Graphene 산화물 트랜지스터의 특성

Characterization of Graphene Oxide Transistors

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1. Introduction

Graphene is a single atomic layer of carbon atoms with sp^2 hybridized honey-comb 2D structure. Recently, most of research groups are showing great interest in graphene not only in fundamental physics but also in applications such as sensor, field effect transistors. Many methods were reported for production of graphene layers in which mechanical exfoliation technique is one of well known technique. However this method is simple, but does not allow for control of graphene layer positioning. Similarly the chemical vapor deposition technique is also found difficult to produce single layer graphene, only thicker layers are possible to make it. So we need to go for an alternative to use graphene oxide (GO) [1-2] because GO is easily solvable in water and can easily exfoliated in water-based solution and then simply spin-coated or sprayed on to any substrate. GO is a chemically derived component from bulk graphite after strong oxidation process. It can be processed in many ways. Most popular method is modified Hummer's method. In recent days, thin graphene oxide (GO) has been a subject of intense scientific investigation as it can be used as a starting material for the synthesis of graphene [3]. Several studies were carried out to understand the electrical characteristics of GO thin film and to explore the possibility of integrating it with graphene based electronic applications.

In this paper, we report the synthesis and electrical characterization of GO for FET applications.

2. Materials and Methods

Graphene oxide was prepared using modified Hummers method [4]. After preparing GO, we characterized the powder XRD and FTIR analysis to confirm the quality of GO. Our experiments were confirmed the obtained GO were in good quality. We made GO dispersions with various concentrations and formed the thin film by spin coating. Figure 1 shows the scanning electron image (SEM) of GO film which we used for FET characteristics.

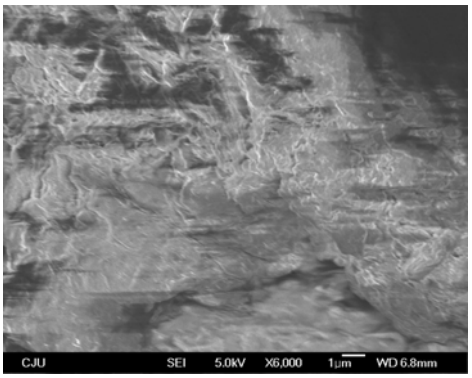

Fig. 1 SEM image of Graphene oxide film surface indicates uniform surface with good quality.

3. FET Characteristics of GO film

The field effect characteristics of GO thin film

were investigated. The schematic of FET device is shown in Fig. 2. The GO thin film was spin coated on Si/SiO_2 substrate followed by Au electrode (source and drain) formation using thermal evaporation technique. Back gate was formed using gold contact. The FET characteristics were measured in Agilent semiconductor parameter analyser.

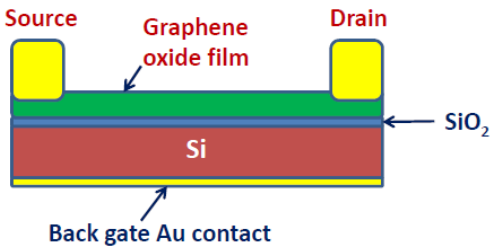

Fig. 2. Schmatic of GO- FET. In this SiO_2 will be act as Gate oxide.

The transfer characteristics of GO-FET (I_{DS} versus V_{GS} for various source-drain voltage (V_{DS}) were measured, which is shown in Fig. 3.

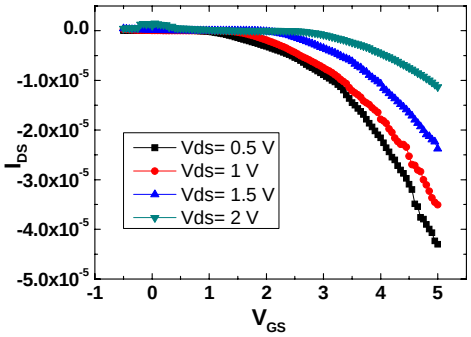

Fig. 2. Transfer characteristics of GO-FET. I_{DS} versus V_{GS} for various source-drain voltage (V_{DS}) is presented.

From Fig. 3, it is clear that GO-FET shows a decrement in source-drain current when the voltage between source and drain is increased. This indicates the p-type semiconducting behavior of FET device. The induced charge carriers in FET channel by the V_{GS} has been blocked due to increase in V_{DS}, hence the current value becomes lower when high V_{DS} applied.

4. Conclusion

We have reported the synthesis of graphene oxide (GO) using modified Hummers method. The FET characteristics were studied for the synthesized GO and found GO exhibits p-type semiconducting behavior. Also GO-film surface found as very smooth and uniform. Graphene oxide with semiconducting nature can be a right candidate to replace existing graphene based field effect transistors.

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References

1. Jeong, H-K., Lee, Y.P., Lahaye, R. J., Park, M-H., An, K. H., Kim, I. J., Yang, C-W., Park, C. Y., Ruoff, R. S., and Lee, Y. H., " Evidence of graphitic AB stacking order of graphite oxides," J. Am. Chem. Soc. **130**, 1362, 2008.
2. Jeong, H-K., Noh, H-J., Kim, J-Y., Jin, M. H., Park, C. Y., and Lee, Y. H., " X-ray absorption spectroscopy of graphite oxide," Europhys. Lett. **82**, 67004, 2008.
3. Li, D., Muller, M.B., Gilje, S., and Kaner, R.B., "Capacitance-voltage and current-voltage characteristics of graphene oxide thin films patterned by ultraviolet photolithography," Appl.Phys. Lett., **95,** 263308-3, 2009.
4. Hummers, W. S. Jr., Offeman, R. E., "Preparation of graphitic oxide," J. Am. Chem. Soc. **80**, 1339, 1958.