
COVALENT AND SUPRAMOLECULAR FUNCTIONALIZATION OF GRAPHENE FOR ELECTONICS APPLICATIONS

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While the outstanding physical properties of graphene are well-known, the full potential of graphene chemistry has not yet been fully exploited. Being based on sp² carbon atoms, the properties of graphene backbone can be tailored by making use of the many covalent and non-covalent approaches of carbon-based organic chemistry, thereby providing new functionalities to this already exceptional material, as well as enabling its large scale production and solution processing.

Alongside, organic semiconductors (OS) have been extensively studied in last few decades as building blocks for technological applications in organic electronics, due to the possibility to use chemistry to tune their electronic and optical properties, despite their poor performance as compared to silicon (charge mobility of the best OS is two orders of magnitude smaller than the one of silicon). Graphene charge mobility is some orders of magnitudes greater

than the one of silicon; moreover, graphene exhibits a strong chemical affinity with organic molecules, spanning from π -conjugated materials, to fullerene, carbon nanotubes and DNA. Graphene properties can therefore be widely enriched and diversified by using organic chemistry, through chemical doping and molecular functionalization of its surface. Here, we give an overview of possible applications of graphene-organic composites, in particular related to recent results obtained in our group on the:

- 1- Covalent functionalization of graphene sheets with optically active oligothiophenes;
- 2- Charge transport in graphene-polythiophene transistors;
- 3- Local current mapping and patterning of reduced graphene oxide;
- 4- Self-assembling of OS on graphene single sheets.

The interaction of graphene and graphene oxide (GO) with optically active quater-thiophenes (T4) can be exploited to achieve efficient visualization of single sheets on different substrates.[1] The T4 oligothiophenes can also be directly tethered covalently [2] on the surface of graphene oxide (GO), to use GO single sheets as two dimensional scaffold to prevent T4 aggregation and to allow processing in polar and apolar solvents. Hybrid graphene-polythiophene layers can be deposited on source-drain FET devices,[3] enabling the tuning of device performance by the presence or absence of percolating paths for charge transport. The preparation technique used yields good, tunable and uniform coverage of graphene sheets on large areas, with basically all sheets present as monolayers, and poor sheet-sheet interactions even for relatively high coverage. GO can be also be locally reduced using electrostatic fields induced by a scanning probe, allowing to "draw" conductive paths [4] of reduced GO over an otherwise insulating GO layer. Overall, graphene chemistry can potentially allow seamless integration of graphene technology in organic electronics devices to improve device performance and develop new applications for graphene-based materials. An overview of running and future initiatives of joint research on graphene at European level will be also presented for discussion.[5]

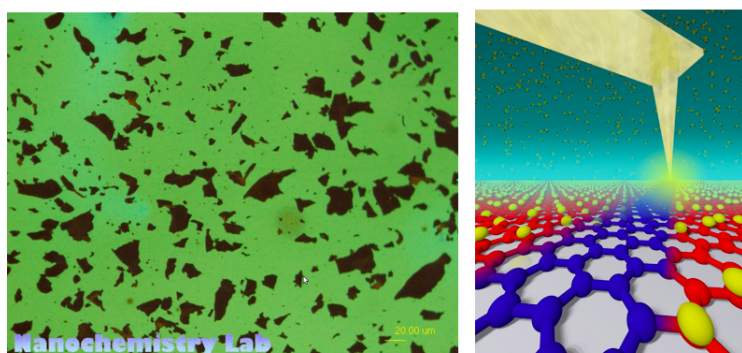


Figure 1: Left: fluorescence image of GO single sheets on a T4 self-assembled monolayer. Right: cartoon depicting local GO electrochemical reduction with a scanning probe tip.

References

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