

## Reactivity of Graphene Sheets: Cycloadditions and Rolling up to form Nanotubes

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The production of graphene by micromechanical cleavage has triggered an enormous experimental activity. Since then, many studies have demonstrated that graphene monolayers possess novel structural, electrical and mechanical properties. However many important issues need to be addressed before this material can be used. Much work has been produced on the chemical functionalization as a tool for tuning graphene chemical and physical properties. For example, chemical functionalization can make graphene dispersible in many solvents. To exploit the high mobility of graphene, the band gap engineering and controllable doping of semimetal graphene can be achieved by chemical functionalization. Moreover, the non-uniformity of graphene edges and the potential for dangling bonds are thought to have significant influence on their chemical properties and reactivity. Chemical modification of various forms of graphene, including reduced graphene oxide, liquid-phase exfoliated graphite, pristine graphene and its multilayers has been obtained. For instance, the aryl diazonium-based reaction has been extensively studied as a specific radical reaction on graphene layers. In graphene, the edges exhibit a higher reactivity than the interior during this specific reaction. Instead, we have recently reported the functionalization of graphene layers by condensation of a protected  $\alpha$ -amino acid and paraformaldehyde, demonstrating that even if the reactivity of graphene differs from that of fullerenes and carbon nanotubes, the 1,3-dipolar cycloaddition can be efficiently performed and yields a highly functionalized material taking place not just at the edges but also at the C=C bonds in the center of graphene sheets. However, further work needs to be performed for understanding the chemical structure of the functionalized graphene and their reaction mechanisms.

In this work we present a detailed study on the reactivity of graphene sheets stabilized in DMF using two different reactions: the 1,3-dipolar cycloaddition reaction and the amide-bond condensation reaction achieved between the free carboxylic groups already present in the exfoliated graphene and the amino functionalities of the attached moieties. In addition, we will show that under certain circumstances, graphene layers can be rolled up to form carbon nanotubes.