Core@shell Ni@NiO nanowire array electrode for catalytic activity towards glucose

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Fabrication of reliable and cost-effective catalysts for the precise monitoring of electro-active species is of significant interest in the development of sensing devices for point of care, environmental control or industrial systems. Nanostructure based material provide very high electrochemically active surface area, thereby leading to high detection sensitivity. Until now, noble metal nanomaterials, such as Pt, Au, Ag and their alloys [1, 2], have been extensively investigated as anodic materials for designing non-enzymatic sensor surface. Although these noble metal-based nanomaterials exhibit high catalytic activity towards various analytes, they were easily fouled by the electrochemically active interferents. Glucose detection is of great interest in diagnosis and management of diabetes mellitus, as well as monitoring and controlling of food processes. It is thus necessary to develop rapid, sensitive, simple and inexpensive glucose sensors. Besides noble metallic nanomaterials, other metal and metal oxides, such as CuO, RuO_2, and MnO_2, have also been used as anodic materials for direct oxidation of glucose [3-5]. Among them, Ni-based nanomaterials have received special attention owing to their low cost and high catalytic activity towards glucose oxidation. You et al. reported the glucose biosensors based on Ni nanoparticles (NPs) decorated carbon nanofibers [6]. He et al. reported the glucose sensors based on Ni NPs modified TiO_2 tube arrays [7]. Recently we have fabricated core@shell nanowire arrays of nickel oxide and nickel, which found to have excellent charge storage capacity when examined as a pseudocapacitor anode electrode [8]. It is because of the core@shell nanowires combined both the high charge storage capacity metal oxide (NiO) in the shell and the conductive metal (Ni) in the core.

In this work, we will report a novel non enzymatic glucose sensor based on Ni@NiO nanowire array composite platform and investigate the effects of NiO thickness on the electrocatalytic properties for glucose detection. We will also study the effect of electrochemically active interferents on glucose detection using Ni@NiO nanowire array electrode. Fig. 1 shows the SEM and STEM image of Ni@NiO nanowire array composites. The reactivity of the nanostructure electrodes towards glucose was characterized by cyclic voltammetry and amperometry. Effects of the applied potential, the concentrations of the analytes upon the response currents of the sensor were investigated for an optimum analytical performance. It has been observed that the electrochemical transformation from $Ni(OH)_2$ to NiOOH on Ni@NiO nanowire surfaces is diffusion controlled, as the corresponding anodic peak exhibits linear dependence on the square root of scan rate. Experimental results also showed that the Ni@NiO platform is highly stable in electrolytes with a high reproducibility compare to other metallic nanostructure electrodes.

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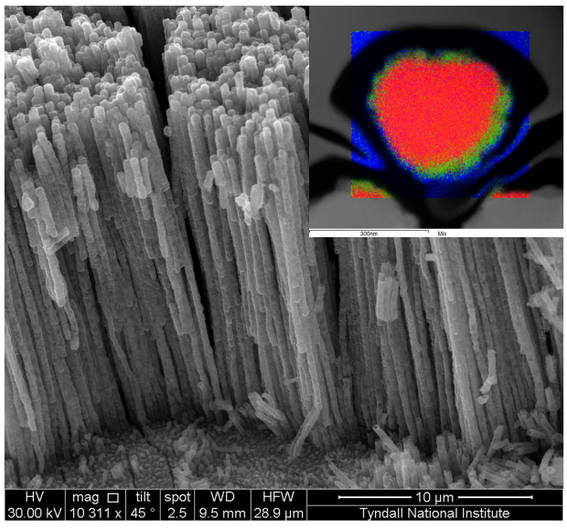

Fig. 1. SEM image of the core@shell Ni@NiO nanowire arrays. Inset: STEM-EDS elemental mapping shows the presence of a thin oxide layer around the Ni circumference: dark field (DF) image of core@shell Ni@NiO nanowire in which nickel at the inner core (red color) and oxygen at the outer shell (green color).