Effects of Temperature on the Performance of Perovskite Solar Cells

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Since perovskite solar cells (PSCs) burst into the photovoltaic world, they have attracted huge interest in the scientific community. This is thanks to its unique optoelectronic performance and the step growth of its efficiency. Nevertheless, several aspects regarding the evolution of their performances under operational conditions are still under debate. Open questions include the effect of the temperature on the main photovoltaic parameters, the reversibility of the associated physical phenomena and the degradation of the different layers making up the device. In this work, we propose a combined theoretical and experimental approach to investigate under realistic conditions the evolution of key parameters such as as the open-circuit voltage (*V*oc), the short-circuit current (*J*sc), and the electrical efficiency (η) by varying the temperature in the range from 273 to 323 K. For this purpose, we have designed a protocol which allows measurements of temperature coefficients during the experiments induced by light, heat and scan direction of IV curve. This protocol is based on a pre-light soak at low temperature. Then, the *V*oc and *J*sc are measured at different temperatures. The time scale between the measurement of *V*oc and *J*sc is adjusted until to find the thermal equilibrium of the cell and the plateau of these parameters. In this way, this protocol avoids extracting erroneous transient values which come from the ion migration when the polarization is changed. From the experimental results, we have observed a change in the thermal behavior between very low and high temperature. Different reversible and irreversible phenomena are detected if the measurements have been done during an increase or decrease of the scan temperature. In addition, from the comparison between the experimental results and a previously proposed thermo-electrical model [4], we evaluate what are the most affected regions in the device. The thermo-electrical model is based on a RC Model that takes into account the essential thermal transfers which take place in a solar cell: conduction, radiation and convection. The deep understanding of the behaviour of the perovskite material at different temperatures can help us to define new paths of improving its design and optimization.

References

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