Emphasizing the Operational Role of a Novel Graphene-based Ink into High Performance Inverted Ternary Organic Solar Cell

Minas M. Stylianakis,[1*] Dimitrios M. Kosmidis,[1] Christos Polyzoidis,[1] Miron Krassas,[1] Konstantinos Petridis,[1,2] Emmanuel Kymakis[1]

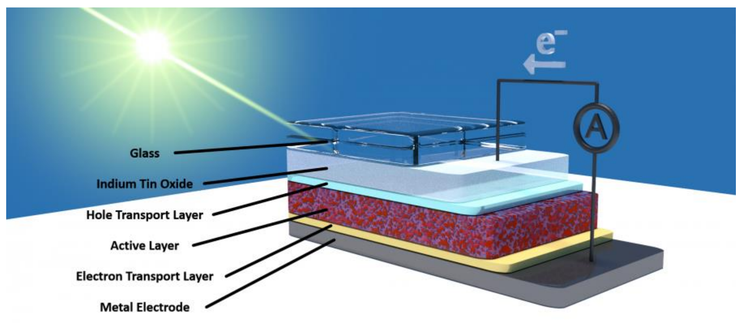
[1]Nanomaterials & Advanced Electronics Group, Center of Materials Technology and Photonics & Electrical & Computer Engineering Department, Hellenic Mediterranean University (HMU), Heraklion 71003, Crete, Greece.
[2]Department of Electronic Engineering, Hellenic Mediterranean University (HMU), Chania 73132, Crete, Greece.

***E-mail: stylianakis@hmu.gr;**
Website: http://nano.hmu.gr

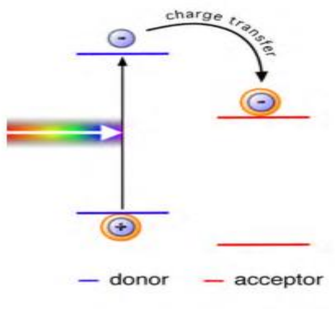
Abstract

A novel solution-processed graphene-based nanomaterial was synthesized by linking graphene oxide (GO) with 2,5,7-trinitro-9-fluorenone-4-carboxylic acid (TNF) moieties, via simple synthetic procedures.[1,2] The yielded GO-TNF was thoroughly characterized and proved that it presents favorable energy levels to function as a bridge structure between the polymer donor poly({4,8-bis[(2-ethylhexyl)oxy]benzo[1,2b:4,5b′]dithiophene-2,6-diyl}{3-fluoro-2-[(2ethylhexyl)carbonyl] thieno [3,4b]thiophenediyl}) (PTB7) and the fullerene derivative acceptor [6,6]-phenyl-C_{71}-butyric-acid-methylester ($PC_{71}BM$). In this context, GO-EDA-TNF ink was incorporated within the binary photoactive layer, in different ratios (1-3% ratio to the polymer), for the effective inverted ternary organic solar cells (OSCs) fabrication of the structure ITO/PFN/PTB7:GO-EDA-TNF:$PC_{71}BM$/MoO_3/Al, entirely in inert atmosphere. The addition of 2% GO-TNF ink led to an overall device performance improvement, achieving a champion power conversion efficiency (PCE) of 8.71%, enhanced by ~10%, compared to the reference cell.

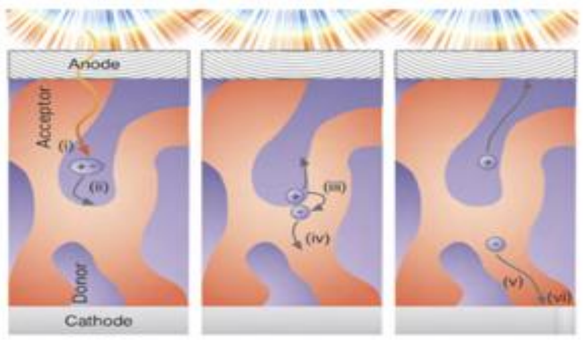
Basic Operational Principles of Ternary OSCs[3]



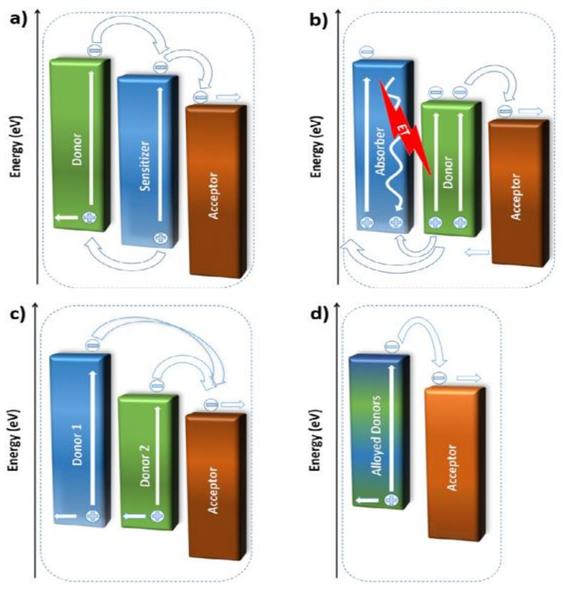
OSC architecture



Exciton dissociation

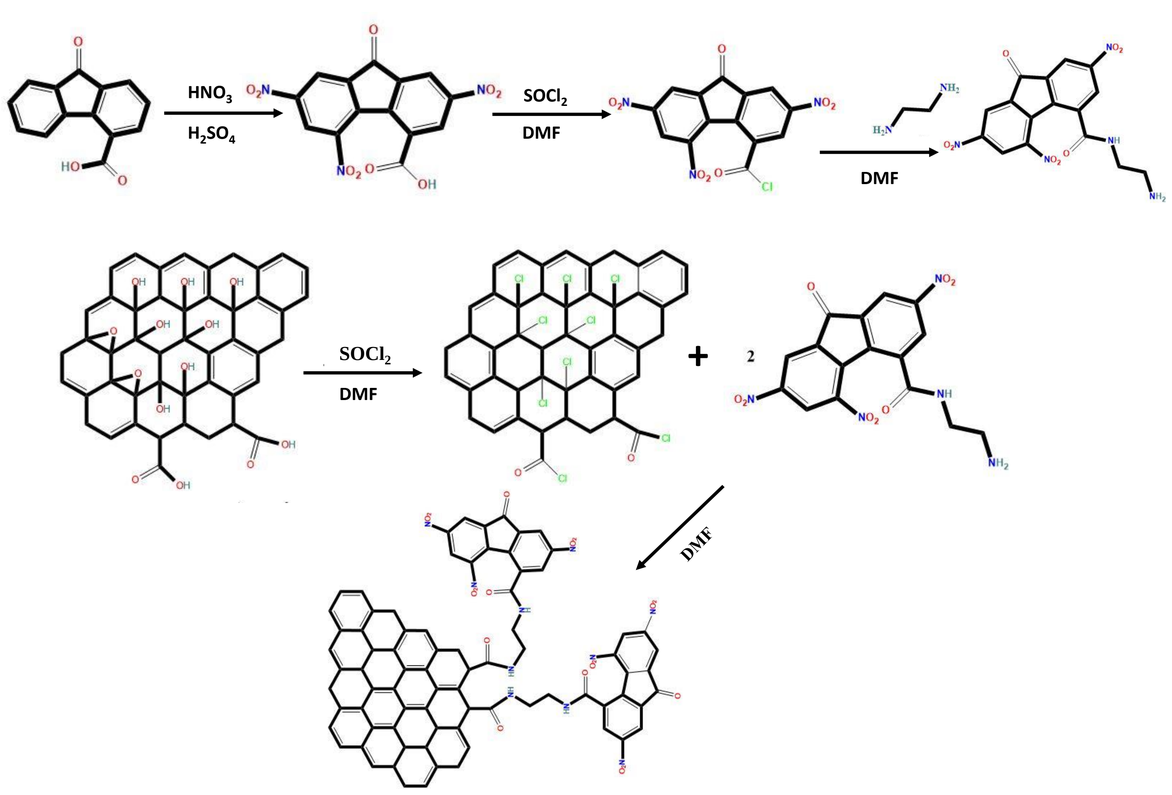


Exciton dissociation mechanism in the active layer



Operational mechanisms of the third component in the active layer of ternary OSCs

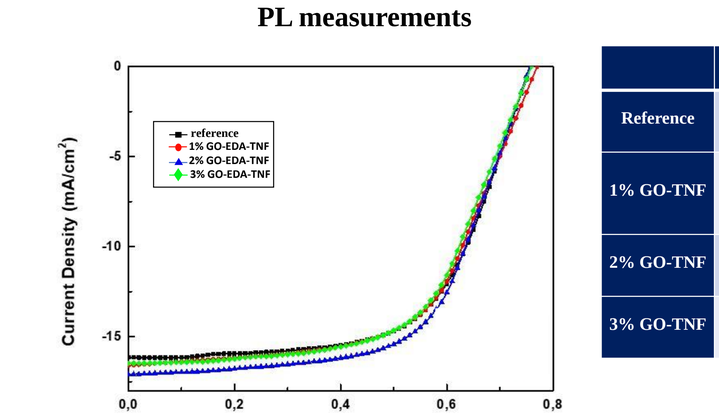
GO-TNF synthetic procedure



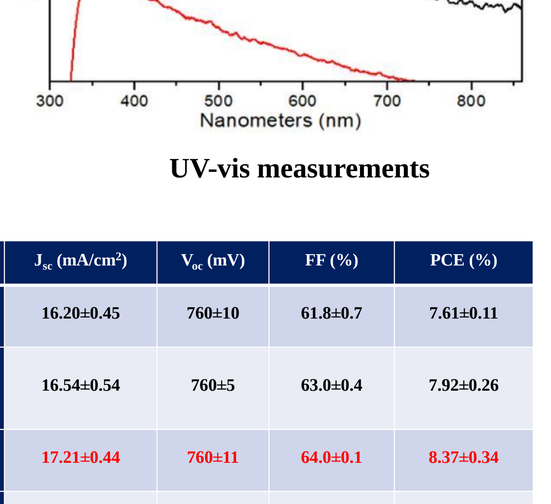
Characterization

- **The energy levels were determined by CV**

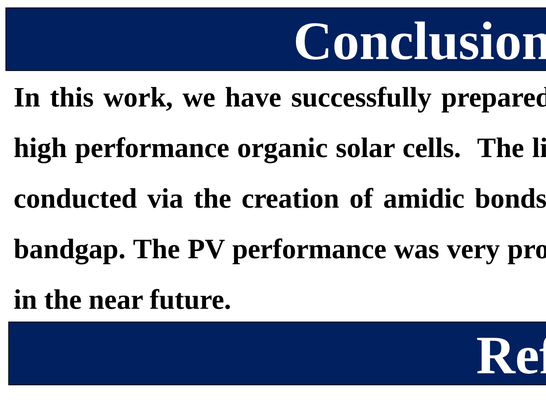
  HOMO: -5.66 eV and LUMO: -4.13 eV



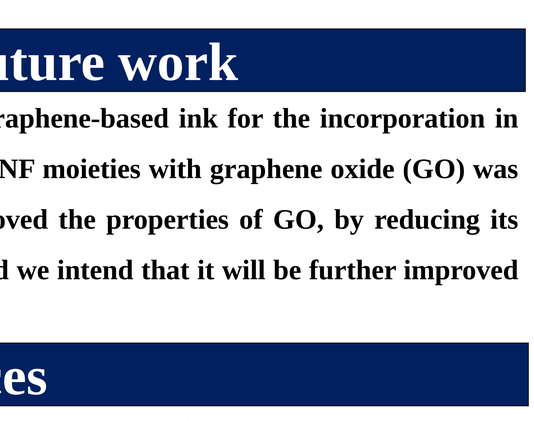
UV-visible absorption spectrum of the active layer



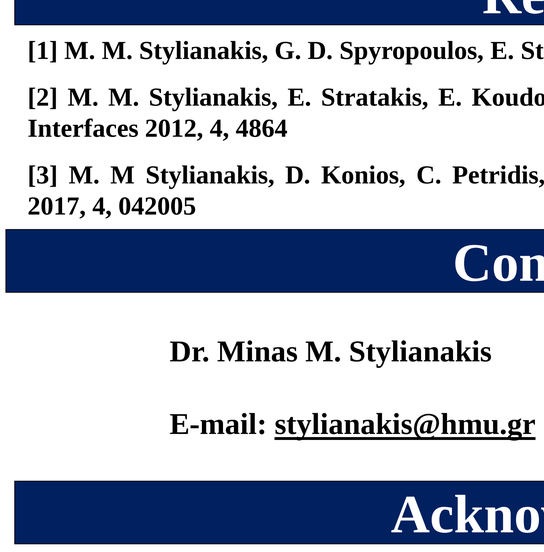
FT-IR measurements



PL measurements



UV-vis measurements



J-V characteristics

	J_{sc} (mA/cm²)	V_{oc} (mV)	FF (%)	PCE (%)
Reference	16.20±0.45	760±10	61.8±0.7	7.61±0.11
1% GO-TNF	16.54±0.54	760±5	63.0±0.4	7.92±0.26
2% GO-TNF	17.21±0.44	760±11	64.0±0.1	8.37±0.34
3% GO-TNF	16.53 ±0.35	760±9	62.4±0.6	7.84±0.17

PV Parameters

Conclusions – Future work

In this work, we have successfully prepared a novel graphene-based ink for the incorporation in high performance organic solar cells. The linkage of TNF moieties with graphene oxide (GO) was conducted via the creation of amidic bonds and improved the properties of GO, by reducing its bandgap. The PV performance was very promising, and we intend that it will be further improved in the near future.

References

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Contact Info

Dr. Minas M. Stylianakis

E-mail: stylianakis@hmu.gr

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