

# Highly Efficient 2D/3D Mixed-Dimensional Cs<sub>2</sub>PbI<sub>2</sub>Cl<sub>2</sub>/CsPbI<sub>2.5</sub>Br<sub>0.5</sub> Perovskite Solar Cells Prepared by Methanol/Isopropanol Treatment

Bicui Li <sup>1,2</sup>, Shujie Yang <sup>1,2</sup>, Huifang Han <sup>1,2</sup>, Huijing Liu <sup>1,2</sup>, Hang Zhao <sup>3</sup>, Zhenzhen Li <sup>3</sup>, Jia Xu <sup>1,2</sup> and Jianxi Yao <sup>1,2,\*</sup>

<sup>1</sup> State Key Laboratory of Alternate Electrical Power System with Renewable Energy Sources, North China Electric Power University, Beijing 102206, China

<sup>2</sup> Beijing Key Laboratory of Energy Safety and Clean Utilization, North China Electric Power University, Beijing 102206, China

<sup>3</sup> College of Metallurgy and Energy, North China University of Science and Technology, Tangshan 063210, China

\* Correspondence: jianxiyao@ncepu.edu.cn

## Methods for fitting

### (a) Time-resolved photoluminescence (TRPL)

The TRPL curves were fitted with a bi-exponential decay function to describe the process of charge extraction.

$$I(t) = A_1 e^{(-t/\tau_1)} + A_2 e^{(-t/\tau_2)} + \gamma_0 \quad (S1)$$

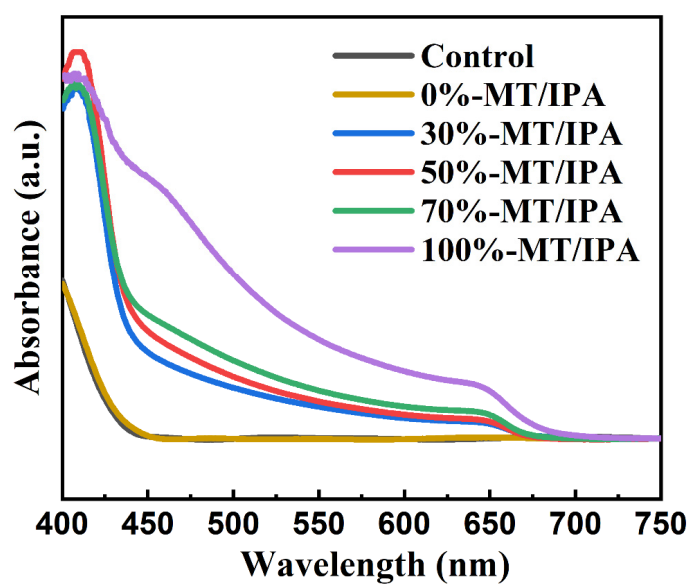
where  $\tau_1$  is the rapid attenuation component, which is generally considered to be caused by the fast recombination of the film surface interface,  $\tau_2$  is the slow attenuation component, which is generally thought to be caused by the recombination of the carrier in the film.  $A_1$  and  $A_2$  are the weights of  $\tau_1$  and  $\tau_2$ , respectively.

### (b) Space charge limited current (SCLC)

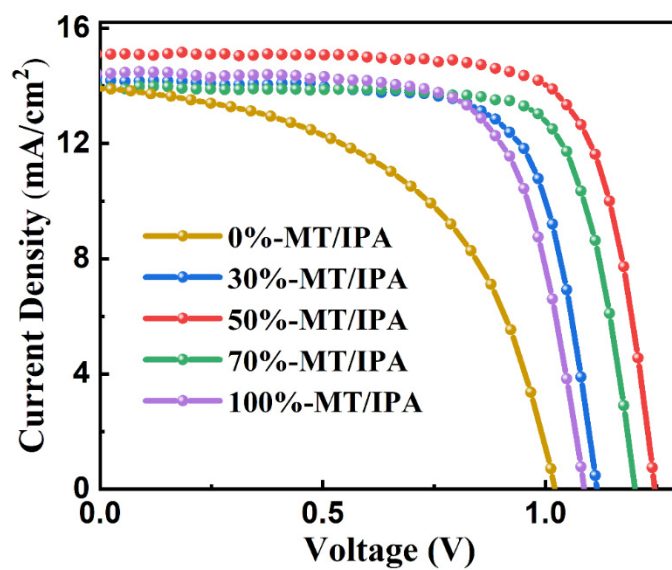
The trap density can be calculated from the following Equation (S2):

$$N_t = \frac{2\epsilon\epsilon_0 V_{TFL}}{eL^2} \quad (S2)$$

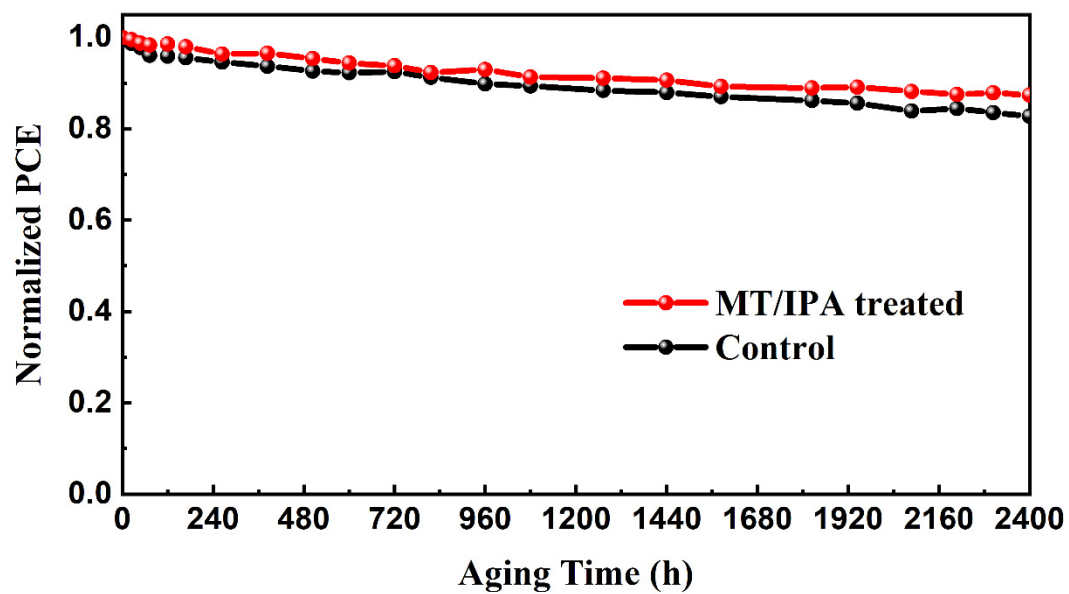
where  $L$  is the thickness of the perovskite film,  $\epsilon_r$  is the relative dielectric constant of perovskite,  $\epsilon_0$  is the vacuum permittivity ( $8.854 \times 10^{-12}$  F/m),  $e$  is the unit charge with the value of  $1.602 \times 10^{-19}$  C, and  $N_t$  is the trap density.



**Figure S1.** UV-vis absorption spectra of unannealed films untreated and treated with different volume ratios of MT/IPA solution.



**Figure S2.** *J-V* curves of solar cells treated with different volume ratios of MT/IPA solutions.



**Figure S3.** Long term stability in N<sub>2</sub> atmosphere of the untreated and MT/IPA-treated solar cells.