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The state of external circuit affects the stability of dye-sensitized solar cells

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Abstract

We found that the electrical state in which dye solar cells operate affect their ageing. Three states were analysed: open-circuit (OC), short circuit (SC), and under maximum power point (MPP) / load. OC and SC are more or less atypical states, which are relevant while storing cells or in the event of malfunction, whereas the MPP/load corresponds to real life operation of the cells. Our results indicate that keeping the cells at OC or near the MPP lead to practically identical stability, whilst the cells at SC degraded much faster in a 1,000 h light soaking test. The underlying cause for the degradation of all the cells was the loss of tri-iodide (i.e. limiting charge carriers) in the electrolyte. While the degradation mechanism appears to be the same, the loss rate of tri-iodide was about five times faster with SC than with OC and MPP cells. In the SC cells, the loss of tri-iodide decreased both the short-circuit current and fill factor resulting in a 36 % efficiency loss by the end of the test. In contrast, the efficiency of the OC and load cells remained quite stable throughout the test. Since OC is the most commonly used state in aging tests, it is good news for ageing studies that the real life MPP state and the OC state yield roughly similar results. The identification of the degradation pathway, the loss of charge carriers, and the related degradation rate were used to estimate the remaining lifetime of cells which did not degrade during the 1,000 h test. Based on the degradation rate related to the charge carrier loss, full degradation of the OC and MPP cells is expected in approximately 3,000 hours of operational time.