Graphene derivatives: synthesis, characterization and application in gas sensing devices. Raman study of the interactions among NO, NO_2 gaseous pollutants, and the graphene gas sensitive layers

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In this work, the chemical synthesis of graphene derivatives have been performed with two different graphite, applied as graphene precursors, by using the modified Hummer's method [1]. Raman, FTIR and TEM characterization were carried out to identify the presence of high quality graphene materials. The highest quality of graphene sample, obtained working with the micro-metric graphite from Merck (as solid powder precursor), was applied for the subsequent functionalization with Triethanolamine (TEOA). FTIR study has been also performed to verify the functionalization of graphene nanosheets with TEOA. This aliphatic amine has been selected because it results highly sensitive [2] and selective toward the NO_2 uptake [3], present as primary pollutant in troposphere.
Theoretical studies (based on Computational models) [4], reveal that the unmodified graphene (i.e. pristine graphene, as deposited) is not an ideal material for gas sensing and for this purpose graphene needs to be functionalized. Especially, FTIR reveals the presence of OH groups on graphene nano sheets and the First-principles calculations also demonstrate the main role of the hydroxyl groups [5] in NO_2 sensing (during the uptake of the gaseous pollutants and their release (when sensors are regenerated).
Finally, Raman spectroscopy clearly highlights the reversible molecular interactions between graphene derivative and NO_2 gaseous pollutant, in both cases: during the selective uptake/capturing and also during the gaseous pollutants desorbing step (this latter necessary for the regeneration of the sensor nanoplatform).

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