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Ingression of Moisture into Hybrid Perovskite Thin Films Probed with In-Situ GISANS

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Organometal halide perovskites mark a paradigm shift in photovoltaic research, as they combine high power conversion efficiencies with easy processing and cheap, abundant precursor materials making them a promising contender for other photovoltaic technologies. The commercial application of perovskite solar cells, however, is so far impeded by fundamental understanding lacking behind this fast progress in device efficiency. Though progress in device efficiencies has been remarkable, especially the sensitivity of the perovskite towards ambient moisture is a big issue which basically renders them unsuitable for widespread use as toxic lead – contained e.g. in $CH_3NH_3PbI_3$, the most commonly used hybrid perovskite – could leak into the environment. Therefore, a lot of research focusses on improving the moisture stability of the perovskite, however, the process of the water uptake itself was so far not deeply addressed. Due to the high sensitivity of CH3NH3PbI3 to water, it tends to hydrolyze in the presence of moisture, leading to the degradation of the perovskite at a critical humidity of 55 %RH [1].

Using grazing-incidence small angle neutron scattering (GISANS) and introducing D_2O vapor, we probed the kinetics of water uptake and followed the structural evolution of a perovskite film synthesis with a common method [2]. We applied several humidities including humidities below and above the critical 55 %RH. As apparent from a shift in the Yoneda peak in the in-plane cuts of the 2D GISANS data the perovskite film is capable of up to 42 % water uptake, whereas the out-of-plane cuts indicate different degradation products depending on the humidity level. Furthermore, we gain insight into the reaction kinetics.

Based on this knowledge routes to stabilize perovskite films against moisture can be developed leading to higher long-term stability and less environmental hazards thus promoting fast market introduction of perovskite solar cells.

References:

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