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Energetic disorder induced ultrahigh open circuit voltage loss at low temperatures in organic bulk heterojunction solar cells WENCHAO YANG, YONGSONG LUO, School of Physics and Electrical Engineering, Xinyang Normal University, YAO YAO, Department of Physics, Fudan University, STATE KEY LABORATORY OF SURFACE PHYSICS TEAM, ENERGY STORAGE AND LOW DIMENSIONAL PHYSICS GROUP TEAM — In organic bulk heterojunction solar cells, the open circuit voltage (V_{oc}) suffers from an ultra-high loss at low temperatures. In this work we investigate the origin of the loss through calculating the $V_{oc}-T$ plots with the device model method systematically and comparing it with experimentally observed ones. When the energetic disorder is incorporated into the model by considering the disorder-suppressed temperature dependent charge carrier mobilities, it is found that for nonselective contacts the V_{oc} reduces drastically under the low temperature regime, while for selective contacts the V_{oc} keeps increasing with the decreasing temperature. The main reason is revealed that as the temperature decreases, the reduced mobilities give rise to low charge extraction efficiency and small bimolecular recombination rate for the photogenerated charge carriers, so that in the former case they can be extracted from the wrong electrode to form a leakage current which counteracts the photocurrent and increase quickly with voltage, leading to the anomalous reduction of V_{oc}.

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