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第 19 回「次世代の太陽光発電システム」シンポジウム（第 2 回日本太陽光発電学会学術講演会）
講演予稿集 （2022.6.28-29） ©日本太陽光発電学会

Surface Modification of SnO_2 by Potassium Carboxylate for MA-free Perovskite Solar Cells with Efficiency over 22%

-Synergy Effect of Potassium Cation and Carboxylic Acid-

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1. Introduction

In the last decade, halide perovskites have attracted a lot of attention. There is no doubt that the halide perovskite could be widely used in various fields, such as perovskite solar cells (PSCs), perovskite light-emitting diodes, and so on due to their high light absorption, suitable bandgap, long exciton lifetime, and diffusion length. Among them, PSCs show amazing potential and have grown explosively in the past ten years. Up to now, the certified power conversion efficiency (PCE) has reached 25.7%[1]. Although a high PCE of solar cells have achieved, there is still room for efficiency enhancement from the viewpoint of crystallization, interface defects, and so on[2-5].

2. Experimental Section

The control device was prepared by the method described in our previous work[3]. These target devices were fabricated on the SnO_2 substrate which was treated with oteracil potassium (OP) aq. solution (0 ~ 1 mg/mL), 20 μL of OP were spin-coated onto the SnO_2 film for the 30s at 5000 rpm before the fabrication of the perovskite layer.

3. Result and discussion

In this work, the structure of ITO/SnO_2/perovskite/Spiro-OMeTAD/Au was used, as exhibited in Fig. 1a. In order to further improve the PCE and stability of the PSCs, a new multifunctional compound was introduced to the interface between SnO_2 (ETL) and the perovskite layer named oteracil potassium (OP). Fig. 1b and 1c show the *J-V* curves and incident photon-to-current conversion efficiency (IPCE) spectra of the devices modify without or with OP modified, respectively. As exhibited in Fig. 1b, the champion of the control device gave J_{SC} of 24.41 mA/cm^2, V_{OC} of 1.08 V, an FF of 76.12%, and PCE of 20.06% while the target device with 0.75 mg/mL OP gave J_{SC} of 24.82 mA/cm^2, V_{OC} of 1.12 V, an FF of 79.48%, and PCE of 22.09%. The integrated current density obtained from Fig. 1c was estimated to be 23.75 mA/cm^2 (control) and 24.43 mA/cm^2 (target), which is consistent with what was obtained from *J-V* curves. Meanwhile, it can significantly inhibit hysteresis. As presented in Fig. 1d, the average hysteresis index (HI) was substantially reduced from 0.053 to 0.020 after OP modification.

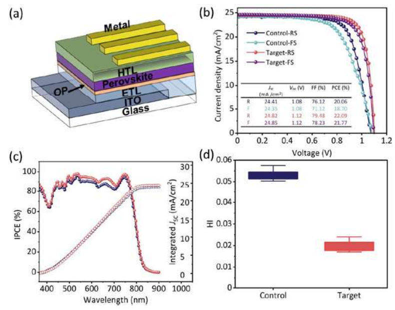

Fig. 1 (a) Device structure of this work. (b) *J-V* curves and (c) IPCE spectra of the champion devices of control and target. (d) Statistical HI distribution.

4. Conclusions

In summary, we have developed a multifunctional interface modification strategy by using OP consisting of C=O and K^+ to manage the SnO_2/perovskite interface. These results guide the realization of high PCE, stable and low hysteresis PSCs using both cation and anion regulation.

Acknowledgements

The authors gratefully acknowledge Prof. Gaoyi Han, Wenjing Hou from Shanxi University (China), and Yao Guo from Anyang Institute of Technology (China) for their strong support of this work.

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