CIC 2025 Conference

4th Coatings and Interfaces Online Conference

21–23 May 2025 | Online

MDPI

Hybrid nanostructures of transition metal oxides on vertical graphene for enhanced electrochemical performance

Alina MATEI*, Cosmin ROMANIȚAN, Oana BRÎNCOVEANU, Marius STOIAN, Octavian-Gabriel SIMIONESCU, Vasilica ȚUCUREANU*

National Institute for Research and Development in Microtechnologies IMT-Bucharest

**Correspondence: alina.matei@imt.ro; vasilica.tucureanu@imt.ro*

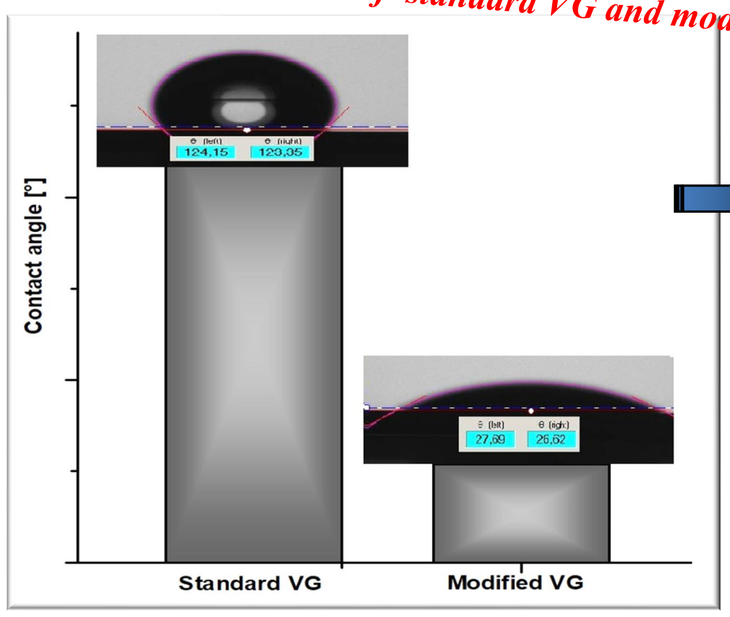
INTRODUCTION & AIM

Transition metal oxide (TMO) nanostructures have attracted particular interest due to their multifunctionality, ranging from biomedical devices to electrochemical sensors for wastewater treatment in the textile industry, food processing and packaging, energy storage systems, catalysts, and solar cells. Among the different materials studied, In_2O_3 nanostructures have the advantages of remarkable physicochemical properties, high specific surface area, high surface-to-volume ratio, substantial chemical and environmental stability, and high electron mobility. Over the years, different substrates have been studied for the deposition of TMO thin films to meet the requirements of the targeted fields.

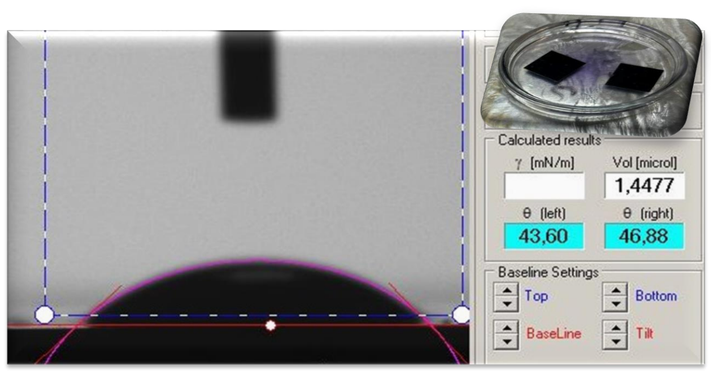
In the present work, In_2O_3 nanostructures were obtained by chemical synthesis, and the process conditions and thermal treatment parameters were controlled, with these factors being considered the determining factors with effects on particle size and morphology. Graphene hydrophilization was performed to ensure the oxide nanostructures were compatible with the substrate of interest. The next step consisted of dispersion of In_2O_3 powders in different media, drop-casting a suspension of oxide particles on the surface of the vertical graphene substrate, and evaporation of the solvent by heat treatment.

RESULTS & DISCUSSION

CA of standard VG and modified VG

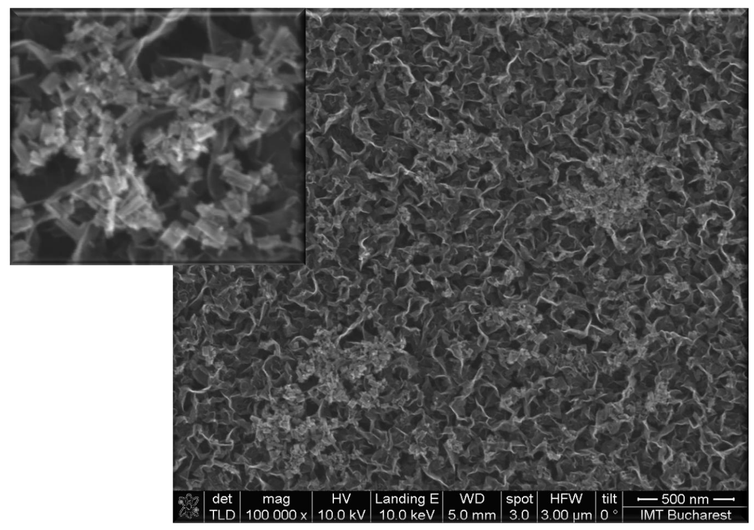


CA of In_2O_3 on modified VG



Standard VG exhibits hydrophobic behavior; by modification, the surface becomes hydrophilic, allowing the dispersion of In_2O_3 on the surface or between sheets.

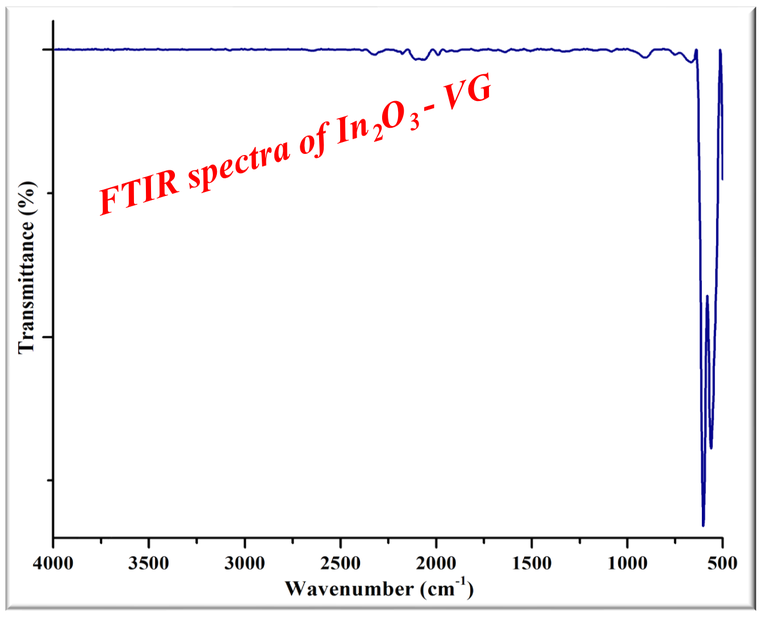
SEM micrograph of In_2O_3 - VG



The SEM images indicate a slight tendency of the particles to agglomerate at the surface and penetrate between the graphene sheets.

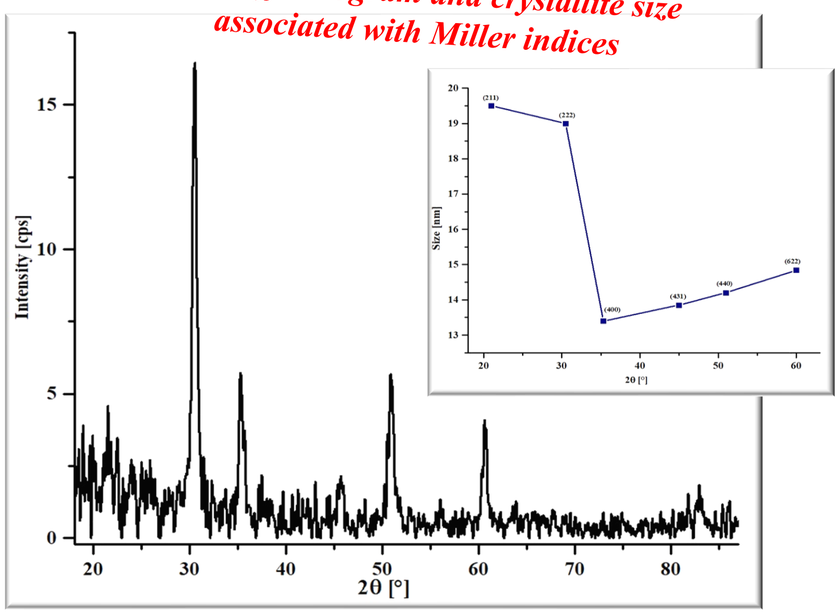
CONCLUSION

FTIR spectra of In_2O_3 - VG



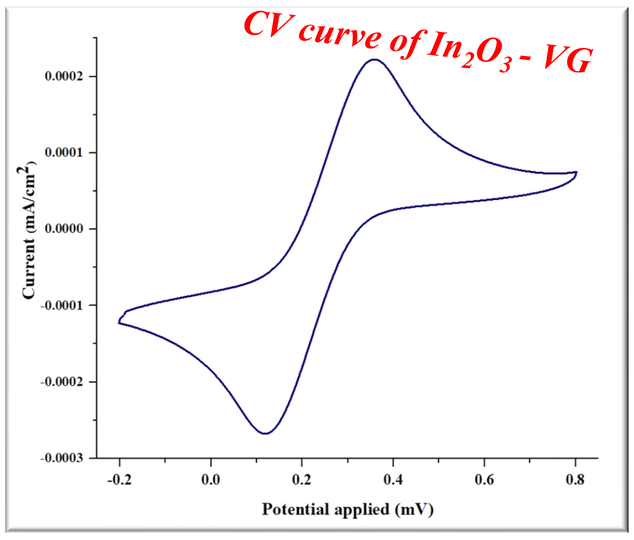
The spectrum confirms the presence of functional groups assigned to the In–O vibration mode characteristic of cubic In_2O_3.

XRD diffractogram and crystallite size associated with Miller indices



The XRD diffractogram shows characteristic In_2O_3 planes at angles of 21°, 30.5°, 35.3°, 45°, 51°, and 60°, with an average crystallite size of 16 nm.

CV curve of In_2O_3 - VG



The oxidation and reduction peaks were observed during the anodic and cathodic sweeps, indicating the electrochemical performance of In_2O_3.

REFERENCES/ ACKNOWLEDGEMENTS

This work was supported by a grant from the Ministry of Research, Innovation and Digitization, CNCS-UEFISCDI, project number PN-IV-P2-2.1-TE-2023-0417, within PNCDI IV and by the Core Program within the National Research Development and Innovation Plan 2022-2027, project no. 2307.

1. L. Xiong, Y. Fu, Y. Luo, Y. Wei, Z. Zhang, C. Wu, S. Luo, G. Wang, D. Sawtell, K. Xie, T. Wu, D. Ding, L. Huang, *Prospective applications of transition metal-based nanomaterials*, Journal of Materials Research 37, 2109–2123 (2022). https://doi.org/10.1557/s43578-022-00648-5

2. V. Maciulis, A. Ramanaviciene, I. Plikusiene, R*ecent advances in synthesis and application of metal oxide nanostructures in chemical sensors and biosensors*, Nanomaterials, 12, 4413 (2022). https://doi.org/10.3390/nano12244413

3. V. Tucureanu, O.G. Simionescu, M. Stoian, G. Craciun, C. Pachiu, A. Matei, *Preparation and characterization of vertical graphene-based nanocomposites for electrochemical applications*, The 5th International Electronic Conference on Applied Sciences (ASEC), session: Nanosciences, Chemistry and Materials Science, sciforum-106415, 94 (2024)