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# Ethanol gas sensing with single-layer fluorinated graphene in ohmic and transistor junctions

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**Abstract**

Graphene, a two-dimensional carbon material with properties such as high cross-sectional area and excellent electrical conductivity, has wide applications in the manufacture of volatile organic compound (VOC) sensors. These sensors allow the detection and measurement of these compounds by changing the electrical properties of graphene upon exposure to VOC molecules. Such sensors are of great importance in air quality and environmental monitoring. In this study, a monolayer graphene-silicon junction-based sensor was fabricated using photolithography and graphene wet transfer. To enhance the performance, the graphene sheet was converted into semiconducting fluorinated graphene using $SF_6$ plasma, and then, the performance of this sensor in detecting ethanol gas was evaluated in both ohmic and transistor modes. The surface characterization of this sensor was carried out using various methods such as scanning electron microscopy and atomic force microscopy, and the effects of fluorination on graphene were also investigated through, Energy-dispersive X-ray spectroscopy, Raman spectroscopy, and attenuated total reflectance spectroscopies. Finally, the sensor performance was evaluated by measuring the current-voltage changes in the presence of ethanol gas. In terms of the mechanism of action, the adsorption of ethanol on the surface of the semiconducting fluorinated graphene leads to electron donation and an increase in the number of charge carriers. These electrical changes are the basis of the sensor performance for ethanol detection. The results show that the saturation limit is reduced by applying a gate voltage compared to the ohmic junctions, and this value becomes even lower with increasing ethanol concentration. Overall, the sensing performance in the transistor mode was better than that of the ohmic one. The development of a new generation of graphene-based VOC sensors will play a vital role in air pollution monitoring due to their high response speed, excellent sensitivity, and surface modification capabilities.

**Keywords:** Gas sensors, Fluorinated Graphene, volatile organic compound, Ethanol, Transistors

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