Mesoporous interface mitigates the impact of defects in perovskite solar cells

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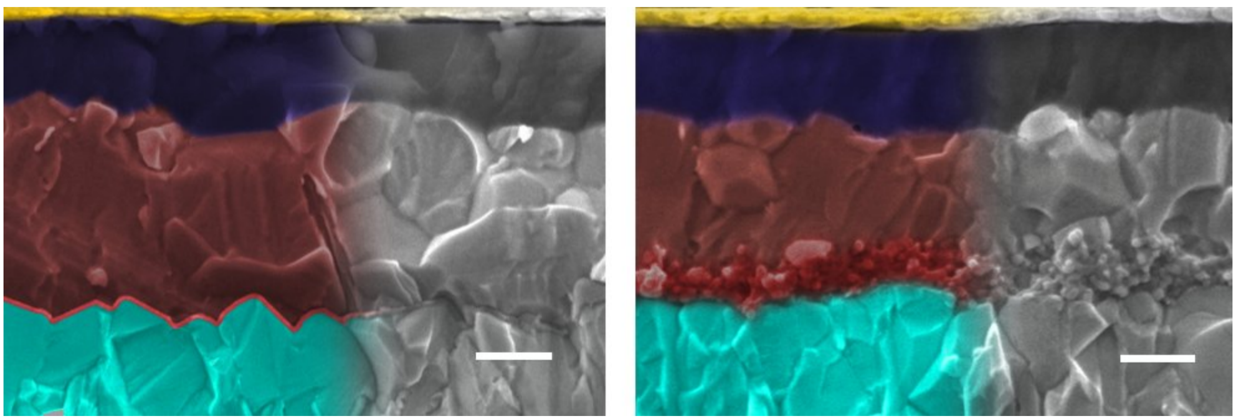

SEM-images of the different perovskite solar cell architectures, left with planar interface, right with mesoporous interface. Images are coloured: metal oxide (light blue), interface (red), perovskite (brown), hole conducting layer (dark blue), topped with contact (gold). Scale bar is 200 nm. Credit: A. Gagliardi/TUM

The nominal cell operating life of perovskite solar cells is strongly influenced by their inner architecture. This was shown by two scientists at the Helmholtz-Zentrum Berlin and the Technical University of Munich. They combined experiments with numerical simulations in order to explain this observation.

In only a few years, efficiencies of perovskite solar cells have been raised from 3 percent to more than 20 percent. Furthermore, the material is inexpensive and easy to process, suggesting a great future for photovoltaics. Unfortunately, there are still issues, including their nominal operating life: Conversion efficiencies decrease sharply when the material is exposed to UV radiation and electric fields, as is the case in real operating conditions. Now, Dr. Antonio Abate and Prof. Allessio Gagliardi, TU Munich, have published new results on the influence of the architecture of perovskite cells on their nominal operating life in the journal *ACS Energy Letters*.

The scientists explored different architectures of perovskite cells, preparing them under identical conditions using metal-oxide electron transport layers (ETL) such as TiO2 and SnO2. One group of cells had a planar interface between perovskite and ETL, whereas in the other one, a mesoporous interface intermingled perovskite and metal oxide to form a sponge-like structure containing a huge number of extremely tiny pores. Surprisingly, the perovskite cell with the mesoporous interface exhibited better output stability over time than the planar ETL-perovskite interface.

After careful experimental observations and numerical simulations, the scientists provided an explanation: "The benefit induced by the mesoporous interface is fundamentally due to its large surface area," Abate explains. Defects that compromise the power output and operating life and which accumulate during operation at the ETL tend to get diluted in this large surface.

The scientists even obtained a threshold density for those defects: Above a certain threshold, the output power of the solar cell decreases rapidly. But below this threshold, the maximum power output remains stable. "We demonstrated that devices in a mesoporous configuration are more resilient to defect accumulation than in a planar configuration," Abate concludes.

More information: Alessio Gagliardi et al, Mesoporous Electron-Selective Contacts Enhance the Tolerance to Interfacial Ion Accumulation in Perovskite Solar Cells, *ACS Energy Letters* (2017). DOI: 10.1021/acsenergylett.7b01101

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