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High efficient fiber-shaped perovskite solar cell

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Flexible fiber electronics are booming up in recent years, which are promising candidates for multifunctional e-textiles or smart fabrics. Fiber-shaped solar cells are considered to meet special energy requirements. Planer perovskite solar cells have attracted wide attention with Power Conversion Efficiency (PCE) of 22.1% in recent years. Moreover, perovskite solar cells have a wide range of raw materials are of low cost to fabricate and are all-solution-processed functional films. These characteristics provide a strong foundation for device preparation on fibrous substrates. We firstly integrate the structure of Ti/c-TiO2/meso-TiO2/perovskite/spiro-OMeTAD/Au into the fiber format (Figure-a). The fiber-shaped perovskite solar cells achieved a 5.3% PCE under AM 1.5 illumination and an apparent 8.4% efficiency in the diffuse model. The device design required no transparent conductive oxides and all the processes for device fabrication were easy to handle and energy-saving. The fiber devices exhibited high reproducibility. Based on the former research, we adopted electrical heating assisted multiple coating method to precisely control perovskite coverage and thickness, which solves the challenges by continuous deposition and hot coating technique. Continuous deposition feature allows improving film coverage and controlling thickness by simply changing the number of coating times. In addition, electrical heating is applied to accelerate film formation and perovskite transformation. A fully covered thin film of perovskite is obtained and the corresponding devices achieve a high average PCE of 6.58% with a narrow standard deviation of 0.558. We further introduce lead acetate as the lead source to improve the perovskite film morphology (Figure-c). A large grain size and uniform perovskite film could be obtained via a simple dip-coating process (Figure-b). The fiber-shaped perovskite solar cells achieved a PCE of 7.53% and VOC of 0.96 V under AM 1.5 illuminations (Figure-c). With further materials optimization and interface engineering, fiber-shaped perovskite solar cell could be practical unites for efficient flexible/wearable energy systems and bring new fascinations for portable fiber electronics.

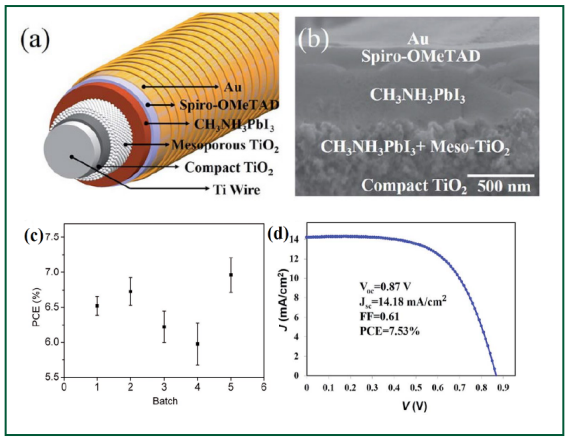

figure-1: (a) schematic; (b) cross-sectional sem image of the fiber-shaped perovskite solar cells based on the lead acetate precursor; (c) reproduction of the highest pce of devices prepared by electrical heating assisted multiple coating method for five batches. each value is the average pce of a batch. error bar is sd; (d) j-v curve of the best-performing fiber-shaped perovskite solar cells based on the lead acetate precursor

Recent Publications

1. Hu Hsienwei, Dechun Zou, et al. (2016) Fiber-shaped perovskite solar cells with 5.3% efficiency. *Journal of Materials Chemistry A*; 4(10): 3901- 3906.
2. Cai Xin, Deuchun Zou, et al. (2014) Flexible planar/fiber-architectured supercapacitors for wearable energy storage. *Journal of Materials Chemistry C*; 2(7): 1184-1200.

Biography

Dechun Zou has completed his BSc from Northwestern Protechnical University and PhD degrees from Kyushu University. He went to Mitsubishi Chemical Corporation as Postdoctoral Fellow. He has worked as Researcher at Tokyo University of Agriculture and Industry, Casio Computer, CREST/JST (Japan Science and Technology Corporation), etc. He went back to China and joined Peking University as a full Professor in College of Chemistry and Molecular Engineering. His field of expertise includes dye sensitized solar cells, hybrid organic-inorganic perovskite based solar cells, flexible/wearable integrated power fiber, memristors and ight-emitting diodes, etc.

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