Graphene *via* electrochemical exfoliation: towards application in electronics

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Abstract

Graphene is a monolayer of carbon atoms arranged in a honeycomb lattice with extraordinary mechanical, electrical and optical properties that attracts the interests of the researchers and industries' since nearly a decade. Despite its promising properties, graphene has not yet found an extensive use in everyday life applications due to the limitations of its up-scalable production. [1] Approaches such as scotch tape exfoliation, epitaxial growth and chemical vapor deposition are not suitable for industrial production, because of high cost and/or low yield. Alongside of these methods, exfoliation processes in liquid media, including ultrasound induced liquid-phase exfoliation (UILPE) and electrochemical exfoliation (EE), are nowadays well established and potentially up-scalable approaches. [2] For instance, in laboratory, gram scale quantities of graphene are electrochemically produced in several minutes, employing low-cost equipment and working in eco-friendly environments. Moreover electrochemical exfoliation lead to micrometer size graphene flakes, encouraging a complete and rapid characterization of produced material at single flake level that is problematic in the case of nanometer sized graphene produced by sonication. A fast preliminary investigation by optical microcopy, analyzing the optical contrast between graphene sheets and proper substrates, can be performed to identify the presence of mono- and few-layered graphene. It can be followed by statistical thickness and flake size analysis by Atomic Force Microscopy (AFM), which supply also information on the morphology of the flake, and the eventual presence of in plane defects. Raman spectroscopy is also performed to further probe the quality of the exfoliated material.
Recent studies shows the effect of different operating parameters (starting graphitic material, [3] type of electrolyte [4] and time of electrolysis [5]) on quality and yield of electrochemically exfoliated graphene.
We here investigate the influence of applied potential and time of electrolysis on the oxidation degree of graphene produced in anodic condition. For the first time such effects are correlated with charge carrier mobility in graphene, exploring the electrical performance of FETs devices based on EEG single sheet.
This work open up new perspectives to the potential introduction of graphene exfoliated in liquid media as active material in electronic industry. Moreover it proves the tunability of EEG properties, which can be tailored to meet the demands of many applications, in the field of electronics as well as composites, energy storage and conversion, etc.

References

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