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Chemiresistive Ammonia Sensors Based on Graphene Oxide and Reduced Graphene Oxide Deposited on Interdigitated Electrodes

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Introduction

Graphene oxide (GO) and reduced graphene oxide (RGO) combine surface functionalities with electrical properties of interest for room-temperature ammonia detection [1,2]. Partial reduction changes the film chemistry and conductive network. Comparing these materials on a common electrode architecture helps examine their contribution to chemiresistive transduction.

Objective

Investigate how GO reduction affects baseline resistance and the direction of the NH_3-induced electrical response on Ti/Au interdigitated electrodes.

Methodology

GO was synthesized by a modified Hummers method and dispersed in Milli-Q water (0.1 mg/mL). Using an insulin syringe, a droplet was deposited onto Ti/Au interdigitated electrodes. The device was held at 80–100 °C during deposition to evaporate the water and form a GO film over the electrode fingers. RGO was obtained by in situ reduction of the GO film with 0.8 mol/L citric acid.

The films were characterized by SEM/EDS, Raman, and FTIR. A source measure unit (SMU) recorded I–V curves during NH_3 exposure at room temperature and atmospheric pressure.

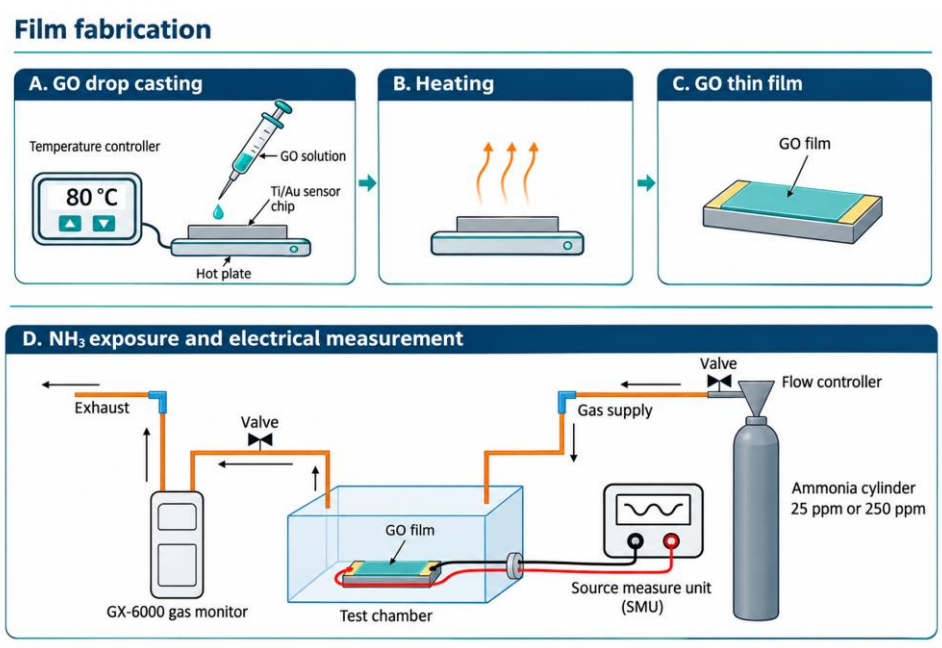


Figure 1. (A–C) GO film fabrication by drop casting. (D) NH_3 exposure and I–V measurements..

Results and Discussion

SEM images show folds and overlapping sheets in the GO and RGO films on the electrodes (Figure 2). The EDS map shows the spatial distribution of the carbon signal, while the spectrum identifies C, O, Au, and Si in the analyzed region (Figure 3).

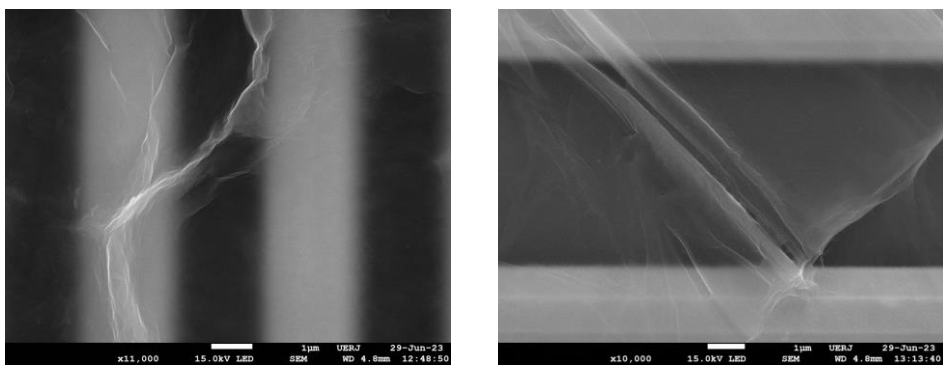


Figure 2. SEM views of the deposited films of (A)GO and (B)RGO over adjacent electrode fingers, showing folds and overlapping sheets.

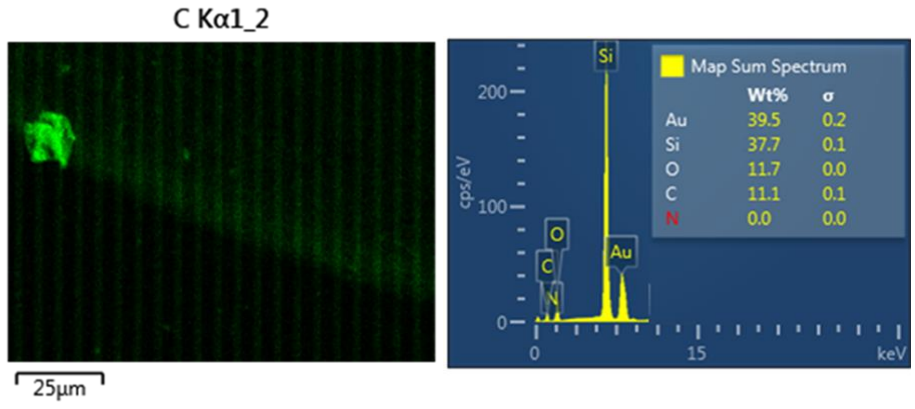


Figure 3. EDS spectrum with C/O signals accompany contributions from Au and Si in the analyzed region.

The Raman spectra show D and G bands in both films, indicating disordered sp^2 carbon domains (figure 4). The FTIR spectra (figure 5) show changes in oxygen-related bands consistent with partial reduction of GO.

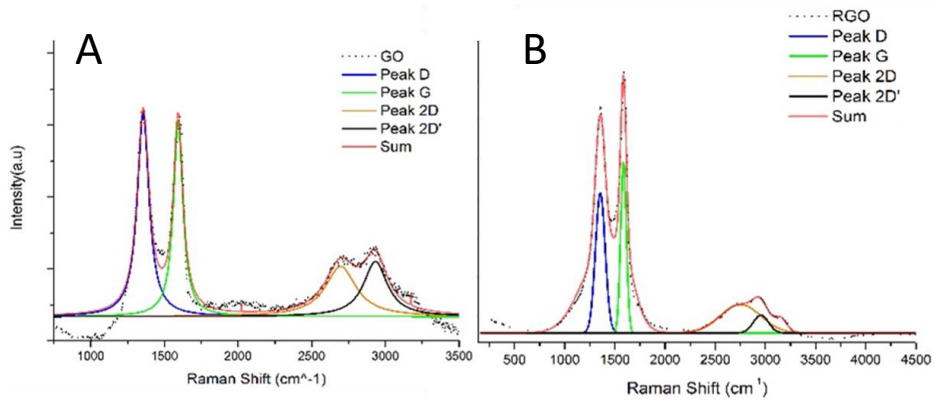


Figure 4. Raman spectra of (A) GO and (B) RGO, showing the characteristic D and G bands, with I_D/I_G ratios of approximately 1.04 and 1.00, respectively.

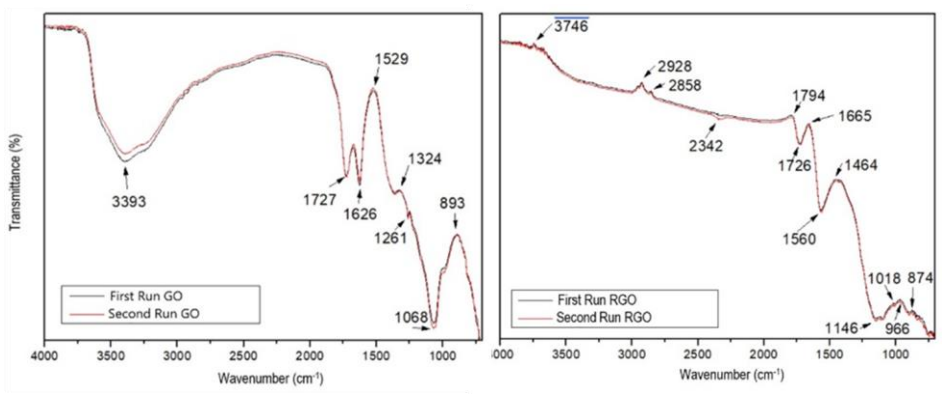


Figure 5. FTIR spectra of GO (left) and RGO (right). Each panel includes two acquisitions.

Both devices exhibit nearly linear I–V characteristics (figure 6). At a fixed voltage, NH_3 exposure increases the current in the GO device and decreases it in the RGO device, indicating a decrease in resistance for GO and an increase for RGO.

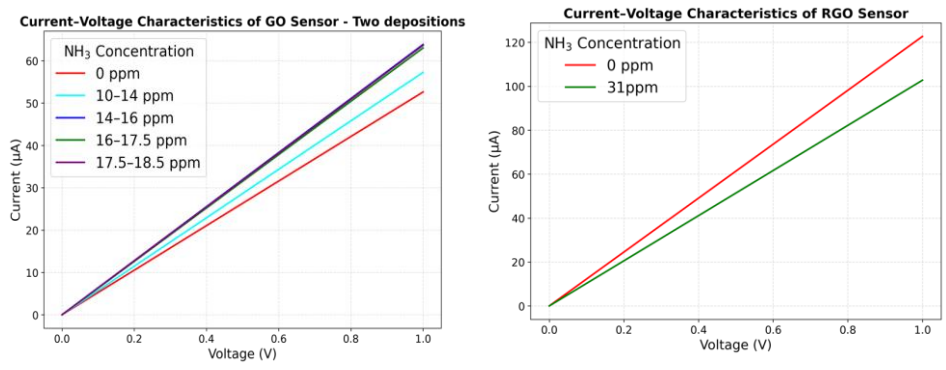


Figure 6. RGO: I–V curves before and during exposure to 31 ppm NH_3.

Film	R_0 (kΩ)	RNH_3 (kΩ)	$\Delta R/R_0$ (%)
GO[1]	19.0	15.7	−17.4
RGO[2]	8.2	9.7	+18.3

[1] Two depositions, 17.5–18.5 ppm. [2] 31 ppm. Rounded manuscript values. $\Delta R/R_0 = (RNH_3 - R_0)/R_0 \times 100$.

Different NH_3 concentration ranges prevent a direct ranking of sensitivity. The GO curves at higher concentrations are close and do not establish a strictly monotonic calibration.

Conclusions

On the same Ti/Au electrode architecture, NH_3 exposure reduced GO resistance from 19.0 to 15.7 kΩ at 17.5–18.5 ppm (−17.4%) and increased RGO resistance from 8.2 to 9.7 kΩ at 31 ppm (+18.3%). These results link the sensing layer's chemical state to baseline resistance and response polarity, both relevant to electrical readout. Quantitative performance comparison requires tests at matched concentrations and repeatability measurements.

References and Acknowledgements

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