Technical Abstract

Inkjet Printed Graphene
Metal Oxide Miniaturized Gas Sensors

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Chemiresistive gas sensors based on reduced graphene oxide (rGO)/metal oxide (MOx) composite are currently considered as the next generation sensing devices due to their advantages over the conventional MOx counterparts. The merits of using rGO/MOx composite derive from material properties of rGO and its interaction with MOx. In this report, theories on the sensor mechanism are discussed in depth, allowing identification of rGO/MOx sensors' properties as well as defects which require improvements.

After a thorough analysis of the background theory, different processes involved in rGO/-MOx based gas sensors are studied. Three different metal oxides are used in this project: Cu_2O, Co_3O_4, and $CuCoO_x$, to synthesize rGO/MOX sensors via inkjet printing. The materials will each be used to describe the common experimental characteristics of 2D incorporated gas sensors and discuss possible methods to allow improvements in sensors' performance.

Characterisation and testing are first done on rGO/Cu_2O sensors to portray archetypal rGO/MOx sensor traits. Different techniques such as SEM, sessile drop method are involved which are used to deepen the knowledge on the nanocomposite and the formulated ink. The sensor also undergoes testing to provide common sensor response to analytes.

The processes above allow identification of two major issues with gas sensing: inaccuracy from baseline drift and selectivity. An attempt at reducing the baseline drift was made via inputting pulse signals to rGO/Co_3O_4 sensor, which was unsuccessful due to several constraints. On the other hand, selectivity improvement was achieved using PCA with classifiers using rGO/$CuCoO_x$ sensor, allowing distinction between similar responses to analytes in different humidity settings, up to an approximated accuracy of 75% which can be optimised. However, the data used for this analysis was created from assumptions and a pseudo-random data generator, due to Covid-19 disruptions.

Overall, the project allows a deeper understanding on rGO/MOx gas sensors. Throughout the duration of the project, it was possible to explore different aspects of gas sensing technology, from the synthesis processes to performance optimization based on theoretical background developed from the project. Different data processing techniques were also explored, with selectivity improvements through use of PCA and classifiers. Finally, the report concludes with ideas and suggestions that could be used in future to further complete the research.