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Accelerated testing of organic and perovskite photovoltaics using concentrated sunlight

Eugene A. Katz

Ben-Gurion University of the Negev, Israel

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A significant challenge en route to commercialization of such novel photovoltaic (PV) technologies as organic PV (OPV) and perovskite-based solar cells is the development of devices combining high efficiency and operational stability. While the efficiency can be measured within seconds, the timescale for stability assessment may be of the order of months or years, raising the need for relevant accelerated stability tests. We suggested to use concentrated sunlight for accelerated studies of OPV degradation [1] and demonstrated experimental methodology that allows an independent control of light intensity (up to 4,000 suns) and the sample temperature during the exposure [2]. This allows to study various routs of OPV degradation [3] and to separate light induced mechanisms from those controlled just by the cell temperature.

Recently, we used this experimental approach for study of photochemical stability of halide perovskites $MAPbX_3$ films (X = I or Br) [4] and their solid solutions $MAPb(I_{1-x}Br_x)_3$ [5]. The relevance of accelerated testing to standard operational conditions of solar cells was confirmed by comparison to degradation experiments under outdoor sunlight exposure. We found that $MAPbBr_3$ films exhibited no degradation, while $MAPbI_3$ and mixed halide films decomposed yielding crystallization of inorganic PbI_2 accompanied by degradation of the perovskites' solar light absorption. The rate of such decomposition was found to depend on light intensity, the halide content and the exposure temperature. The crystal coherence length was found to correlate with the stability of the films.

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