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$NiMoO_4$ nanoparticles decorated carbon nanofiber membranes for the flexible and high performance glucose sensors

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ABSTRACT

The free-standing and flexible carbonaceous nanofiber membrane (CNF) comprising of $NiMoO_4$ nanoparticles decorated carbon fibers were developed for glucose sensing analysis. The applicability of polymeric nanofiber membranes in electrochemical sensors is accelerated by enhancing their electrical conductivity *via* carbonization process. The cavities exist in CNFs accelerate the rapid diffusion of glucose and maximizes the analyte utilization efficiency. The uniform implantation of catalytic active sites of $NiMoO_4$ on CNFs accelerates the glucose sensing kinetics further. With the synergism of bimetal active sites, porous architecture, and conductive carbon network, $NiMoO_4$/CNF demonstrates the excellent sensitivity, low detection limit, and broad linear range, respectively, of 301.77 μA mM^{-1} cm^{-2}, 50 nM, and 0.0003–4.5 mM toward glucose sensing. Also, the sensing concerts of $NiMoO_4$/CNF are reliable, repeatable, and electrochemically stable along with the high specificity and real sample applicability toward glucose detection. Thus, the free-standing, bendable, binder-free, reusable, and cost-efficient fabrication process developed for the $NiMoO_4$/CNF membrane realizes it's conscription in the development of cost-efficient and high performance glucose sensors.

1. Introduction

Glucose is deemed as an essential nutrient to promoting the metabolism process and physiological activities of living organisms [1]. However, an improper glucose level in human body leads to the metabolic disorders of insulin secretion reduction (Diabetes Mellitus - Type 1 (DM1)) and insulin resistance (Diabetes Mellitus - Type 2 (DM2)) [2]. It causes major health afflictions including peripheral arterial, diabetes mellitus, kidney failure, obesity, and nerve degeneration [3]. Hence, the development of cost efficient, accurate, and reliable glucose sensors is emphasized as the prime of hour in various fields including clinical diagnostics [4], ecological [5], food [6], biotechnology [7], and pharmaceutical industries [7]. Amid the various techniques adopted for the detection of glucose, enzymeless electrochemical technique is prevalently recommended owing to its simple handling, environmental friendliness, cost-effective platform, high sensitivity, and good selectivity [8,9].

Although various electrodes including glassy carbon electrode (GCE) [10], Indium titanium oxide (ITO) [11], Fluorine-doped titanium oxide (FTO) [12], carbon cloth [13], gold [14], and platinum [15] were widely used in glucose sensors, their disadvantages including conventional polishing, pre-treatment and modification processes, use of inactive binder, inferior stability, large potential, and lower sensitivity hinder their prospective applications [16]. It urges the development of free-standing electrodes and their direct modification with the catalytic nanostructures. Recently, our group has demonstrated the use of

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