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# $V_2O_5$-rGO based chemiresistive gas sensor for $NO_2$ detection

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ABSTRACT

Current study displays an actual hydrothermal synthesis of $V_2O_5$-rGO composite and further investigates how changes in rGO composition in $V_2O_5$-rGO composites affected their $NO_2$ sensing property. The orthorhombic crystal structure is confirmed by XRD and Raman techniques, and the optimum proportion of disorders in the composite as a result of rGO is also confirmed. Porous nanostructure is observed in SEM images. The C, V, and O present in the composite are confirmed by the XPS results, along with a fluctuation in $V^{4+}/V^{5+}$. The BET technique was used to measure specific surface area (25.91 $m^2g^{-1}$) and pore radius (6.4140 nm). A prominent PL peak confirm presence of oxygen vacancies. At 150 °C, gas sensing for 100 ppm concentration of $NO_2$ gas revealed improved response about 121.85%. The calculated response/ recovery time for sample consisting 10 mg rGO are 39 and 262 s, respectively. Along with response, sample C shows excellent reproducibility and good stability.

## 1. Introduction

Due to industrialisation and globalisation in recent years, several harmful gases from various industries and automobiles have emerged, affecting the air quality. There are significant issues with the environment and human health as a result of these dangerous and poisonous gases. As a result of industry and transportation, $NO_x$ ($NO_2$ and NO) is continuously released into the environment, posing a severe health risk by contributing to lung disease and breathing difficulties. Another problem brought on by $NO_x$ emissions is smog, as well as acid rain. $NO_x$ is emitted into the atmosphere through a variety of natural processes, including lightning, in addition to artificial human-made activity [1]. Detecting and decomposing $NO_2$ without having any negative environmental effects is crucial. A gas sensor is a device that utilises a specific mechanism to identify dangerous gases and transforms that information into signals that can be observed. The sensing parameters, which include gas response, detection limit, selectivity, response and recovery time, material stability, and many more, determine the quality of the gas sensors. The quality of a good gas sensor is, it must possess a strong response and selectivity, a quick response/ recovery time, a low operating temperature, and a good stability and many others. There are a variety of metal oxide semiconductor (MOS) based gas sensors in the market, depending on the sorts of dangerous gases they detect, such as $NO_2$, $NH_3$, CO, $CO_2$, $C_2H_5OH$, and so on [2]. The most crucial components in gas sensing applications are MOS's which has several good properties such as, large surface area, low cost, low operating temperature, stability, and many other. Due to its numerous oxidation states, excellent thermal, optical, as well as chemical stability, low toxicity, low cost, and numerous other positive characteristics, vanadium pentoxide ($V_2O_5$) is attracting greater attention [3]. $V_2O_5$ can be employed in various applications such as gas sensor [4–5], photocatalysis [6–7], supercapacitor [8], solar cell [9] and many others. It displays good performance in the area of gas sensors. Vanadium pentoxide has been described in several morphologies that have been produced using various chemical processes. As per numerous literature survey an orthorhombic $V_2O_5$ is a layered structure in which corner and edge-sharing $VO_5$ pyramids of $VO_6$ octahedra are periodically arranged and jutting out at both sides of the layer. Trigonal bipyramidal polyhedral oxygen atoms distortedly arranged around vanadium oxide make up the final structure. Three different sorts of oxygen atoms are found in this

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