Improved electrical transport properties of CVD graphene by sulfur doping

G.V. Bianco[a],
A. Sacchetti[a], A. Milella[b], G. Bruno[a].
a) CNR-NANOTEC Institute of Nanotechnology, Via Orabona 4, Bari 70126, Italy;
b) Department of Chemistry, Univ of Bari. Via Orabona, 4-70123 Bari, Italy.
giuseppevalerio.bianco@cnr.it

Graphene from the metal catalyzed chemical vapor deposition, CVD, methodology opened the way for the large area applications of this material as transparent electrodes for substituting conductive oxides. However, CVD graphene layers are polycrystalline and their structure at atomic level is well far to be free of defects, which affect graphene properties. Atomic scale defects act as scattering centers and lead to a loss of carrier mobility. On the other side, structural disorder at grain boundaries provides additional resistance in series that affect the material conductivity.

Graphene chemical functionalization has been demonstrated to be an effective way for improving graphene conductivity mainly by increasing carrier concentration in the material [1, 2]. The present study reports the healing effects of sulfur doping on the electrical transport properties of single layer CVD-graphene. Single layer of graphene on Corning-glass and Si/SiO_2 substrates are treated by a post-growth thermal sulfurization process operating at 250°C. Combined, XPS and Raman analysis reveals the covalent attachment of sulfur atoms in graphene carbon lattice without creating new C-sp^3 defects. Measurements of transport properties show a strong improvement of material conductivity that is related to an increased mobility as revealed by Hall measurements. The sulfur-chemistry leading to the graphene defects healing, including the creation of disulfur bridges at grain boundaries, and their effect on carrier mobility are discussed.

References

[1] G.V. Bianco, A. Sacchetti, M. Grande, A. D'Orazio, A. Milella, P. Capezzuto, G. Bruno, Carbon, 170, **2020**, 75 – 84;
[2] G.V. Bianco, A. Sacchetti, M. Grande, A. D'Orazio, A. Milella, G. Bruno, Scientific Reports, 12, **2022**, 8703.

Figures

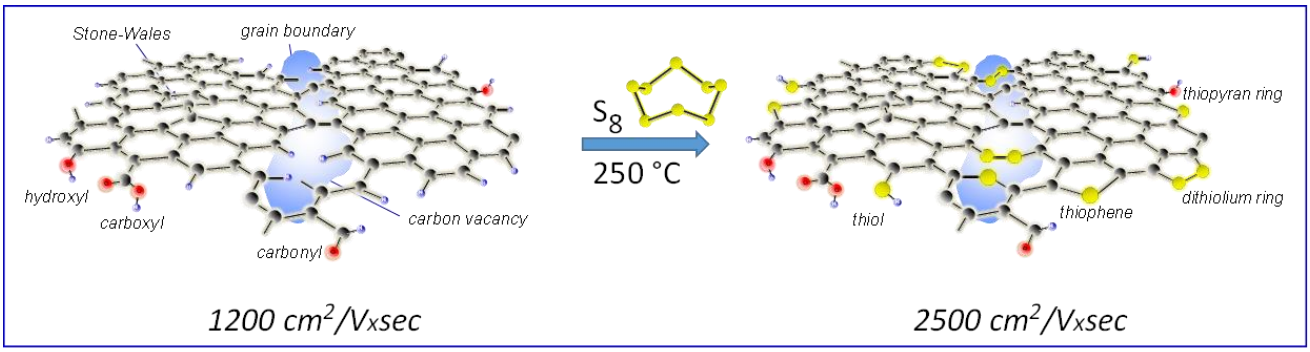

Figure 1: . Schematic representation of CVD graphene as prepared and after thermal sulfurization process. The yellow spheres represent sulfur atoms. The different C–S bonding configurations inserted into the graphene network are evidenced as well as the typical carbon vacancies, grain boundaries and the Stone–Wales defects.