Electronic Supplementary Material (ESI) for Nanoscale.

Supporting Information

Spray coating of the PCBM electron transport layer significantly improves the efficiency of p-i-n planar perovskite solar cells

Yifan Zheng, Jaemin Kong, Di Huang, Wei Shi, Lyndsey McMillon-Brown, Howard E. Katz, Junsheng Yu and André D. Taylor**

Y. Zheng, W. Shi, Prof. J. Yu
State Key Laboratory of Electronic Thin Films and Integrated Devices, School of Optoelectronic Information, University of Electronic Science and Technology of China (UESTC), Chengdu 610054, P. R. China. E-mail: jsyu@uestc.edu.cn.

Y. Zheng, Dr. J. Kong, D. Huang, L. McMillon-Brown, Prof. A. Taylor
Department of Chemical and Biomolecular Engineering, New York University, Tandon School of Engineering, 6 MetroTech Center, Brooklyn, NY 11201, USA. E-mail: andre.taylor@nyu.edu

W. Shi, Prof. H. Katz
Department of Materials Science and Engineering, Johns Hopkins University, 3400 North Charles Street, Baltimore, Maryland, 21218, United States. E-mail: hekatz@jhu.edu

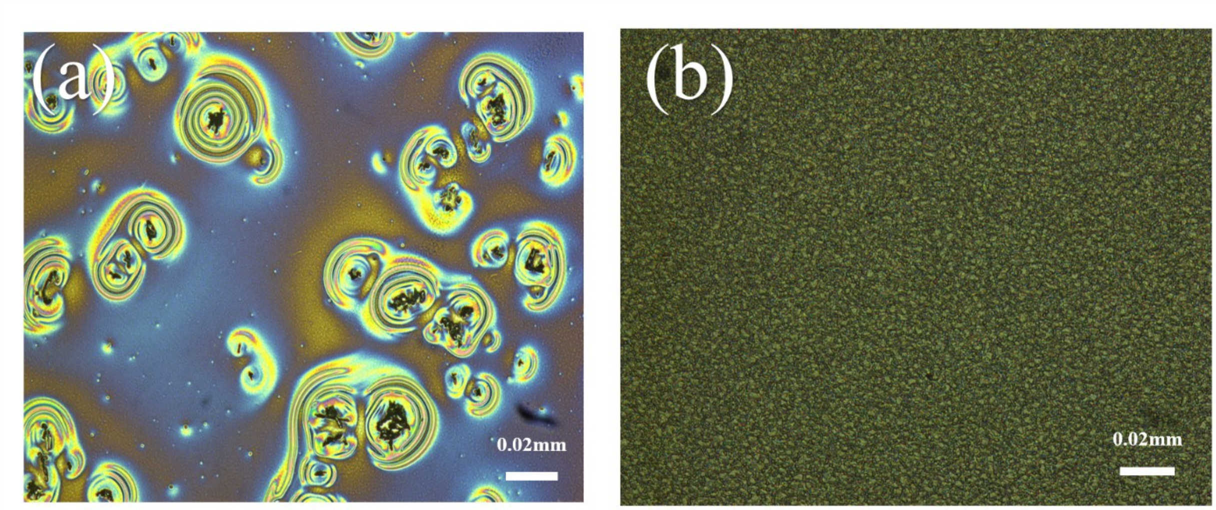

Figure S1 Metallographic image of (a) spin coated PCBM and (b) spray coated PCBM ETL on the top of perovskite film.

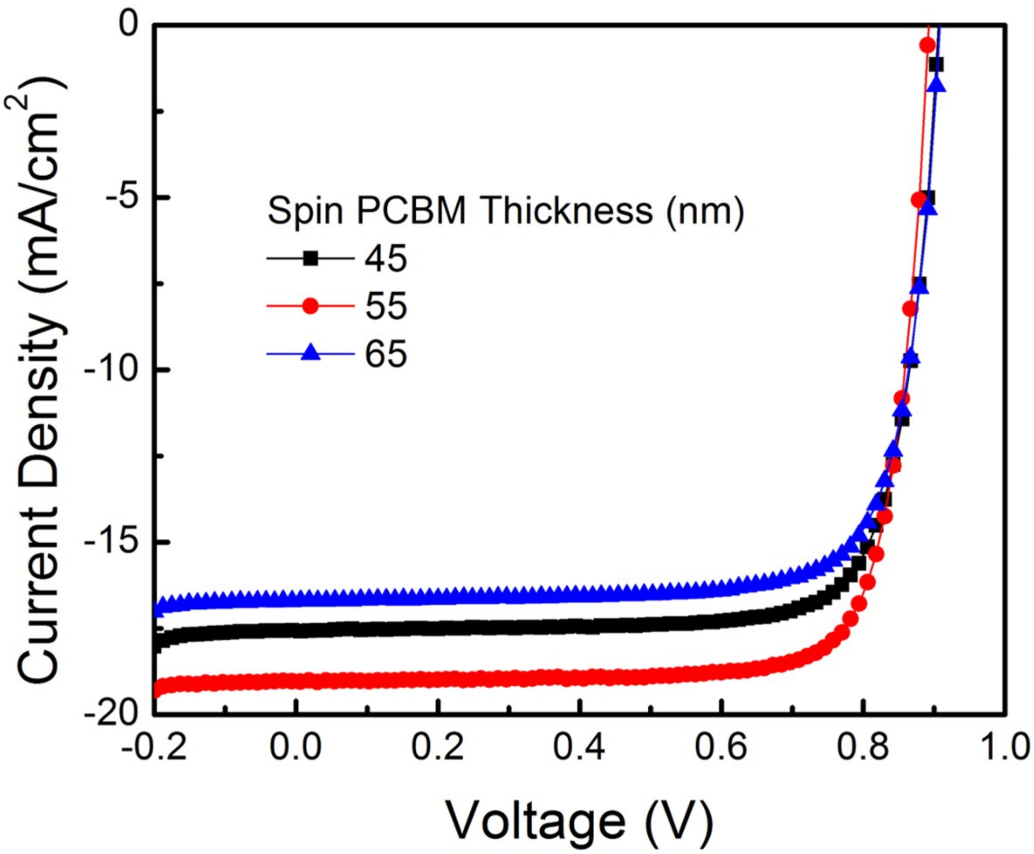

Figure S2 Characteristic *J-V* curve of the device with different thickness of spin coated PCBM ETL.

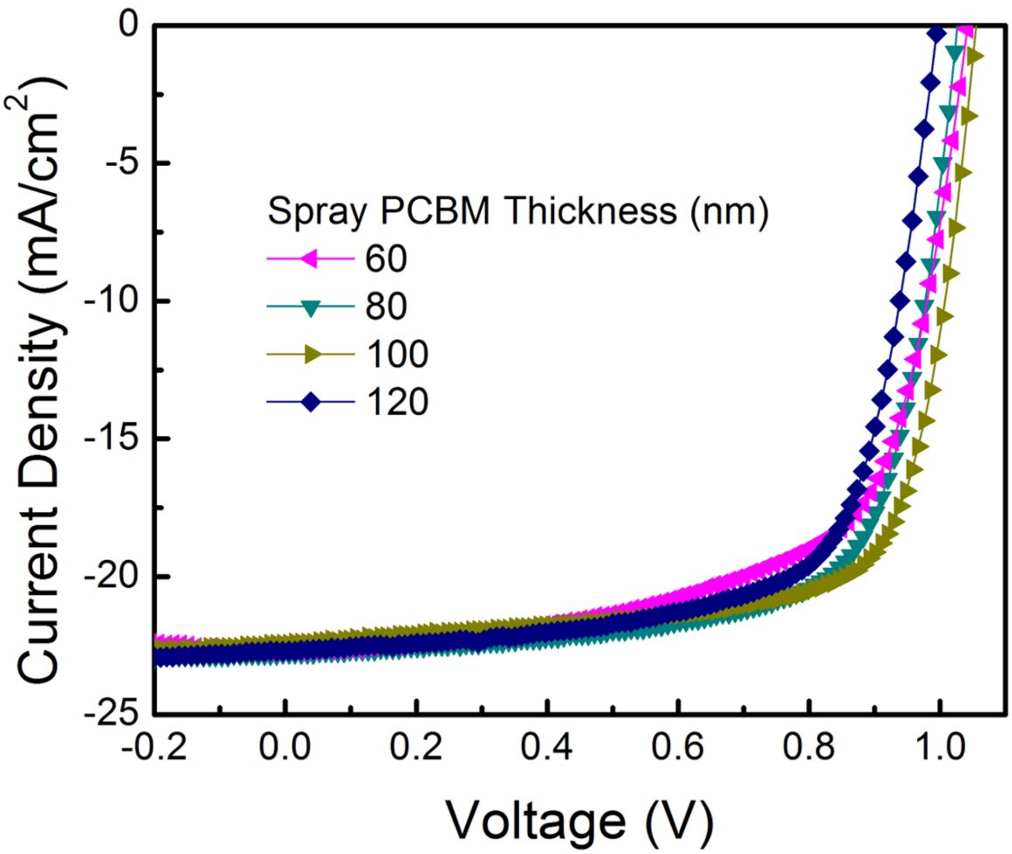

Figure S3 *J*-*V* curve of the device with different thickness of spray coated PCBM ETL

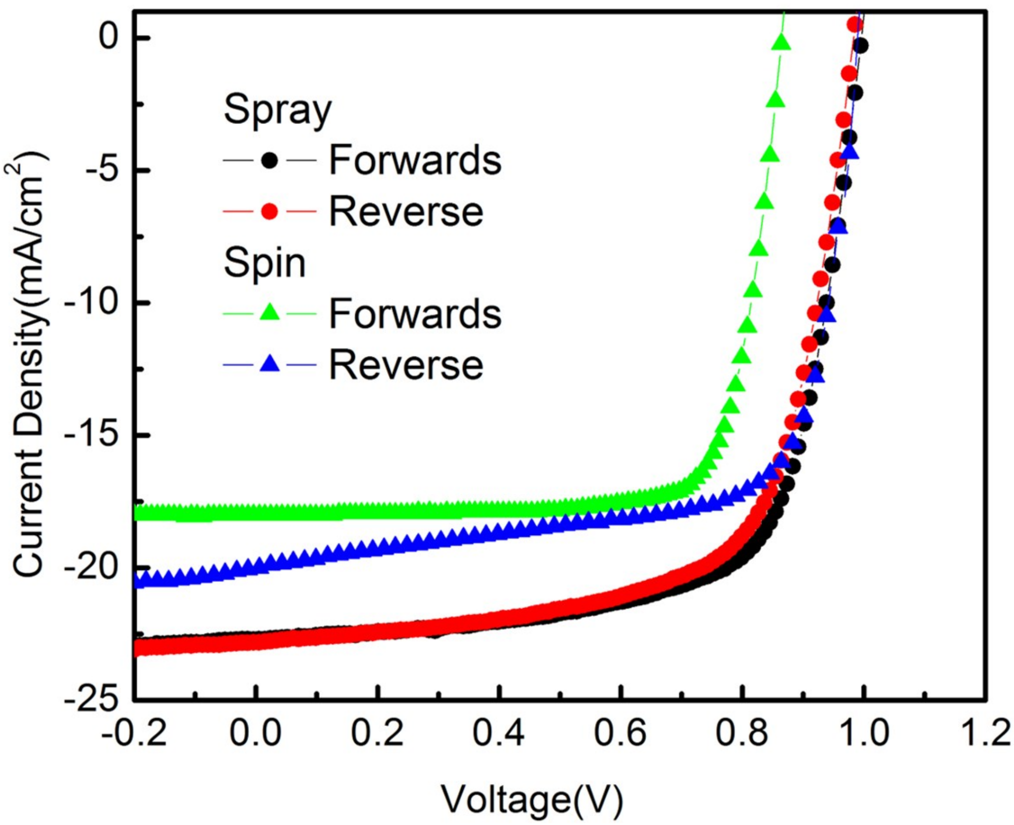

Figure S4 Comparison of *J-V* curves of best cell with spin and spray coated PCBM ETL measured by forward and reverse scans.

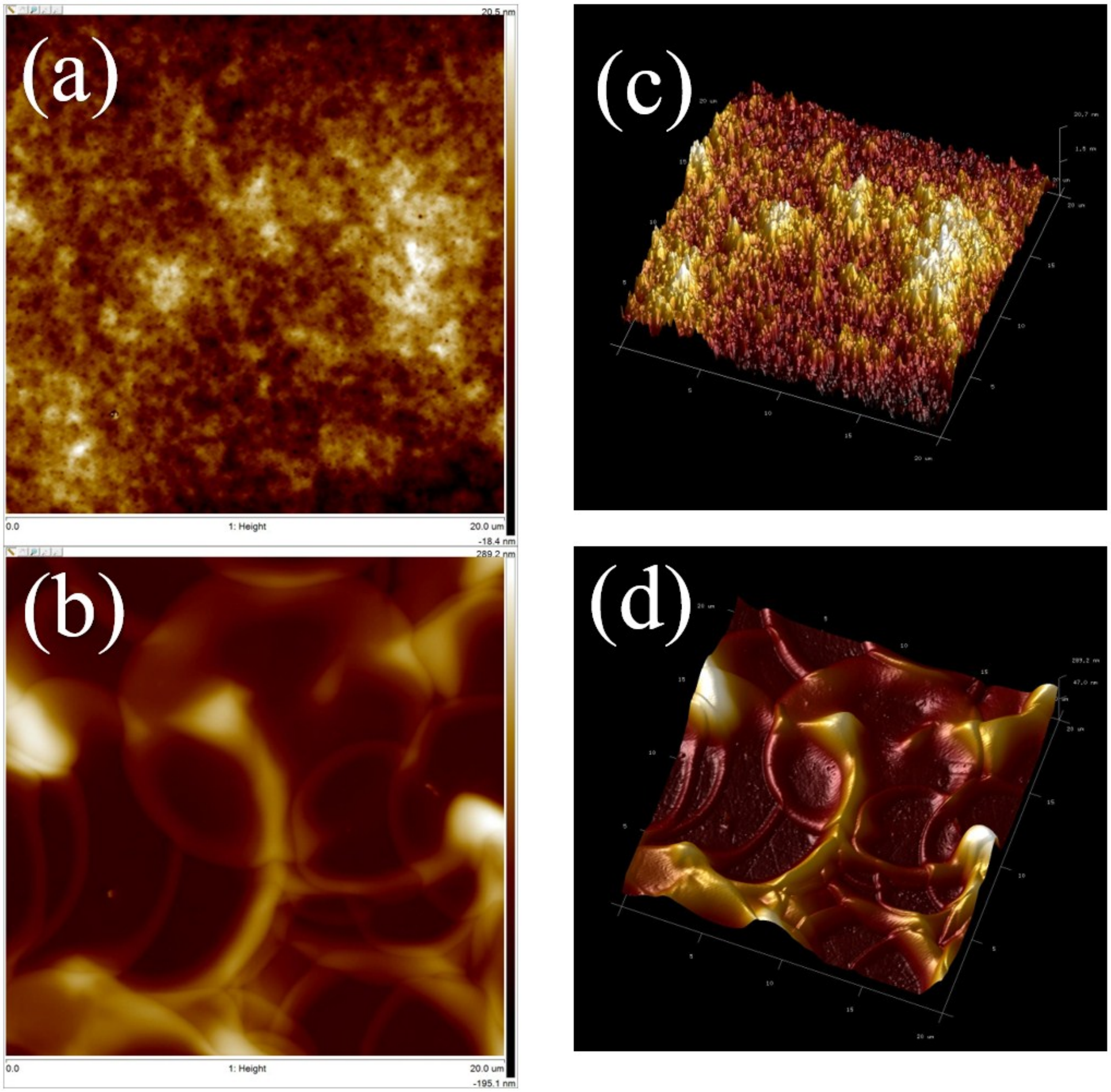

Figure S5 2D-AFM height image of (a) spin coated and (b) spray coated PCBM film on the top of glass. (c) and (d) are the 3D-AFM morphology image of (c) spin coated and (d) spray coated PCBM film, which is related to (a) and (b), respectively.

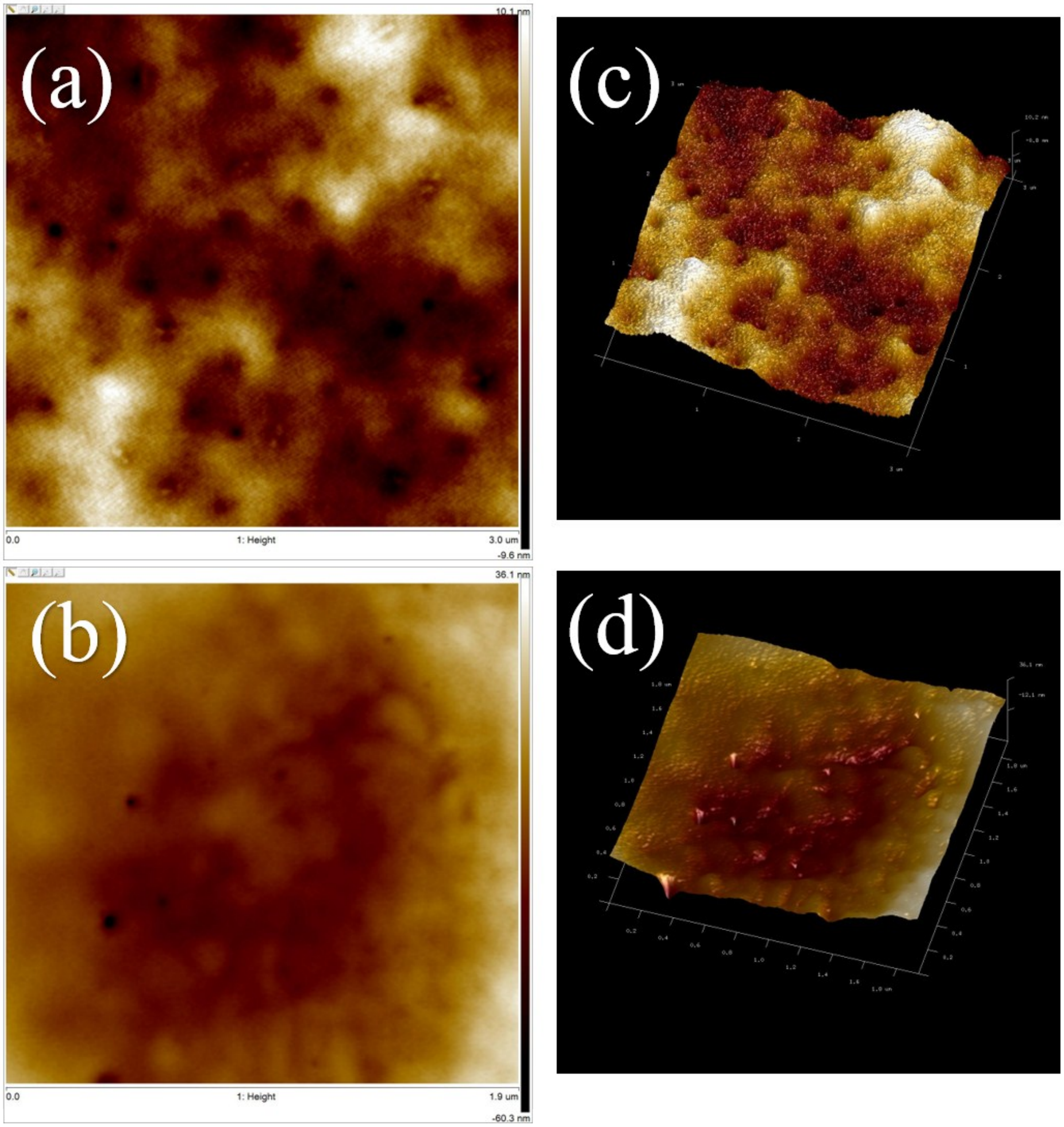

Figure S6 2D-AFM height image of (a) spin coated and (b) spray coated PCBM film on the top of perovskite film. (c) and (d) are the 3D-AFM image of (c) spin coated and (d) spray coated PCBM film, which is related to (a) and (b), respectively.

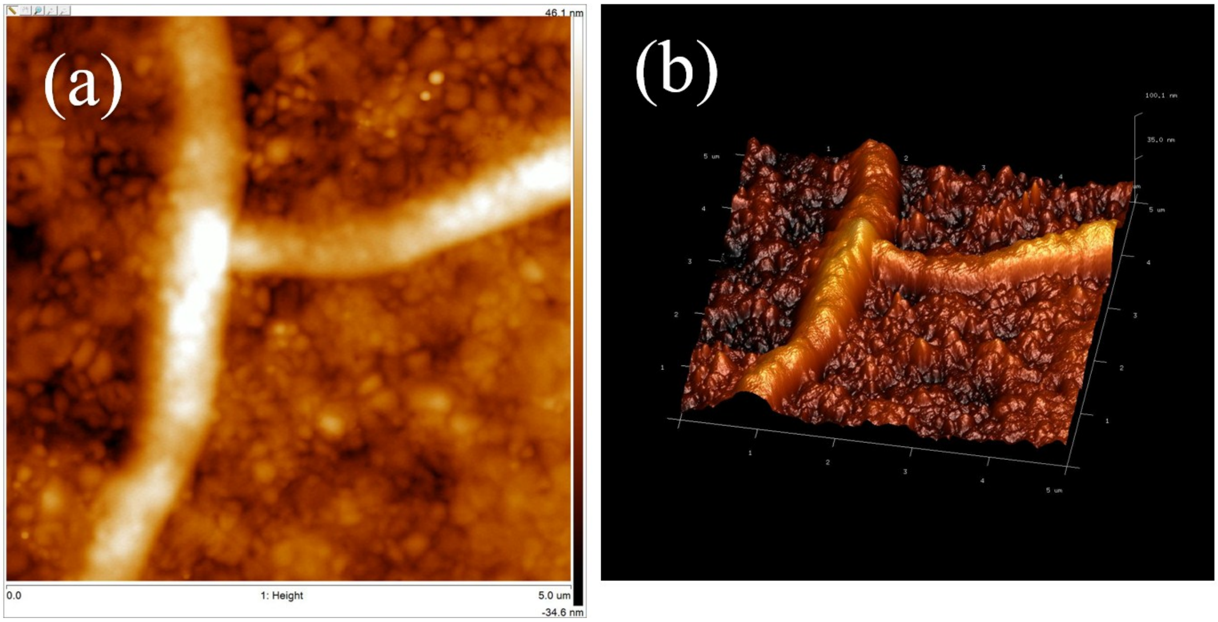

Figure S7 (a) 2D-AFM height image and (b) 3D-AFM morphology image of the morphology of spray coated PCBM film on the top of perovskite, which clearly shows the PCBM coffee ring.

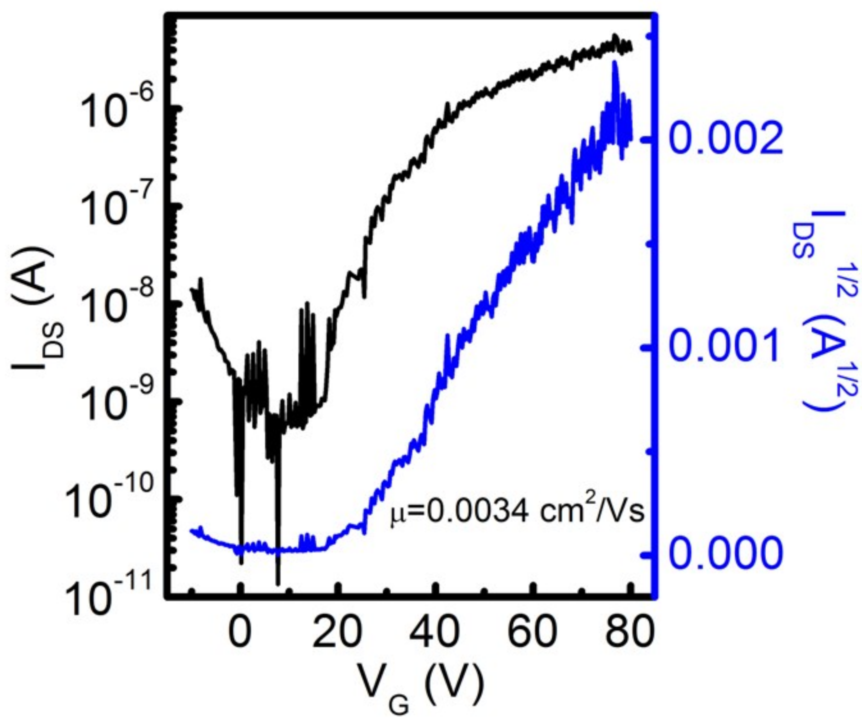

Figure S8 Transfer characteristics of PCBM (spray coated) transistor operating in the n-channel regime at different gate voltages.

Charge carrier mobility (μ) and threshold voltage (V_{TH}) were extracted in the saturation regime from the highest slope of $|I_{DS}|^{1/2}$ vs. V_{GS} plots using the following equation:

$$I_{DS} = \frac{W}{2L}\mu C_i (V_{GS} - V_{TH})^2$$

where L (300 μm) is the channel length, W (1 cm) is the channel width, C_i is the capacitance (per unit area) of the dielectric, V_{GS} is the gate voltage, and I_{DS} is the drain-source current. The source-drain voltage was 80 V.