THE SEARCH FOR NEW ORGANIC SEMI-CONDUCTORS WITH EFFICIENT HOLE TRANSFERING PROPERTIES

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Since the first industrial revolution, humanity's demand for energy increased rapidly. Furthermore, the growing need for fossil fuels brought the issues related with global climate change. No wonder that during several decades scientific community has been working on the search of alternative energy sources and different approaches to optimize household energy consumptions. Compared to widespread incandescent and fluorescent light bulbs efficient light emitting diodes (LED) brought huge impact to the sphere of interiors and exteriors illumination. In spite of of toxic metals (cadmium, indium, gallium) and their compounds used for massive production of inorganic LEDs devices possess mechanical fragility and high utilization cost. Recently, as an alternative to LEDs, the interest of organic light emitting diodes (OLEDs) in the global market is growing rapidly. Taking into account alternative energy sources, the considerable increase of power conversion efficiency (~25 %) of perovskite solar cells (PSC) have made them very attractive to the photovoltaic (PV) community, as well.[1] In both types of devices the structure is built using more than three electroactive organic layers packed between two electrodes. Each layer possess their own specific function. For example, in OLEDs the purpose of hole transporting layer is to ensure the efficient transportation of holes to light emitting layer and blocking of electrons, which are passing the emission layer from cathode. In case of organic perovskite solar cells, despite of reduction of recombination processes and increment of the light absorption the main role of hole-transporting layer is smooth transportation of holes to the electrode. Therefore, the efficiency of OLEDs and PSCs depends not only on the efficient formation/dissociation of the excitons, but on balanced charge transportation, as well. By focusing our attention on hole transporting materials, we found that in solar cells[2] and organic light emitting diodes[3] triphenylamine and carbazole derivative - TCTA, 4,4',4''-tri(carbazol-9-yl)triphenylamine - is widely used.

Our work aim is to synthesize three new hole transporting materials modifying the TCTA compound through carbazole moiety by:

- replacing the 2nd and 7th position hydrogens with methoxy- groups.
- replacing the 3rd and 6th position hydrogens in the carbazole molecules with methoxy- groups.
- replacing the 2nd and 7th position hydrogens in the carbazole molecules with methoxy- groups and 3rd and 6th position hydrogens with tretbutyl- derivatives.

We believe that the addition of methoxy groups could increase the number of intermolecular bonding (hydrogen bonds) which should improve the morphological characteristics and charge transporting properties in the layer. Furthermore, by replacing the active C-3 and C-6 hydrogen atoms in the carbazole fragment with alkyl-derivatives, we hope to improve the electrochemical stability of the compounds The main aspects of the synthesis and characterization of new compounds as well as comparative study of their photophysical, optical, thermal, electrochemical, charge transporting properties will be reported in the presentation.

[1][Best Research-Cell Efficiencies. 2019; https://www.nrel.gov/pv/assets/pdfs/best-reserch-cell-efficiencies.20190923.pdf
[2] Dänekamp, B., et al. Journal of Materials Chemistry C, 7(3), 523–527. https://doi.org/10.1039/C8TC05372C 2019, the effectivness of the device reaches 14 %)
[3] Ràfols-Ribé, J., et al. Science Advances, 4(5), eaar8332. https://doi.org/10.1126/sciadv.aar8332, 2018, the effectivness of the device reaches 24 %