

# Investigation of Triphenylamine (TPA) based Metal Complexes and Their Application in Perovskite Solar Cells

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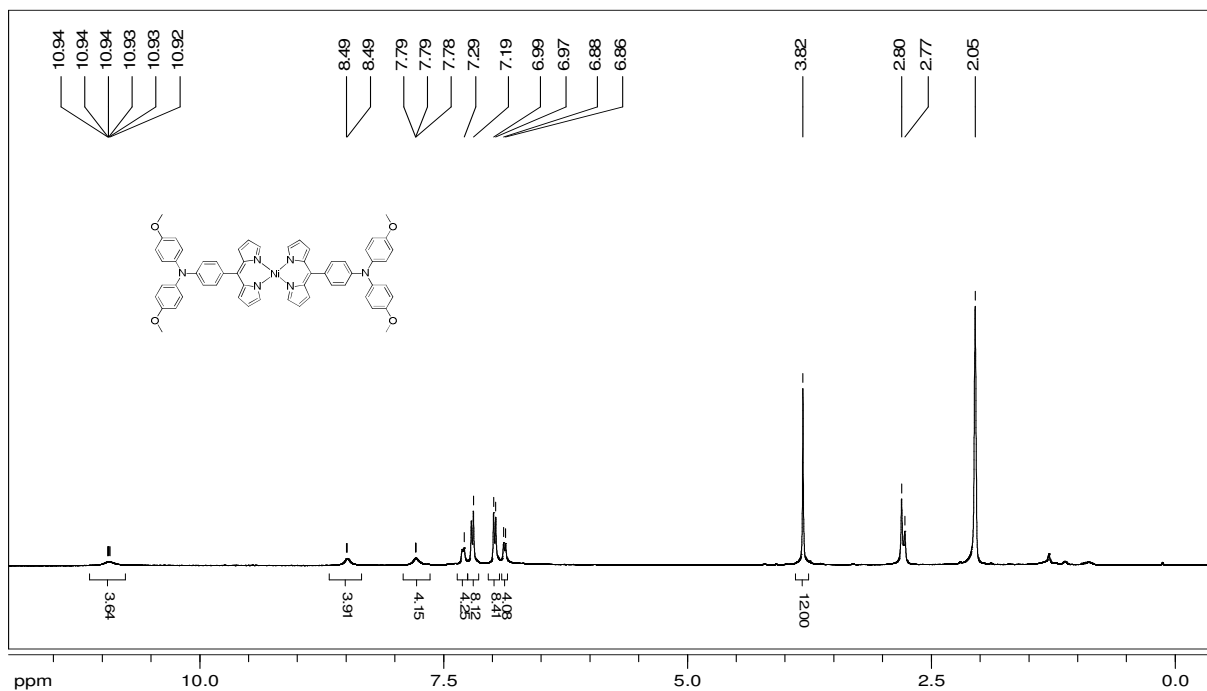


Figure S1.  $^1\text{H}$  NMR of Y1 in  $d_6$ -Acetone

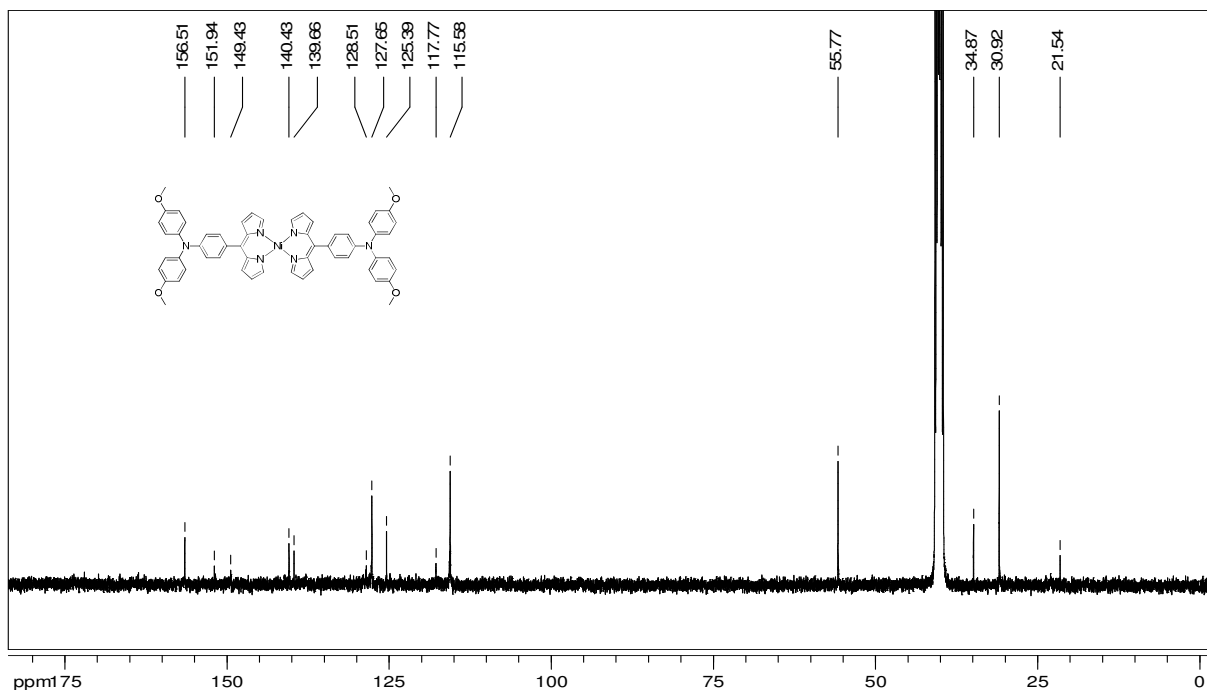


Figure S2.  $^{13}\text{C}$  NMR of Y1 in  $d_6$ -DMSO

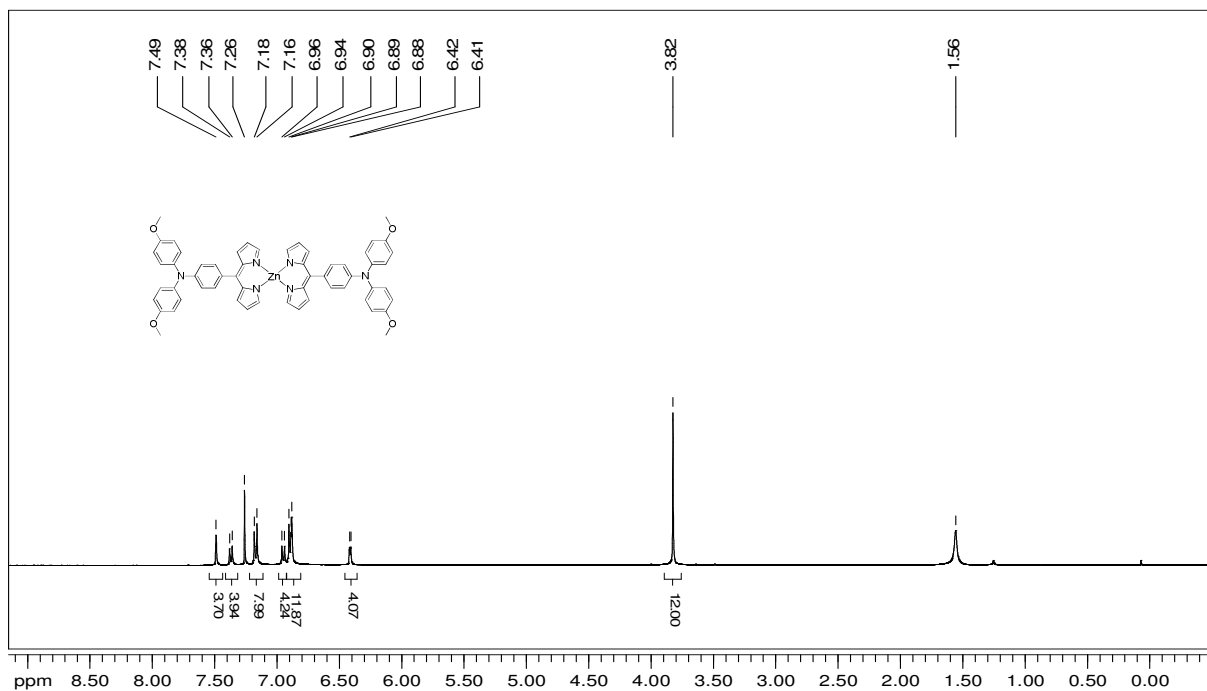


Figure S3. <sup>1</sup>H NMR of Y3 in CDCl<sub>3</sub>

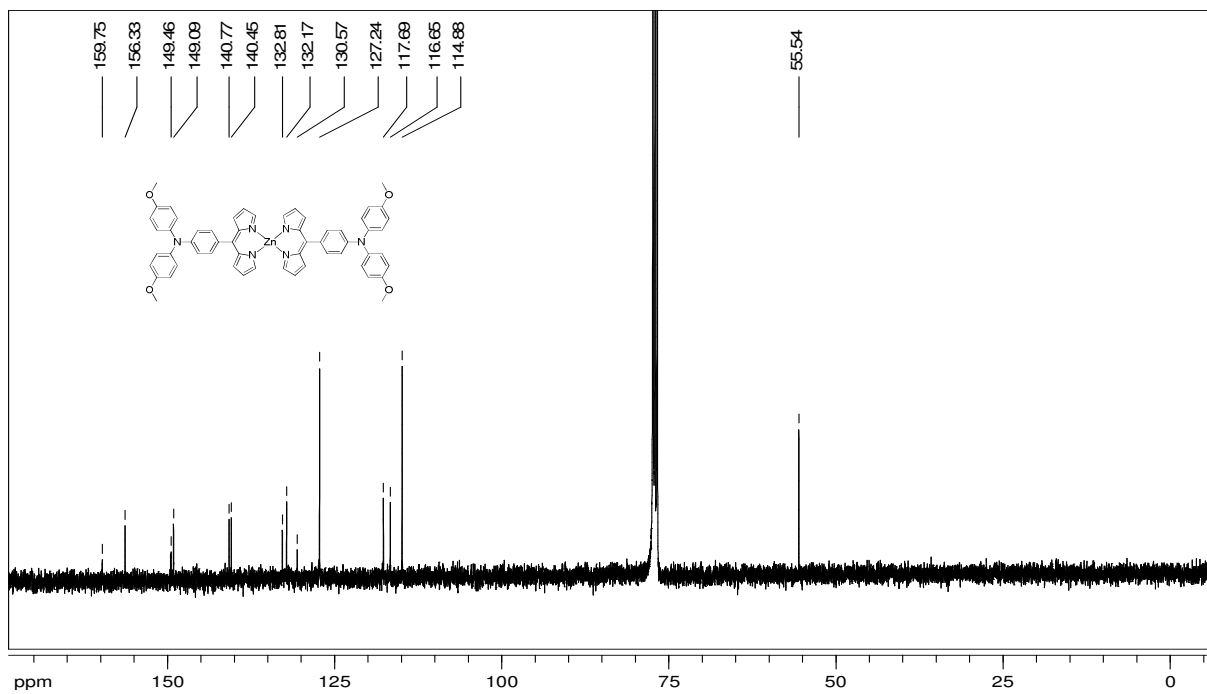


Figure S4. <sup>13</sup>C NMR of Y3 in CDCl<sub>3</sub>

LJJ-1(CHCA)  
17032900 82 (2.734)

TOF LD+  
5.93e3

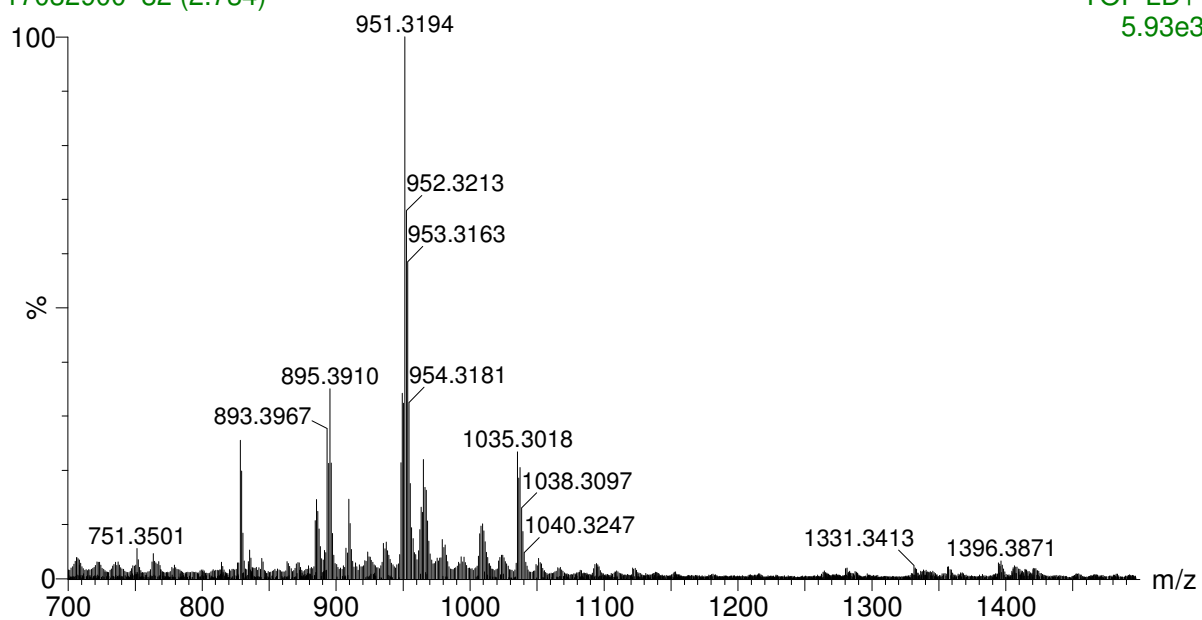


Figure S5. Mass Spectroscopy of Y1

LJJ-2  
17032902 30 (0.999)

TOF LD+  
1.67e3

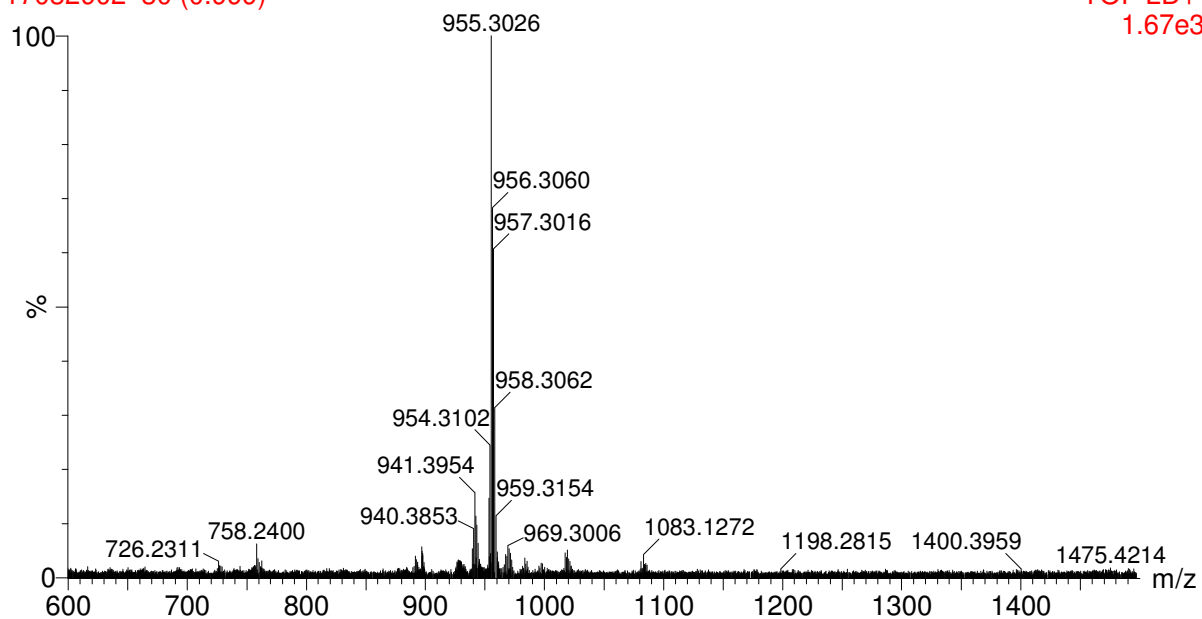


Figure S6. Mass Spectroscopy of Y2

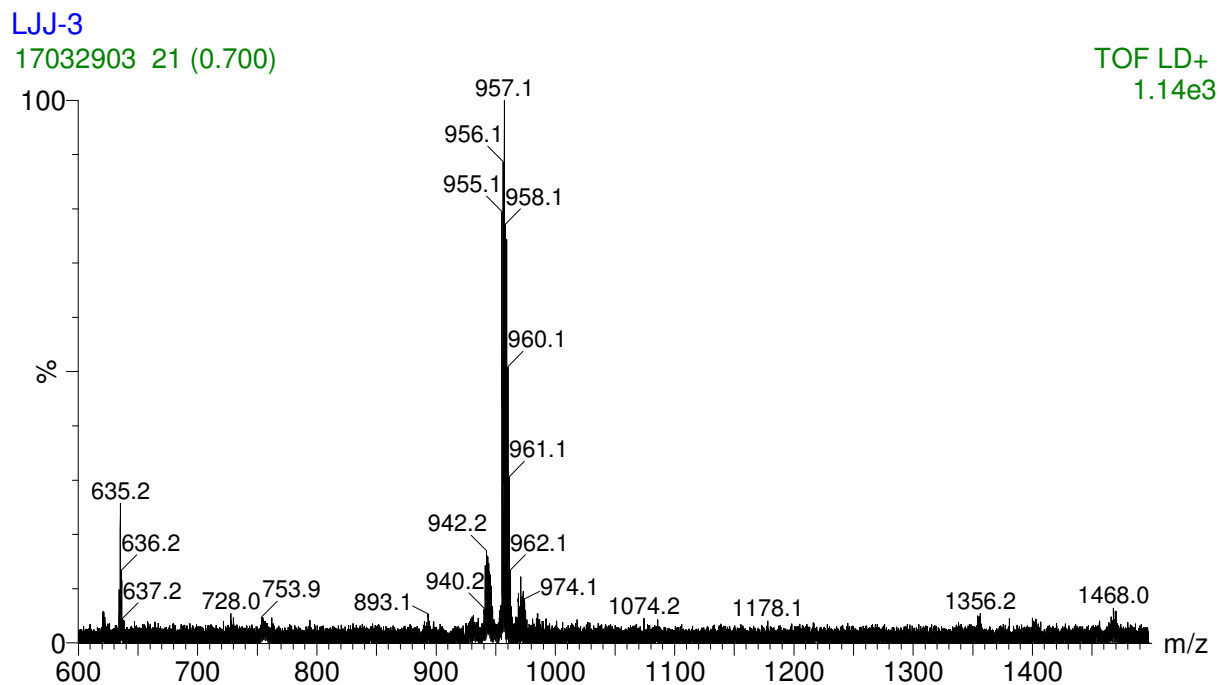


Figure S7. Mass Spectroscopy of **Y3**

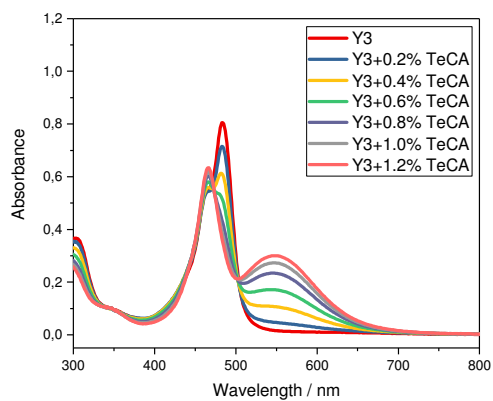


Figure S8. changes in the UV-vis spectra of **Y3** with gradual addition of different amounts of TeCA as dopant.

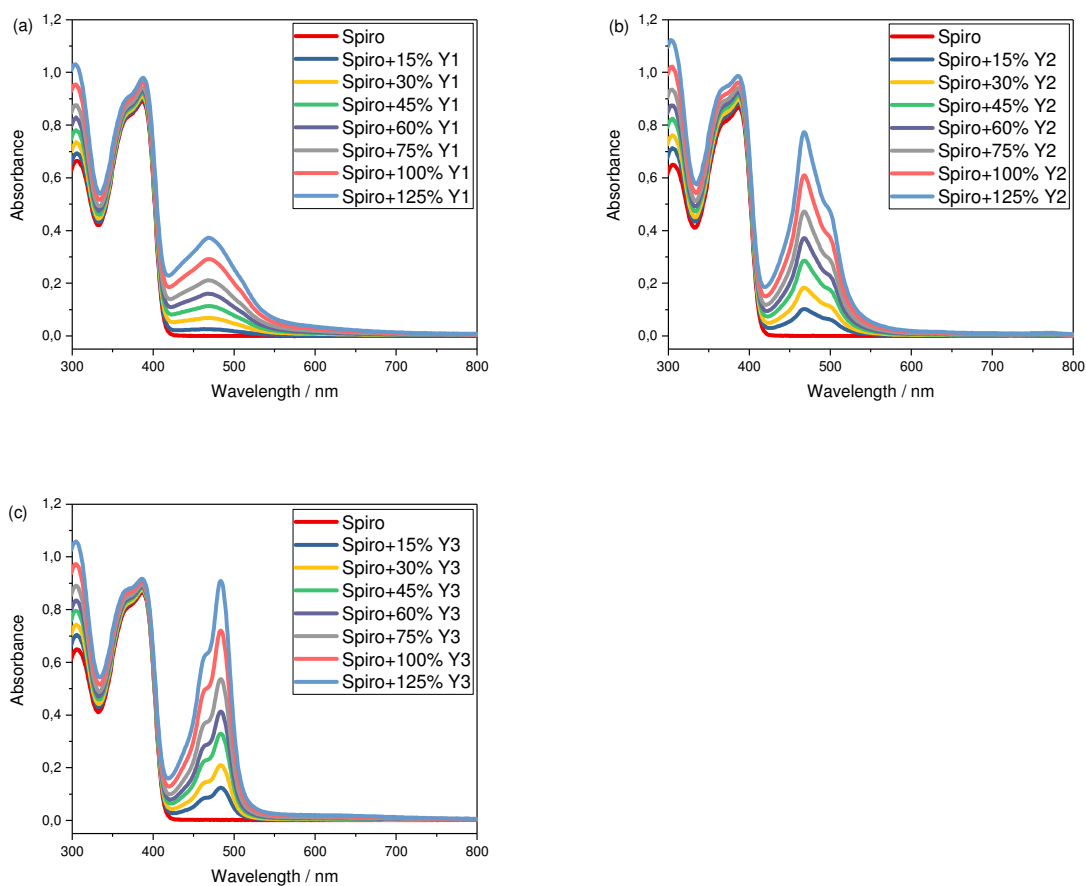


Figure S9. (a) UV/vis absorption of Spiro-OMeTAD with gradual addition of different amounts of **Y1** as dopant. (b) UV/vis absorption of Spiro-OMeTAD with gradual addition of different amounts of **Y2** as dopant. (c) UV/vis absorption of Spiro-OMeTAD with gradual addition of different amounts of **Y3** as dopant.

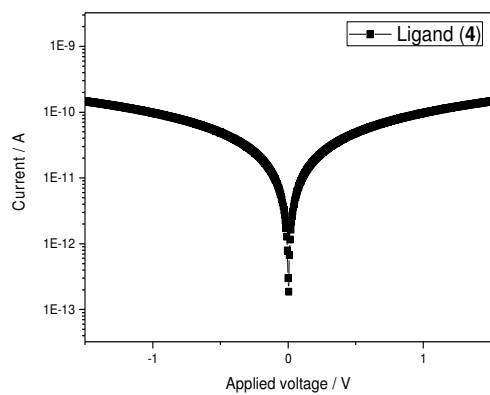


Figure S10. Current-voltage characteristics of ligand (4) with doping of 10 mM LiTFSI, 100 mM TBP and 4% volume TeCA

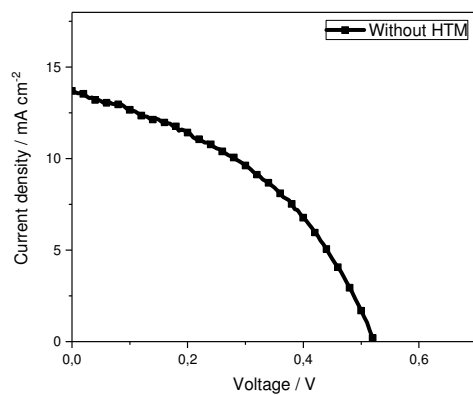


Figure S11. Photovoltaic performance of perovskite solar cell without hole transport materials.

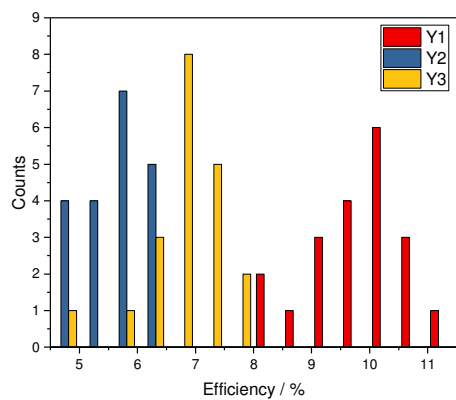


Figure S12. Distribution of efficiencies of PSCs based on **Y1**, **Y2** and **Y3** as hole transport materials.

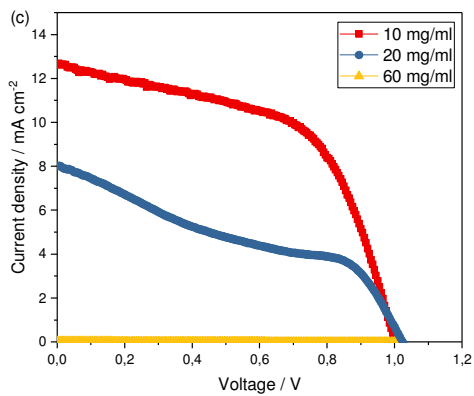
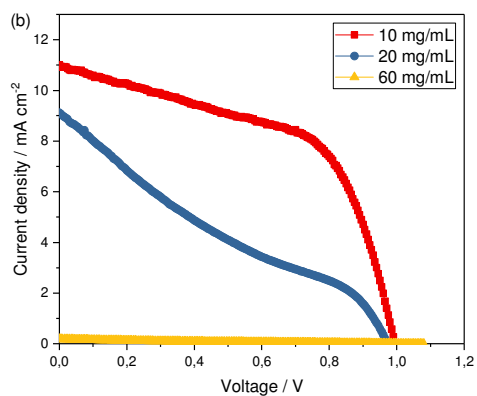
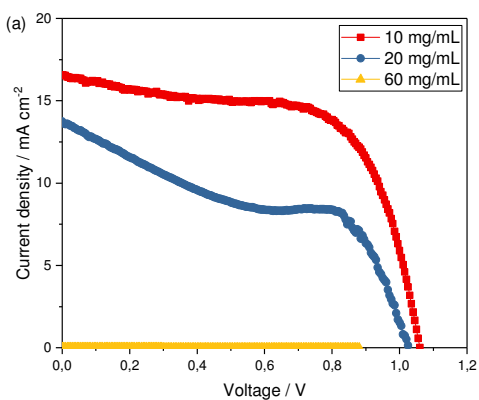




Figure S13. (a) Photovoltaic performance with increased concentrations of **Y1**, (b) Photovoltaic performance with increased concentrations of **Y2**. (c) Photovoltaic performance with increased concentrations of **Y3**.