Reduced Graphene Oxide (rGO) based Conductometric Sensors for Drinkable Water Quality Monitoring

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1 Introduction

Access to clean drinking water is essential, but current monitoring systems are often expensive and technically complex. This project aimed to develop a low-cost, scalable sensor using reduced graphene oxide (rGO) and molybdenum disulfide (MoS_2) to detect heavy metal ions in water.

The proposed sensor leverages the high conductivity of rGO and the semiconducting nature and surface activity of MoS_2. A heterojunction formed by these materials enhances sensitivity and enables effective signal transduction upon analyte interaction.

2 Materials and Fabrication

Synthesis of rGO and MoS_2:

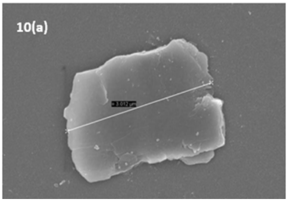
- Graphene Oxide (GO) was synthesized using the modified Hummer's method, involving the oxidation of graphite using $KMnO_4$ and H_2SO_4 under carefully controlled temperatures.
- MoS_2 nanosheets were produced using liquid-phase exfoliation in aqueous ammonia. Ultrasonication at 5°C for 3 hours ensured effective exfoliation while preserving structural quality.

Device Fabrication: The sensor was constructed using sequential drop-casting- 7 layers of rGO drop-casted on a clean glass substrate and dried at $70°C$, with a Teflon tape mask applied to define the junction region, and 3 layers of MoS_2 dispersion deposited on the unmasked area to form the receptor layer.

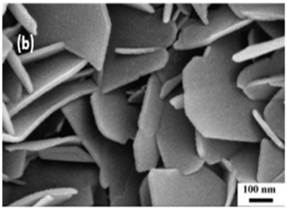
3 Characterization and Results

Structural and Morphological Characterization:

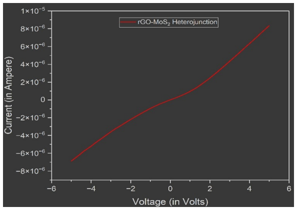
- X-ray diffraction (XRD) confirmed that GO was successfully reduced to rGO (peak near 24–26°). MoS_2 showed characteristic peaks around 14.4°, indicating layered structure.



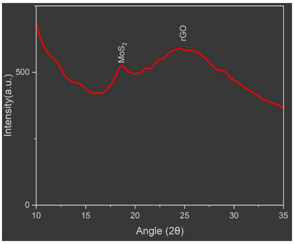
(a) FEESEM of rGO



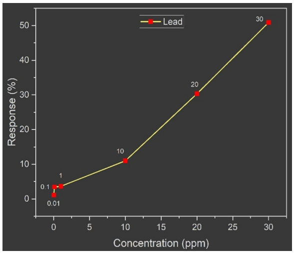
(b) FESEM of MoS_2



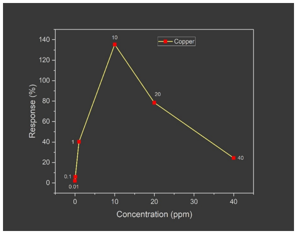
(c) I-V characteristic



(d) XRD of the sensor



(e) Response to Pb^{2+}



(f) Response to coppper

Figure 1: Results

- FESEM (Field Emission Scanning Electron Microscopy) revealed rGO nanoflakes with uniform film formation, and MoS_2 nanosheets evenly distributed, confirming good adhesion and structure.

Electrical Characterization: A 4-point probe cryogenic station showed that the device displayed Shottky-type I-V characteristics, confirming the formation of a p–n heterojunction, which is crucial for sensing functionality.

4 Conclusion

The sensor was tested with five heavy metal ions: Nickel, Cadmium, Mercury, Lead, and Copper, across multiple concentrations.

- Highest selectivity and sensitivity observed for Pb^{2+} (Lead ions).
- Copper ions also showed strong response at higher concentrations.
- Sensor performance for Pb^{2+} was both quantifiable and consistent, with response $> 50\%$ at 30 ppm.