Proceedings of the 10th World Congress on Recent Advances in Nanotechnology (RAN 2025)
Barcelona, Spain - April, 2025
Paper No. ICNNFC 113
DOI: 10.11159/icnnfc25.113

Solution-Deposited Metal Oxides as 4th Generation Glucose Sensors

Mahabubur Rahman Chowdhury
Functional Materials Research Unit (FMRU), Cape Peninsula University of Technology
Cape Town, South Africa
chowdhurym@cput.ac.za

Extended Abstract

The growing need for advanced glucose monitoring technologies, particularly in managing diabetes, has directed significant attention towards non-enzymatic electrochemical glucose sensors. Nanoparticulate metal oxides such as cobalt oxide (Co_3O_4), copper oxide (CuO) and nickel oxide (NiO) have demonstrated strong potential due to their cost-effectiveness, stability, and ease of deposition [1-4]. However, traditional methods that rely on nanoparticle powder-based electrodes introduce contact resistance, often due to binder usage, resulting in lower sensor performance. To address this, a metal-organic complex synthesis method is proposed, eliminating the need for binders and thus lowering contact resistance between the active material and the electrode (Figure 1).

One notable drawback of the metal-organic complex synthesis route is the lack of morphology control over the deposited films. However, to overcome this limitation, we have developed post-processing techniques that enable the engineering of the deposited films. These techniques optimise the active surface area, enhance mass transport, and ensure better electron transfer, which is crucial for sensor sensitivity [5].

In conclusion, solution-deposited metal oxides like Co_3O_4, CuO, and NiO represent a significant advancement in fourth-generation non-enzymatic glucose sensors. By addressing the limitations of binder-induced contact resistance and employing post-processing techniques to control morphology, these sensors can achieve higher sensitivity and stability, making them promising candidates for more effective glucose monitoring technologies.

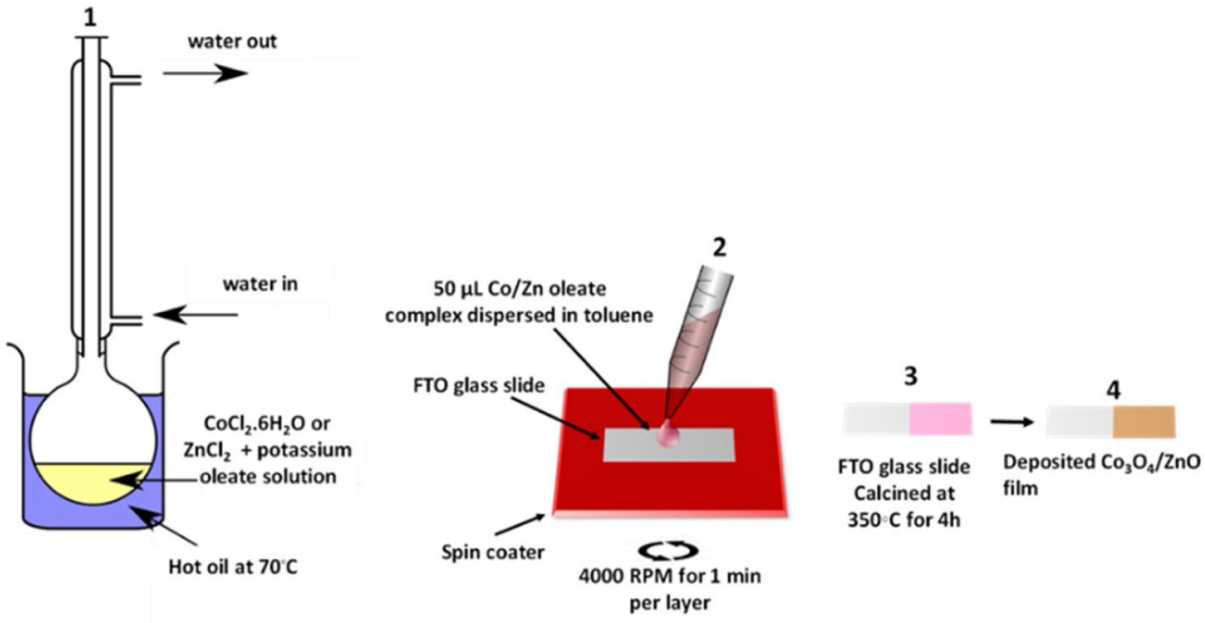

Figure 1: Illustration of a typical metal-organic complex solution to electrode

References

[1] Y. Chitare, S. Jadhav, P. Pawaskar, V. Magdum, J. Gunjakar, and C. Lokhande, "Metal oxide-based composites in nonenzymatic electrochemical glucose sensors," *Ind. Eng. Chem. Res.*, vol. 60, no. 50, pp. 18195-18217, 2021. DOI: 10.1021/acs.iecr.1c03662.

[2] H. Abunahla, B. Mohammad, A. Alazzam, M. Jaoudé, M. Al-Qutayri, and S. Hadi, "Momsense: metal-oxide-metal elementary glucose sensor," *Sci. Rep.*, vol. 9, no. 1, 2019

[3] M. Morais, A. Marques, S. Ferreira, T. Pinheiro, A. Pimentel, and M. Macedo, "Visible photoluminescent zinc oxide nanorods for label-free nonenzymatic glucose detection," *ACS Appl. Nano Mater.*, vol. 5, no. 3, pp. 4386-4396, 2022.

[4] S. Liu, W. Zeng, Q. Guo, and Y. Li, "Facile synthesis of $CuCo_2O_4$@$NiCo_2O_4$ hybrid nanowire arrays on carbon cloth for a multicomponent non-enzymatic glucose sensor," *Nanotechnology*, vol. 31, no. 49, p. 495708, 2020.

[5] W. Yang, L. Shi, Y. Li, Q. Zeng, X. Jin, and X. Zha, "Morphology control strategy of bimetallic complex-derived nanosheets for upgrading the sensitivity of noninvasive glucose detection," *ACS Appl. Mater. Interfaces*, vol. 14, no. 33, pp. 37843-37852, 2022.