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Electrochemical performance of the spinel $NiCo_2O_4$ based nanostructure synthesized by chemical bath method for glucose detection

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ABSTRACT

Diabetes is a chronic disease, which can give serious damages to the human organs that affect life expectancy. Such a life-threatening diabetes is diagnosed by systematic monitoring of blood glucose levels; thus, accurate detection of glucose within a specified target range becomes more important for glucose sensor to provide detailed information relating with diabetes, which can result in reliable decision for diabetes treatment. Thanks to many efforts developing the reliable glucose sensors, electrochemical performance of the sensor including sensitivity and selectivity in response to glucose is gradually improved. Herein, we developed spinel type $NiCo_2O_4$ (NCO) nanostructure with excellent sensitivity, selectivity and chemical robustness for glucose detection. NCO was prepared by conversion of NiCo-layered double hydroxide (NCH) at comparatively low temperature, which is synthesized by simple and facile chemical bath method and following post-heat treatment of the NCH. Electrochemical sensitivity, selectivity and detection time of the NCO in response to glucose was investigated, compared to those of the NCH. Also, long-term stability of the NCO on repetitive glucose detection was evaluated. Based on the systematic analysis on materials properties and electrochemical performance of the NCO, possible mechanism of the glucose oxidation, which significantly improves electrochemical performance of the NCO, is discussed.

1. Introduction

Diabetes is a chronic life-threatening disease that is considered as one of the most critical health problems worldwide [1–3]. It is believed that an uncontrolled glucose level can cause diabetes mellitus and thus, accurate detection of the glucose level in biological fluids becomes an important issue for clinical diagnosis and real-time human health monitoring purposes [4–6]. Much effort has been directed toward the development of numerous analytical techniques for glucose detection including a resonator, field-effect transistor, optical detector, and electrochemical sensor [7,8]. Among them, the electrochemical detection of glucose has been attractive due to several advantages such as high sensitivity, rapid detection and effective processing cost.

Transition metals in the oxide can act as active sites for glucose oxidation and therefore different combinations of transition metals in the oxide can control the electrochemical performance, including sensitivity and selectivity. For example, $NiCo_2O_4$ (NCO) shows better electrochemical activity than NiO or Co_3O_4, which implies that the combination of Ni and Co in $NiCo_2O_4$ shows a synergetic electrochemical performance that boosts glucose oxidation [9,10]. Combined with control of chemical composition for glucose sensor, different strategies for materials design have been suggested to prepare NCO nanostructures showing improved electrochemical performance. Therefore, it is highly desirable to develop facile and simple synthetic route for

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