Title: **Development of Graphene Oxide based Ethylene Gas Sensor for Freshness Monitoring of Fruits.**

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Abstract:

This thesis deals with the development of Graphene Oxide (GO) based Ethylene gas sensor for freshness monitoring of fruits. A conductive type GO-based pellet sensor and also drop casted thin film sensor have been fabricated and fruit ripeness condition is monitored via Ethylene gas sensing in a closed chamber at room temperature. Here we used fruits as the source of ethylene.

GO was prepared by standard Hummer's method, and morphological and structural characterizations have been performed using field emission scanning electron microscopy (FESEM), X-ray powder diffraction (XRD), and Raman spectroscopy analysis.

Four different types of fruits of same weight (200gm of orange, banana, guava, and mango) were used for sensor response measurements. Fruit samples were kept in the closed chamber, and the change in conductivity of the sensors (both pellet and thin film based) were observed with increase in emitted Ethylene concentration in the chamber which was cross-verified with standard MSR sensor. The sensors showed almost linear response in the Ethylene concentration range of 40–120 PPM, and it was observed that orange samples produce maximum response for the GO pellet sensor with a sensitivity of 0.06 μAmp/PPM for a fixed exposure time (5 minute). The sensor was found capable to successfully differentiate between four individual fruit samples in perfect ripening condition which could be utilized in fruit detector e-nose application.

From the response characteristics, different sensor parameters like, sensitivity, repeatability, reproducibility, storage stability have been studied. Studies on temperature optimization and humidity interference have also been performed. The studies show good response and an excellent repeatability. The storage stability of the sensors is also very good up to 10 days in ambient air. The optimized operating temperature of our sensors is found to be ~22°C, which is an added advantage for

hydrocarbon gas sensing. Further, a comparative study between the response of our developed GO sensor and the sensors based on different well known gas sensing materials like ZnO and MoS_2 towards ethylene have been performed. All of these studies conclude that our GO based sensors can be a promising alternative for cost-efficient measurement of ethylene gas at room temperature.

The integration of the sensor with commercially available radio frequency identification device (RFID) tags for in-field wireless monitoring of the ripening condition of fruits may be the future scope of work.

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