Thermally Evaporated Donor Molecules for Low-Voltage Loss Organic Solar Cells

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Novel molecules are key drivers in the development of efficient organic solar cells (OSCs). Two fabrication routes have proven successful to make devices from molecules [1]: casting from solution - mostly involving polymers in the blend - and thermal evaporation of small molecules in vacuum, similar to the industrial fabrication of OLEDs. Until about 2015, the best results for both routes were achieved by tailoring the donor molecule, yielding power conversion efficiencies of around 10% [2,3]. For the acceptor, both fabrication technologies relied on fullerene or its derivatives. The advent of non-fullerene acceptors (NFAs) in solution processing pushed OSC efficiency by 50% to around 18% [4] as of now, outpacing the development of vacuum-deposited OSCs. So far, highly efficient evaporated NFAs have not been reported.

Here, we take an important first step towards efficient NFA-based evaporated OSCs by demonstrating that also vacuum deposited donors would benefit from NFAs. We do so by depositing evaporated donors onto solution-processed NFAs to form a planar heterojunction. We find that voltage losses of donor/NFA systems are reduced by up to 400mV compared to corresponding donor/C60 systems, without compromising photocurrent. In-depth analysis of voltage losses is carried out via sensitive external quantum efficiency and electroluminescence measurements.

Our findings show that evaporable donor molecules are well-suited for high-performance OSCs and stress the need for evaporable non-fullerene acceptors. Once such molecules are available, a significant increase in efficiency can be expected. Together with the existing technological advantages of evaporated OSCs - industrial scalability as proven by OLEDs and the relative ease of fabricating multijunction solar cells – our findings highlight the further potential of evaporated organic solar cells.

References:

[1] Riede, M.; Spoltore, D.; Leo, K. Organic Solar Cells—The Path to Commercial Success. Adv. Energy Mater. 2021, 11, 2002653. (https://doi.org/10.1002/aenm.20200265)

[2] Kawashima, K.; Tamai, Y.; Ohkita, H.; et al. High-efficiency polymer solar cells with small photon energy loss. Nat. Commun. 2015, 6, 10085. (https://doi.org/10.1038/ncomms10085)

[3] Che, X.; Chung, C.; Hsu, C.; et al. Adv. Energy Mater. 2018, 8, 1703603. (https://doi.org/10.1002/aenm.201703603)

[4] Liu, Q., Jiang, Y.; Jin, K.; et al. 18% Efficiency organic solar cells. Science Bulletin 2020, 65, 272. (https://doi.org/10.1016/j.scib.2020.01.001)

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