

# Covalent Functionalization of Graphene Oxide *via* a Chemical and Photochemical Method for Organic Photovoltaic Applications

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## Abstract:

Natural graphite powder was oxidized by Hummers' method and graphite oxide was prepared [1]. After ultrasonication was expanded, in order to exfoliate single or/and few layered graphene oxide sheets (GO). Although, the quite low solubility of GO, which is a very important factor in organic photovoltaics, blocks the formation of stable suspensions, as well as solutions, for the exploitation of its unique mechanical properties. In this study, we report our recent results on the covalent functionalization of graphene oxide via a chemical and photochemical method; the addition of an aliphatic amine group linked with a small molecule is demonstrated to increase the dispersability of chemically and photochemically functionalized graphene oxide in organic solvents, so that to synthesize new electron acceptors, appropriate for organic photovoltaics, based on heterostructure polymer-graphene composite layers. In particular, the carboxyl groups of GO are activated using thionyl chloride (SOCl<sub>2</sub>) and finally are coupled with 3,5-dinitrobenzoyl chloride (DNBC) by using 1,4-ethylenediamine as ligament. The above coupling reaction was performed by chemical, as well as by photochemical way, yielded GO-EDNB and LGO-EDNB, respectively. The photochemical method for the simultaneous functionalization of GO was held through pulsed UV laser irradiation of GO in liquid precursor media [2]. Using this technique we have successfully synthesized GO-ethylene dinitrobenzoyl (EDNB) at room temperature in less than 2 hours, compared to 3 days required upon using a conventional chemical route [3]. GO-EDNB and LGO-EDNB derivatives were used as the electron acceptor materials in poly-(3-hexylthiophene) (P3HT) bulk heterojunction photovoltaic devices to significantly enhance the performance, yielding a power conversion efficiency improvement of two orders and one order of magnitude compared with the pristine P3HT and the P3HT-GO devices respectively.

## References

[1] William S. Hummers Jr., Richard E. Offeman, J. Am. Chem. Soc., **80** (1958) 1339.

[2] Minas M. Stylianakis, Kyriaki Savva, Emmanuel Kymakis, Emmanuel Stratakis, Submitted.

[3] Minas M. Stylianakis, George D. Spyropoulos, Emmanuel Stratakis, Emmanuel Kymakis, Carbon, **50** (2012) 5554.

## Figures

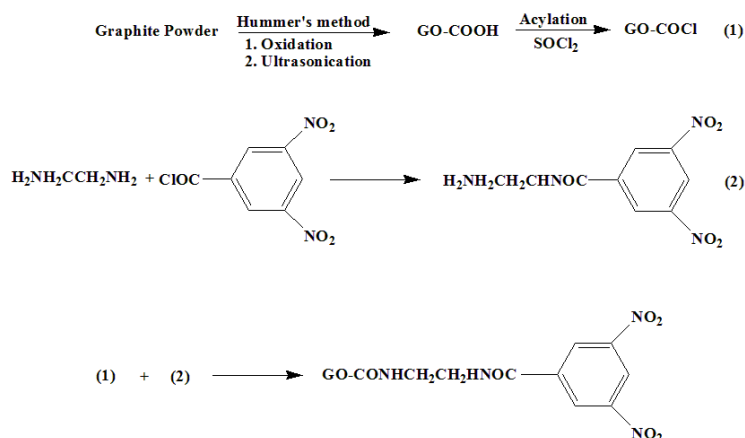
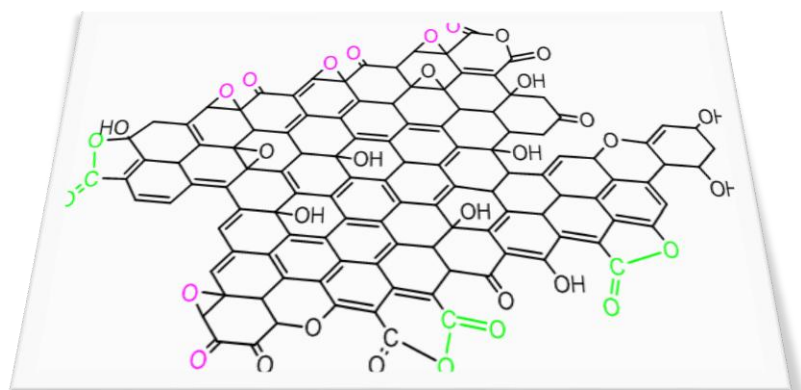


Figure 1. The chemical functionalization of GO



**Figure 2. The photochemical functionalization of GO**