Improvement of the gas sensitivity of a CNT/graphene hybrid structure sensor by the application of strain

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Graphene is considered to be the most promising next-generation gas sensing material. It has an ultra-high sensitivity for detecting various gas molecules. However, graphene cannot distinguish a specific gas molecule from the mixture of the adsorbed multiple gases, and the lack of selectivity limits the application of graphene in the gas sensing field. To improve the performance of the graphene-based gas sensors, the authors proposed two methods: (1) application of mechanical strain for controlling the effective adsorption energy of gas molecules on graphene[1)] and (2) surface modification of graphene by carbon nanotube for increasing the gas adsorption area and forming heterojunction to enhance the response of graphene-based gas sensor.

In this study, a flexible graphene-based gas sensor and a CNT-graphene hybrid gas sensor were developed by applying acetylene-base LP-CVD method. High-quality graphene was synthesized on an inner surface of a copper foil pocket structure. It was transferred onto a polyimide and SiO_2 substrate by a wet transfer method. The CNT was grown on the graphene/SiO_2 by LPCVD by using fine Al_2O_3/Fe particles as catalyst. After the deposition of Au/Pt electrodes, the sensing area was pattered by using O_2 plasma. The gas sensing tests were performed in a homemade sealed chamber. The bending strain was applied to the fabricated sensor using a motorized stage. Figure 1(a) shows the outlook and the response of the flexible graphene-based gas sensor to 2-ppm NO_2. The sensitivity was increased by about 6 times under the application of tensile bending strain. The change of the resistance of graphene in the CNT/graphene hybrid gas sensor is also shown in Fig.1(b). The sensitivity to water molecules was increased by about 4 times compared to the conventional graphene gas sensor. In addition, the response time decreased to about 1/5. These results strongly indicated the possibility of the graphene-based gas detecting sensors with high sensitivity and selectivity for real time health monitoring.

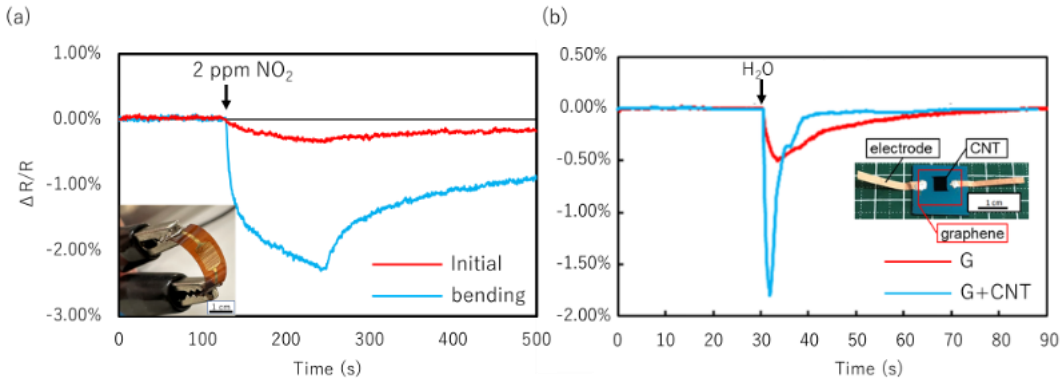

Fig. 1 (a) Measured strain-induced change of the resistance of graphene with the adsorption of NO_2 gas molecules and (b) Measured resistance change of the CNT-G hybrid gas sensor with the adsorption of H_2O.

References

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2) Xiangyu Qiao, et al., Proc. of ASME IMECE2020, No. IMECE2020-23581, (2020).