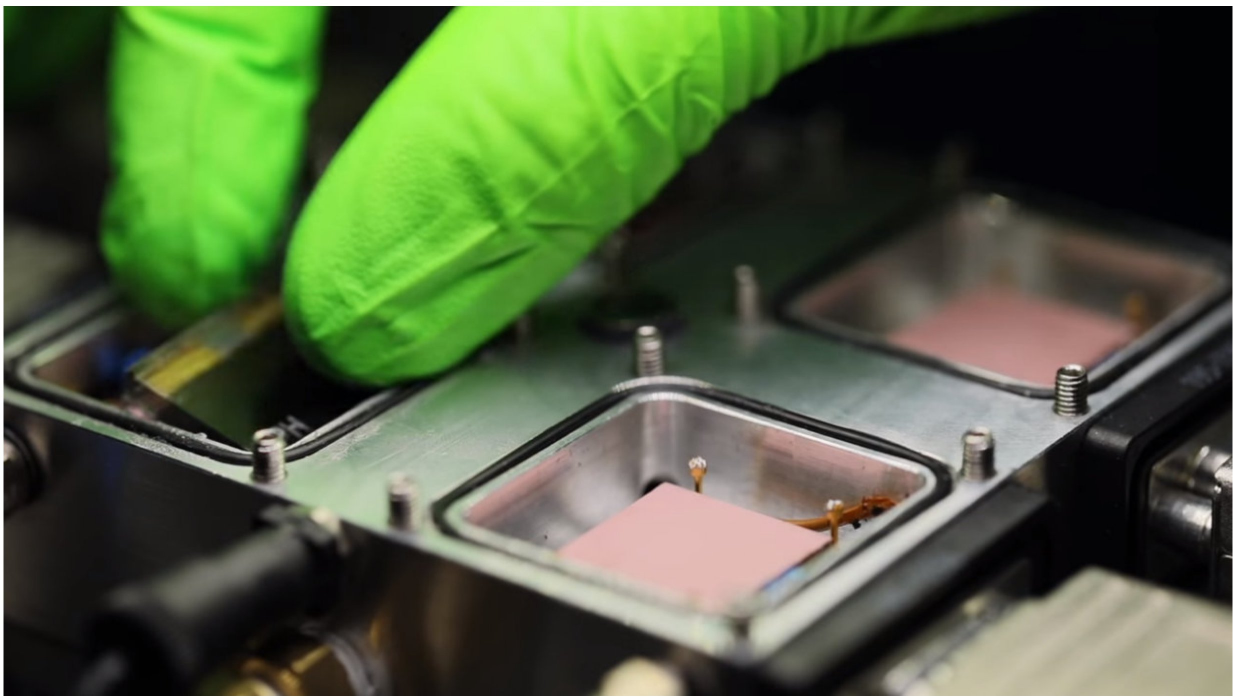

Perovskite solar cells are an alternative to conventional silicon solar cells, and are poised to overtake the market with their high power-conversion efficiencies (over 22% now) and lower capital expenditure and manufacturing costs. But one of the greatest obstacles on this road is stability: to be commercially viable, perovskite solar cells must also be able to maintain their efficiency over time, meaning that they must not degrade significantly over 25 years of service.

"As a first-order approximation, we are talking about stabilities of several years for the most stable perovskite solar cells," says Konrad Domanksi, first author on the paper. "We still need an increase of an order of magnitude to reach the stabilities of silicon cells."

While research efforts are continuously made to improve perovskite stability, the community is hamstrung by the fact that there are no general standards by which scientists can measure the stability of perovskite solar cells. Consequently, the results coming in from different laboratories and companies cannot be easily compared to each other. And even though dedicated stability measurement standards have been developed for other photovoltaic technologies, they have to be adapted for perovskite solar cells, which show new types of behavior.

Now, the labs of Michael Grätzel and Anders Hagfeldt at EPFL have carried out a study that proposes to standardize the measurements of perovskite solar cell stability across the entire field. The researchers investigated the effects of different environmental factors on the ageing of perovskite solar cells, looking at the impact of illumination (sunlight-level light), temperature, atmospheric, electrical load, and testing a systematic series of combinations of these.

"We designed and built a dedicated system to carry out this study," says Domanski. "It is state-of-the-art for measuring stability of solar cells - we can vary light intensity over samples and control temperature, atmosphere etc. We load the samples, program the experiments, and the data is plotted automatically."

The study shows how certain behaviors specific to perovskite solar cells can distort the results of experiments. For example, when the cells are left in the dark, they can recover some of the losses caused by illumination and "start fresh in the morning". As solar cells naturally undergo day-night cycles, this has important implications on how we define that a solar cell degrades in the first place. It also changes our perception on the metrics used by industry to describe lifetime of solar cells.

"The work can lay the foundations for standardizing perovskite solar cell ageing," says Wolfgang Tress, last author on the paper. "The field can use it to develop objective and comparable stability metrics, just like stabilized power is now used as a standard tool for assessing power-conversion efficiency in perovskite solar cells. More importantly, systematically isolating specific degradation factors will help us better understand degradation of perovskite solar cells and improve their lifetimes."

"We are not trying to impose standards on the community," says Domanski. "Rather, being on the forefront on perovskite solar cells and their stability research, we try to lead by example and stimulate the discussion on how these standards should look like. We strongly believe that specific protocols will be adopted by consensus, and that dedicated action groups involving a broad range of researchers will be formed for this purpose."

More information: Konrad Domanski et al, Systematic investigation of the impact of operation conditions on the degradation behaviour of perovskite solar cells, *Nature Energy* (2017). DOI: 10.1038/s41560-017-0060-5

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