

FLUORENE-BASED ENAMINES AS LOW-COST AND DOPANT-FREE HOLE TRANSPORTING MATERIALS FOR PEROVSKITE SOLAR CELLS

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The power conversion efficiency of perovskite solar cells is approaching the Shockley–Queisser limit, and therefore this technology is next to the commercialization stage [1]. Inexpensive and stable hole transporting materials are highly desirable for the successful scale-up. Most high performing devices generally employ expensive hole conductors that are synthesized via cross-coupling reactions which require expensive catalysts, inert reaction conditions and time-consuming sophisticated product purification [2]. In a quest to employ cost-effective chemistry to combine the building blocks, we explore enamine-based small molecules that can be synthesized in a simple condensation reaction from commercially available materials leading to an estimated material cost of a few euros per gram.

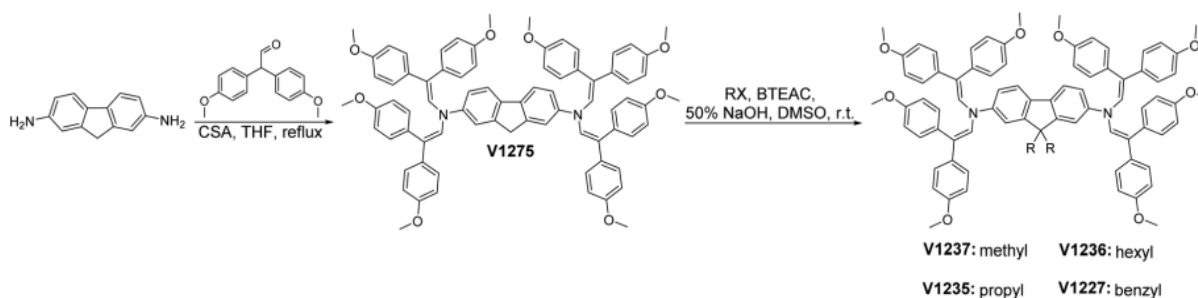


Fig 1. Structures and synthesis of novel hole transporting materials.

The synthesized fluorene-based enamines exhibit a very high hole mobility up to $3.3 \times 10^{-4} \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1}$ and enable the fabrication of perovskite solar cells with a maximum power conversion efficiency of 19.3% in a doped configuration and 17.1% without doping. In addition, both PSC systems demonstrate superior long-term stability compared to spiro-OMeTAD.

This work shows that hole transporting materials prepared via a simple condensation protocol have the potential to compete in terms of performance with materials obtained via expensive cross-coupling methods at a fraction of their cost and deliver exceptional stability of the final device.

References

1. NREL, Photovoltaic Research: Best Research Cell Efficiency Chart, <https://www.nrel.gov/pv/cell-efficiency.html>, accessed 28 April 2020.
2. T. P. I. Saragi, T. Spehr, A. Siebert, T. Fuhrmann-Lieker and J. Salbeck, *Chem. Rev.*, 2007, 107, 1011–1065.