CARBAZOLE DERIVATIVES AS HOLE TRANSPORTING MATERIALS FOR EFFICIENT SOLAR CELLS

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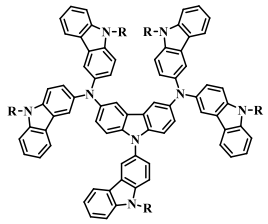
Nowadays, people cannot imagine their life without electricity. Renewable energy sources, such as solar energy is an alternative for non-renewable energy generation. Solar cells are devices that convert absorbed light into electricity and silicon solar cells are currently the most commonly used technology to do that. However, it has its own drawbacks and other high efficiency solar cell technologies have been developed. The efficiency of hybrid Solar Cells, for example perovskite, has increased significantly over the last decade. However, there are obstacles that need to be addressed in order for it to see a widespread use. One of them is the use of expensive charge-transporting semiconductors such as Spiro-OMeTAD or fullerene derivatives to obtain efficient devices [1]. Therefore, there is a vigorous search for cheaper and simpler methods for the synthesis of organic semiconductors. Carbazole class compounds have attracted the attention of scientist due to their plain synthesis and simple purification methods [2]. The aim of this project is to synthesize inexpensive carbazole class materials, that would be suitable as hole-transporting semiconductors for perovskite solar cells.



V1310: R= -CH_2CH_3;
V1322: R= -$CH_2CH(CH_2CH_3)CH_2(CH_2)_2CH_3$;
V1332: R= -$CH_2(CH_2)_4CH_3$.

Fig. 1. New carbazole derivatives (V1310, V1323, V1332).

All target materials are amorphous and has thermal stability greater than 400 °C. The obtained data shows that ionization potential is near up to 5 eV. The charge carrier mobility is in range of $3.7 \cdot 10^{-6} – 1.6 \cdot 10^{-6}$ cm^2 /V·s in weak fields.

Table 1. Properties of new Carbazole derivatives (V1310, V1323 and V1332).

Compound nr.	T_g[a], °C	T_d[b], °C	I_p, eV	μ_0, V · cm $^{-1}$/s^{-1}
V1310	216.8	511	4.86	$1.6 \cdot 10^{-6}$ [c]
V1323	97	411	4.99	$3.7 \cdot 10^{-6}$
V1332	109.1	482	4.87	$3.5 \cdot 10^{-6}$

[a] Glass transition temperature, extracted from the second DSC heating cycle.
[b] Decomposition temperature, corresponding to the 5% weight loss.
[c] V1310 + PC-Z (1:1).

Based on the thermal and photoelectric properties, it can be stated that the materials can be used as HTM in Solar cells.

References

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2. A. Singh et al. Bis(diphenylamine)-tethered carbazolyl anthracene derivatives as hole-transporting materials for stable and high-performance perovskite solar cells, ACS Appl. Energy Mater., 3, 11, 10752–10764 (2020)