
Rational designing of materials for high performance and stable perovskite solar cells

Shahzada Ahmad^{*†1}, Laura Calio^{'*}, Manuel Salado^{*}, and Samrana Kazim^{*}

¹Abengoa Research, Abengoa – C/ Energía Solar n° 1, Campus Palmas Altas-41014, Sevilla, Spain, Spain

Abstract

The use of perovskite as a semiconducting pigment to harvest light has attracted great interest in recent years due to its ease of fabrication and cost competitiveness. Organoleadhalide perovskites shows ambipolar behavior and has high absorption coefficient.¹ By tuning their composition in a mixed perovskite environment their photovoltaic properties can be modulated and power conversion efficiencies (PCE) in excess of 22% can be measured. We have observed that mixed perovskites shows higher stability than methylammonium leadhalide perovskites. On the other hand in most of the device architecture, Spiro-OMeTAD is used as the material of choice as hole transporting layer specially when mesoscopic configuration is adopted. Apart from being cost uneffective, Spiro-OMeTAD is UV unstable and can perform only when doped with lithium salts, additives and/or with metal complex. The doping with hygroscopic salts accelerates the device instability. We will demonstrate the use of hydrophobic dopant to increase the stability in these solar cells. In our search for HTMs with high thermal stability, hole mobility and suitable energy level with respect to the perovskite valence band, we found linear acene derivatives, triarylamine derivatives and triazatruxene based hole transport molecules to be an effective alternative.^{2,3} With the judicious design of triazatruxene based molecule PCE of up to 18% can be measured, which supersede the value of Spiro-OMeTAD. Triazatruxene core consists of three indole units joining to a benzene ring. The presence of benzene ring provides an extended delocalized π -system, improved electron-donating potential for intramolecular charge transfer.³ For the triarylamine core the HOMO-LUMO energy levels can be modulated by selecting anchoring group to yield a better PV properties. These HTM hold potential to rival the use of Spiro-OMeTAD, are cost effective and can be prepared using few synthetic steps. These p-type semiconductors can also be utilized in organic light emitting diodes and organic electronics.

References

S. Kazim, M. K. Nazeeruddin, M. Grätzel and S. Ahmad, *Angew. Chem., Int. Ed.*, 2014, 53, 2812–2824; *Angew. Chem.*, 2014, 126, 2854–2867.

S. Kazim, F. J. Ramos, P. Gao, M. K. Nazeeruddin, M. Grätzel and S. Ahmad, *Energy Environ. Sci.*, 2015, 8, 1816–1823.

F. J. Ramos, Kasparas Rakstys, S. Kazim, M. Grätzel, M. K. Nazeeruddin and S. Ahmad, *RSC Adv.*, 2015, 5, 53426–53432.

^{*}Speaker

[†]Corresponding author: shahzada.ahmad@abengoa.com