Abstract Submitted
for the MAR15 Meeting of
The American Physical Society

Mechanism of charge recombination in organic-inorganic hybrid perovskite solar cells[1] WENCHAO YANG, YAO YAO, CHANG-QIN WU, Department of Physics, Fudan University, Shanghai, China, ORGANIC GROUP TEAM — In the recent popular organic-inorganic hybrid perovskite solar cells, the slowness of the charge recombination processes is found to be a key factor for contributing to their high efficiencies and open circuit voltages, but the underlying mechanism remains unclear. In this work we study the recombination mechanism in perovskite solar cells and its roles on determining the device performance. Based on macroscopic device model simulations, the recombination resistances ($R_{\rm rec}$) under different applied voltages are calculated to characterize the recombination mechanism, and the current density-voltage ($J-V$) curves are simulated to describe the device performance under at the same time. Through comparison with the impedance spectroscopy (IS) extracted $R_{\rm rec}$ data, it is found that bimolecular recombination (BR) is the dominant recombination process in the whole applied voltage regime and can determine the open circuit voltage, while the trap-assisted SRH monomolecular recombination (MR) is only important if the trap density is high or the BR rate is significantly reduced. The different electron injection barriers at the contact can induce different patterns for the $R_{\rm rec}$-V characteristics. Under the cases of increased band gap or decreased BR rate, the $R_{\rm rec}$'s are enhanced which leads to high open circuit voltages.

[1]We are grateful to the support from the state key laboratory of surface physics, Fudan University.

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Date submitted: 29 Oct 2014 Electronic form version 1.4