Investigating Non-Covalently Functionalized CVD Graphene and Hexagonal Boron Nitride (hBN) Heterostructures as Platforms for Hydrogen Sensing

Evans Addo-Mensah[1], Hugh Churchill[2], Uche Wejinya[3]

[1]*Materials Science and Engineering Program, University of Arkansas, Fayetteville, USA*
[2]*Department of Physics, University of Arkansas, Fayetteville, USA*
[3]*Mechanical Engineering Department, University of Arkansas, Fayetteville, USA*

evansa@uark.edu

An exciting new direction in developing hydrogen sensing technology is the application of non-covalently functionalized chemical vapor deposition (CVD) graphene and hexagonal boron nitride[1] (hBN) heterostructures. We examine in this work if these heterostructures might serve as appealing platforms for applications related to hydrogen sensing.

Graphene and hBN-based nanostructures have remarkable qualities including large surface area, superior electrical conductivity, and mechanical resilience. Because of their complementary qualities, combining these materials in heterostructures provides synergistic benefits for hydrogen sensing. High electrical conductivity and sensitivity to surface interactions are attributes of graphene, whereas hBN acts as an insulator, reducing environmental interference and improving selectivity.

To change the surface of graphene and hBN heterostructures with hydrogen-sensitive compounds or nanoparticles, non-covalent functionalization approaches like physisorption or π-π stacking interactions are needed. Such functionalization techniques make it easier to detect hydrogen gas at lower concentrations and allow for improved hydrogen adsorption.

This study entails an evaluation of the functionalized heterostructures through the use of atomic force microscopy (AFM) and scanning electron microscopy (SEM)[2]. These investigations provide an understanding of the heterostructures' shape, chemical makeup, and structural integrity both before and after functionalization. Through electrical measurements, we assess the sensing capabilities of the non-covalently functionalized graphene-hBN heterostructures involving adjustments to resistivity and carrier mobility as a function of temperature following exposure to different surfactant doses and treatment times.

In summary, our results show that substantial non-covalently functionalized CVD graphene and hBN heterostructures containing Sodium Octyl Sulfate (SOS) surfactant raise the CVD graphene's average and root-mean-square surface roughness parameters. It is believed that the localization of charge carriers close to the interface or surface due to this rise in surface roughness may affect transport behavior. Also, the density of states and electronic band structure can be changed by surface roughness due to quantum confinement phenomena. This subsequently influences the threshold voltage and other device characteristics, as well as the transport qualities including conductivity and mobility. The parameters of electronic transport in materials and devices are significantly influenced by surface roughness. To achieve precise and repeatable electronic transport measurements and maximize the functionality of electronic devices, surface roughness must be understood and managed.

References

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