

# Effects of Doped Sulfur Element in Graphene Using Heat Treatment

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## Abstract

Graphene is a two-dimensional (2D) carbon atomic plane whose carbon atoms fill the honeycomb lattice points of the plane. Studies in order to improve the electrical properties of graphene have been carried out consistently using the doping method in which carbon atoms were replaced with other elements.

In this study, we tried to change the electronic properties of graphene on which some carbon atoms were substituted with sulfur atoms and vacancy defects as shown Fig. 1. Graphene was grown on copper foils using a typical CVD method with hydrocarbon gas and transferred onto a SiO<sub>2</sub>/Si substrate. The graphene having artificially created defects was doped with sulfur using heat treatment under sulfur atmosphere.

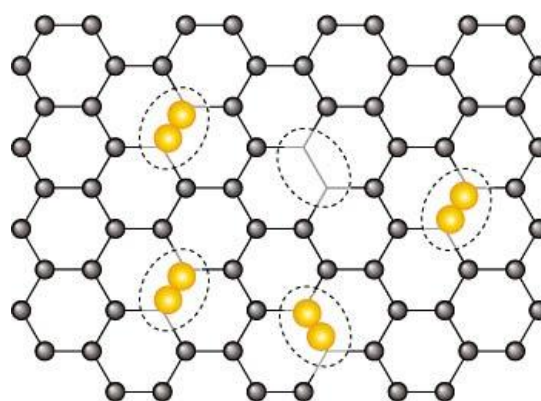
Raman spectroscopy revealed that the sulfur atoms were doped on a graphene layer. The electrical properties of sulfur-doped graphene were measured using 4-probe measurement method with gold electrodes as shown Fig. 2. These results indicate that the sulfur-doped graphene can be used for a channel layer of semiconductors.

## References

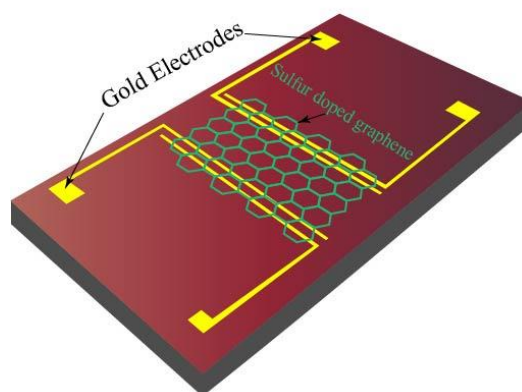
[1] J. Dai, J. Yuan, and P. Giannozzi, *Appl. Phys. Lett.*, 95 (2009) 232105

- [2] C. Liang, Y. Wang, and T. Li, *Carbon*, 82 (2015) 506-512
- [3] Y. Ren et al, *Appl. Phys. Lett.*, 100 (2012) 163114
- [4] Z. Yang et al, *ACS Nano*, 6 (2012) 205-211
- [5] H. Gao et al, *Nanotechnology*, 23 (2012) 275605

## Figures



**Figure 1:** The sulfur atoms (yellow) and vacancy defects (dashed ellipse) in a graphene layer.



**Figure 2:** Schematic of a sulfur doped graphene layer (green) on SiO<sub>2</sub>/Si wafer to measure of electric characteristics.