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The Versatility of Mesoscopic Solar Cells

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In our work on solid-state dye-sensitized solar cells (ssDSSC) we have recently shown that copper phenanthroline complexes can act as an efficient hole transporting material. We prepared ssDSCs with a novel organic dye WS-72 and $[Cu(tmby)_2]^{2+/+}$ as redox system and achieved record power conversion efficiencies for ssDSCs of 11.7% [1]. With this redox system DSSCs give also excellent performance under ambient light conditions [2]. Our best DSC efficiency of 13.1% for a liquid Cu-complex electrolyte is achieved by the discovery that the PEDOT based counter electrode can be directly contacted with the dye/TiO_2 photoelectrode [3]. Thus, there is no space between the two electrodes minimizing diffusion limitations and fill factors up to 0.8 is achieved.

In our work on perovskite solar cells (PSC) we have achieved efficiencies above 20% with a mixed composition of iodide/bromide and methyl ammonium/formamidinium [4]. With the use of SnO_2 compact underlayers as electron acceptor contacts we have constructed planar perovskite solar cells with a hysteresis free efficiency above 20% [5,6]. The strategy of cation mixing of the perovskite film was taken further by including the Cs in a so-called 'triple cation' composition, i.e. Cs/FA/Ma as well as Rb in a quadruple cation mixture [7,8]. Larger grains grown in a monolithic manner are observed and reproducibility and device stability are improved. For example, above 22% efficiency has been obtained with an outstanding open-circuit voltage of 1.24 V at a band gap of 1.63 eV entailing one of the smallest loss-in-potential of 0.39 V measured for any solar cell material. With regards to lifetime testing, we have shown a promising stability at 85 ^oC for 500 h under full solar illumination and maximum power point tracking (95% of the initial performance was retained). Recently, we have also commented on the standardization of PSC aging tests [9].

References

[1] Zhang et al. et al., Energy & Envir. Sci., DOI: 10.1039/c8ee00661j
[2] Freitag et al. Nature Photonics, 11 (2017) 372
[3] Cao et al., Joule, https://doi.org/10.1016/j.joule.2018.03.017
[4] Bi et al., Science Advance, DOI: 10.1126/sciadv.1501170
[5] Correa et al., Energy & Envir. Sci., DOI:10.1039/C5EE02608C
[6] Anaraki et al., ACS Energy Lett. 2018, 3, 773−778
[7] M. Saliba et al., Energy & Envir. Sci., 2016, DOI: 10.1039/C5EE03874J
[8] M. Saliba et al., Science 10.1126/science.aah5557 (2016)
[9] Domanski et al. Nature Energy 01 January 2018. DOI: 10.1038/s41560-017-0060-5