

## Goals and objectives

This project aims to manufacture, functionalize, characterize, and optimize the lab's carbon nanotubes for the chemical detection of various gases, aiding the nonproliferation mission of NNSA.

## Introduction

Carbon nanotubes (CNTs) are cylinders of hexagonally-arranged carbon atoms. This structure leads to a high surface-area-to-volume ratio and high stability and makes their electrical resistance highly sensitive to the presence of analytes. These properties then make them ideal for the detection of various gases, giving them vast applications in various fields.

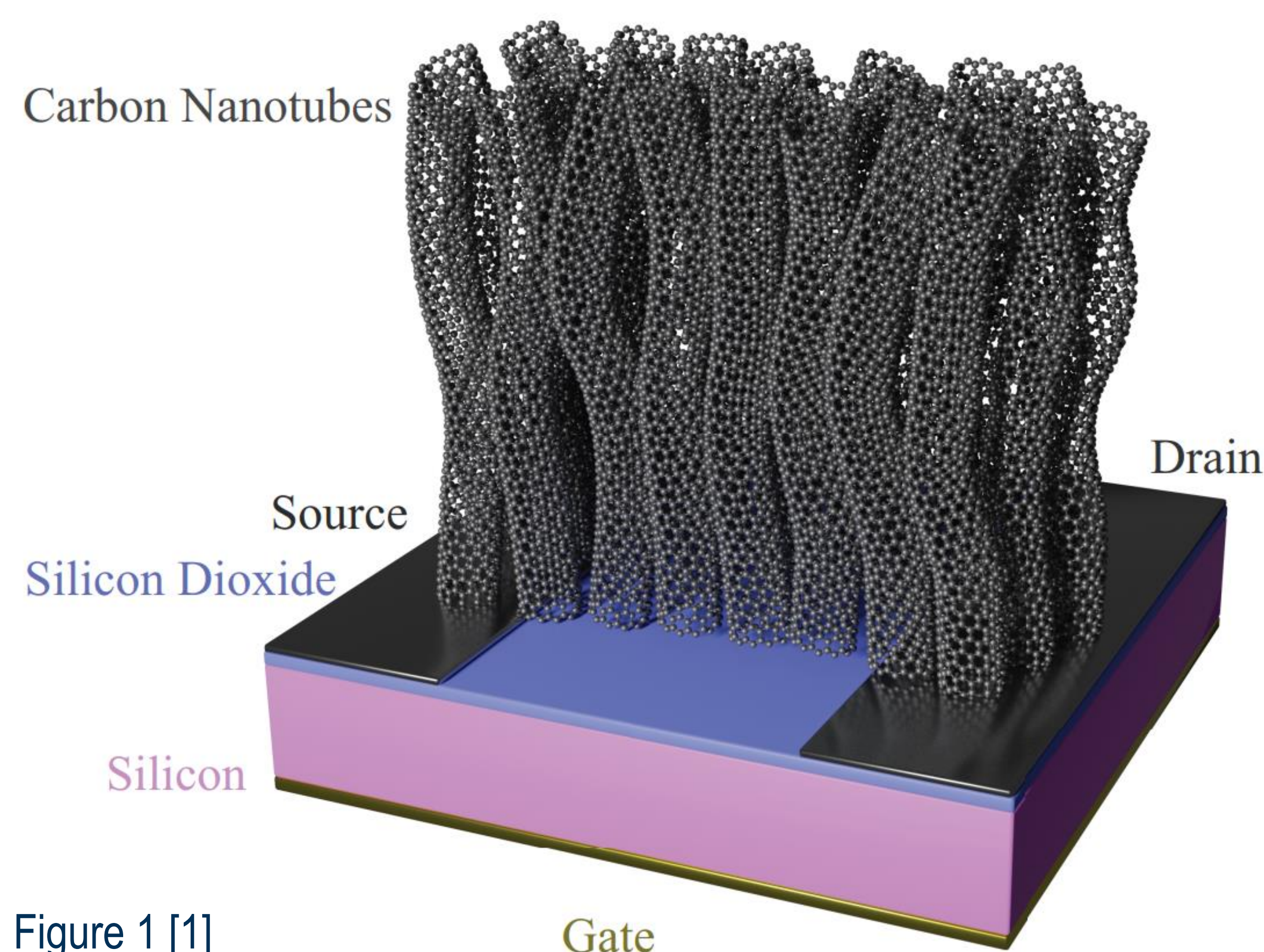


Figure 1 [1]

## Methods

The preliminary methods are as follows:

1. Control: Measure the resistance of the unfunctionalized CNTs and if there is a measurable change in resistance in the presence of ammonia, starting with this gas since it has been shown to create relatively great changes in resistance in functionalized CNTs [2].
2. Carboxyl functionalization: Since the CNT forest may be sensitive to added mass, the least massive functionalization will be attempted first, following the method shown in papers such as "Synthesis and characterisation of MWCNTCOOH and investigation of its potential as gas sensor" by Naief et al. [3]
3. Polymeric functionalization: This option will be explored since various polymeric functionalizations have shown great sensitivity.
4. As shown in Figure 4, the length of the CNTs can affect the resistance, so an optimal height of functionalized CNTs will be explored.

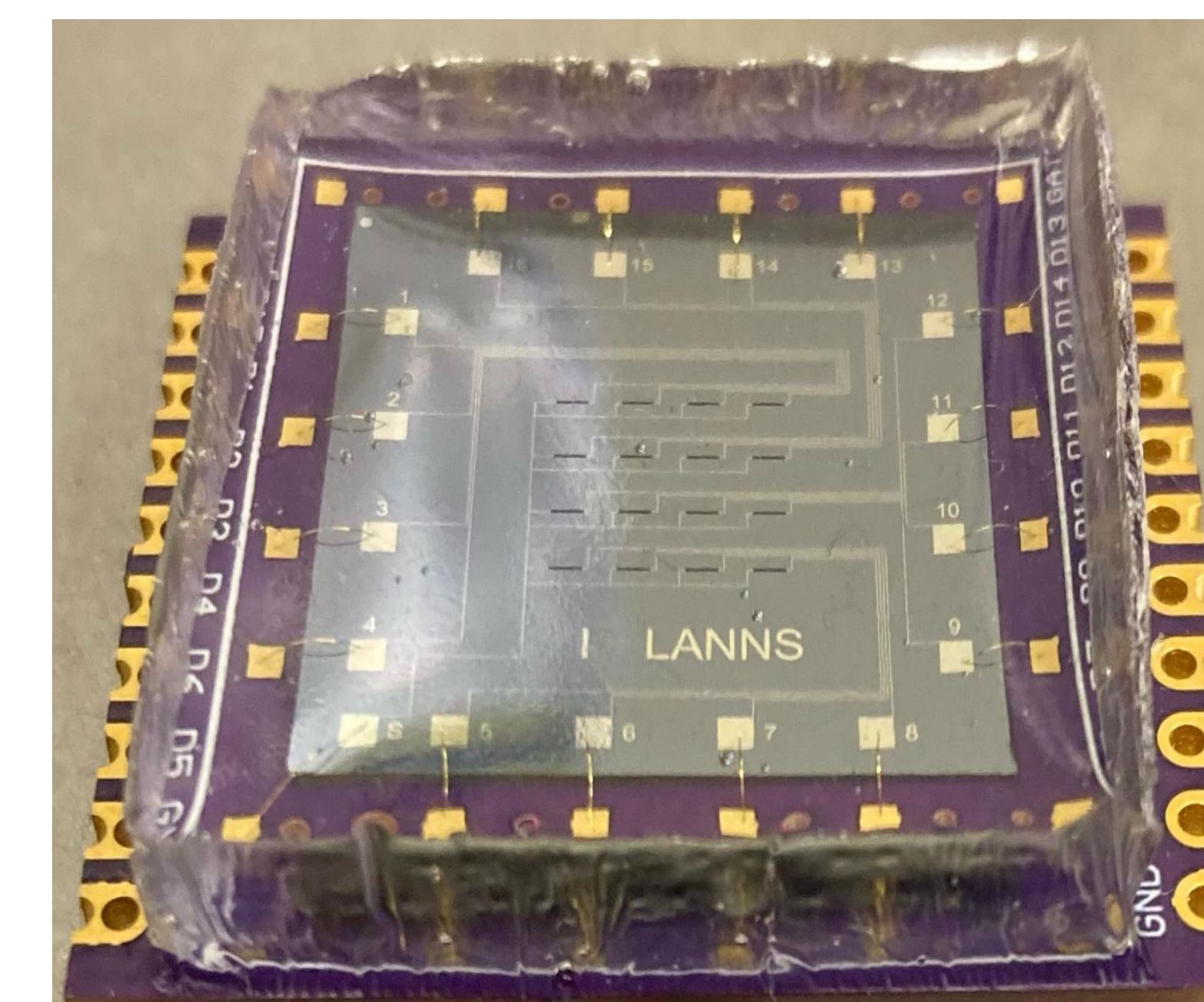


Figure 2 [1]

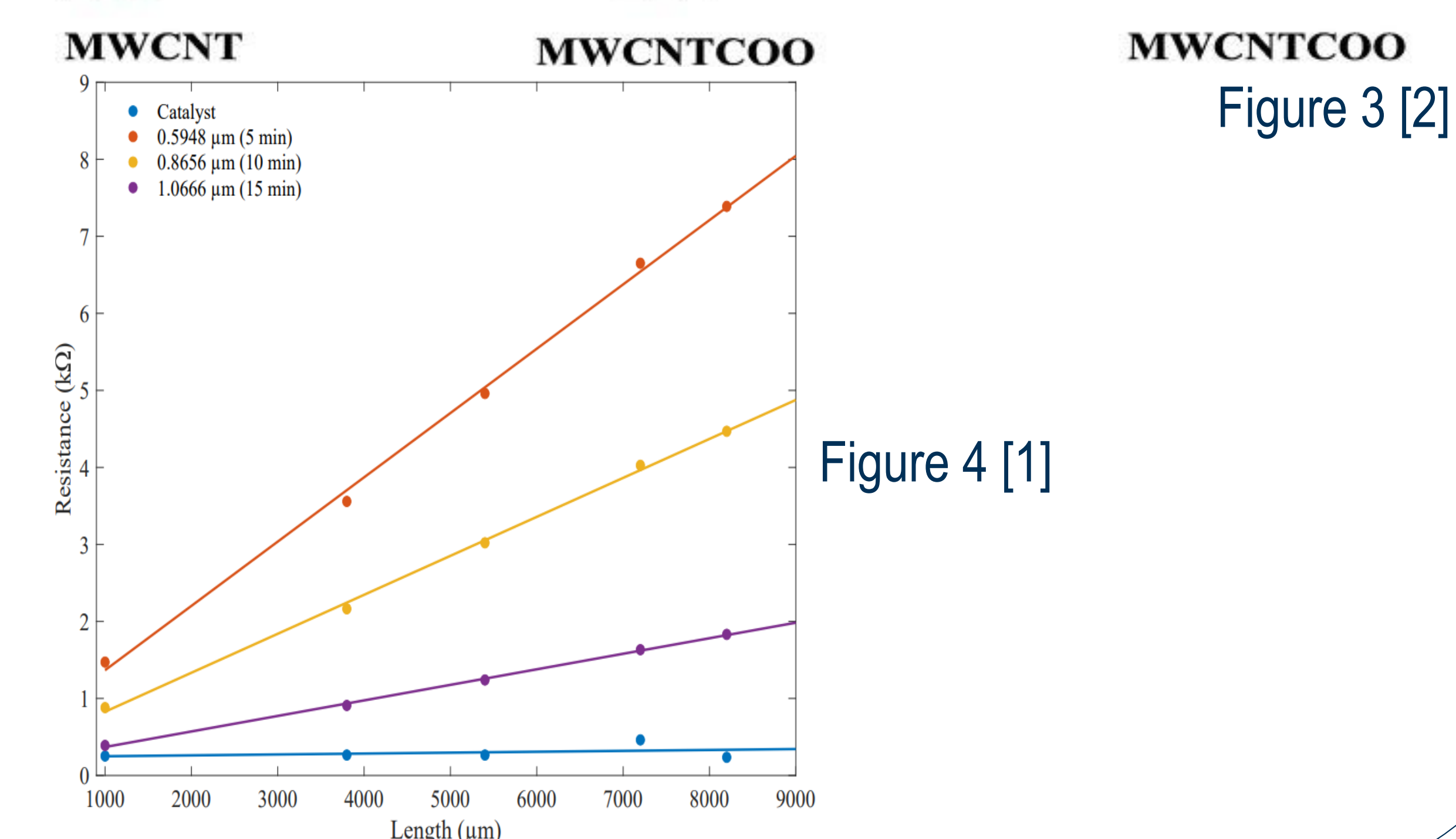
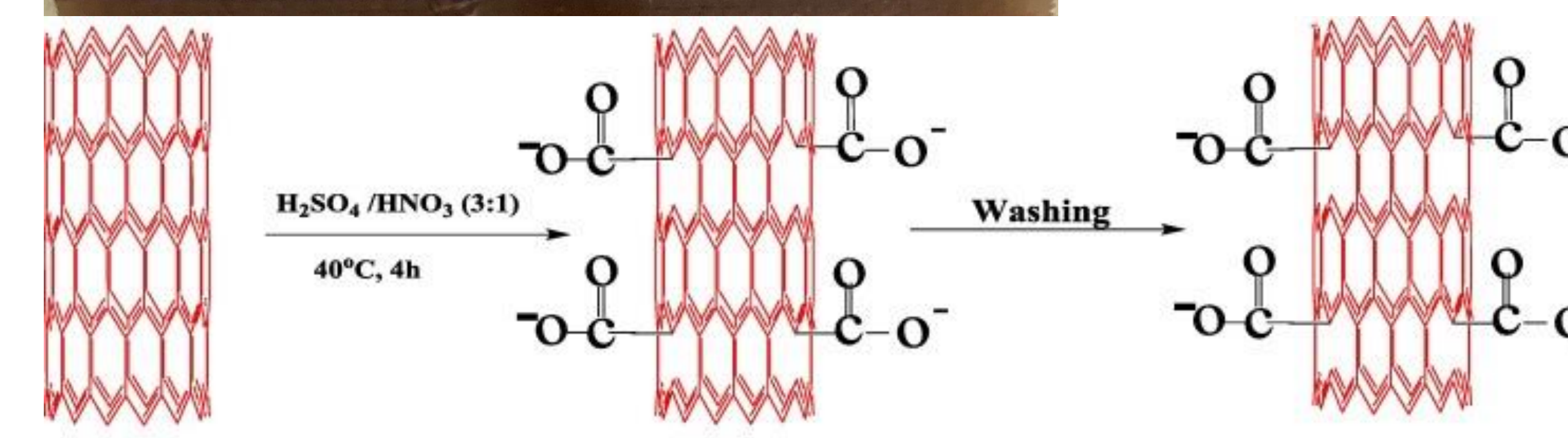


Figure 4 [1]

## Conclusion

Carbon nanotubes have various properties that make them ideal for gas sensing, and this will be explored to further ETI thrust area three by developing a novel gas sensor with carbon nanotubes of this configuration.

## References

1. Figures used with permission from Arith Rajapakse, which initially appeared in his dissertation, "Sensing the Interaction of Ionizing Radiation in a Semiconductor Substrate Using Carbon Nanotubes." Mohammed Faiad Naief, Samar Naser Mohammed, Yasser Najji Ahmed, Ahmed Mishaal Mohammed. (2023). *Synthesis and characterisation of MWCNTCOOH and investigation of its potential as gas sensor*. Inorganic Chemistry Communications. 57.
2. Mohd Nurazzi Norizana, Muhammad Harussani Moklisa, Siti Zulaikha Ngah Demona, Norhana Abdul Halima, Alinda Samsuria, Imran Syakir Mohamadb, Victor Feizal KnightORCID logoc and Norli Abdullah. (2020). *Carbon nanotubes: functionalisation and their application in chemical sensors*. Royal Society of Chemistry. 10.