DOI 10.5162/IMCS2018/P2EC.1

An electrochemical sensor based on NiAl-layered double/graphene oxide hydroxide for detection of Vitamin B6

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Abstract:

Vitamin B6 (VB6) is an important part of vitamin B, involved in amino acid metabolism, carbohydrate and fat metabolism and hemoglobin formation. NiAl-layered double hydroxide (NiAl-LDH) and graphene oxide (GO) were complexed by hydrothermal method to form NiAl-LDH/GO composite. The NiAl-LDH/GO modified composite electrode was characterized by XRD, SEM and EIS, and presents a good electrocatalytic performance towards the oxidation of VB6. Under optimal experimental conditions, the linear response range for VB6 is 0.08 μM to 500 μM, with the low limit detections of 0.027μM. In addition, the electrode shows a good stability and high sensitivity. The new modified electrode can be used as electrochemical sensors.

Key words: NiAl-layered double hydroxide, graphene oxide, Vitamin B6, electrochemical sensor

Introduction

B vitamins are essential nutrients for the normal metabolism of human[1]. VB6 is an important biomolecule that is widely involved in the body's metabolic, physiological and developmental processes[2]. VB6 plays an important protective role in the human body. It inhibits all kinds of cancer cells and their derivatives, reduce the incidence of cancer, simultaneously[3]. Therefore, VB6 can be used as a specific transport carrier to carry cells in human body[4]. However, due to the sluggish electron transfer processes and high over-potential, the voltammetric signal is not significant on bare glassy carbon electrode (GCE). Enormous effort have been put into the modification on glassy carbon electrode in order to overcome these problems during the electro-oxidation process of VB6.

In this work, a certain percentage of GO and LDH are complexed by hydrothermal method, prepared an electrochemical sensor based on NiAl-LDH/GO on glass carbon electrode. The NiAl-LDH/GO was extensively characterized by XRD and SEM. In order to study electronic properties of the electrochemical sensors prepared by NiAl-LDH/GO for electrochemical application. The obtained NiAl-LDH/GO was modified on a glassy carbon electrode by dropping method, and sensitive applied in NaOH solution detected VB6.

Characterization of NiAl-LDH/GO

In order to observe the surface morphology and structure of the NiAl-LDH/GO, the SEM characterization was used. Fig. 1A shows the SEM of the NiAl-LDH/GO. On the surface of the GO, there are NiAl-LDH nano-materials wrapped and covered evenly. The results show that LDH is successfully grown on the surface of GO, so that a new electrochemical sensor can be prepared. The XRD pattern of the NiAl-LDH/GO shows in fig. 1B, proved that we synthesized the NiAl-LDH/GO composite material. The Nyquist plots of bare GCE, NiAl-LDH/GCE and NiAl-LDH/GO/GCE in 0.1M KCl solution containing the redox probe $Fe[(CN)_6]^{4-/3-}$ showed in fig. 1C. Compared to bare GCE, the semicircles diameter of NiAl-LDH/GCE and NiAl-LDH/GO/GCE are significantly increased. However, the Ret of NiAl-LDH/GO/GCE is smaller than the NiAl-LDH/GCE, indicating between the electrode surface and the redox probe has a faster electron transfer and a lower resistance in NiAl-LDH/GO/GCE.

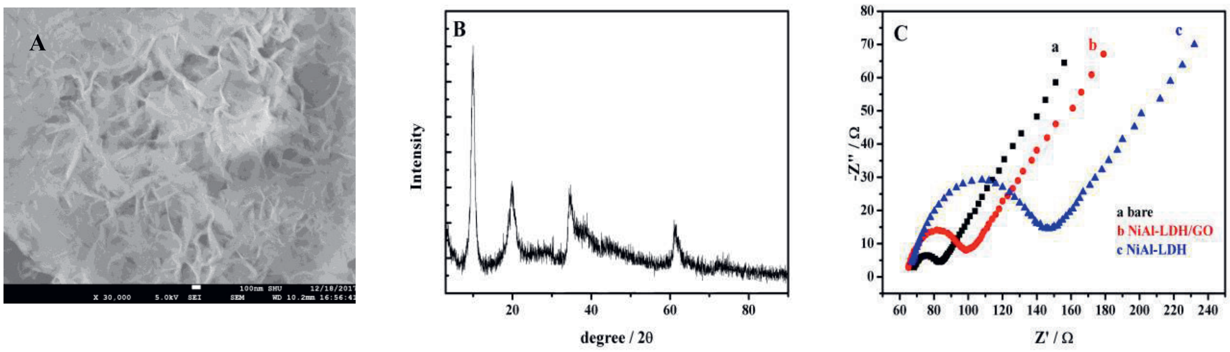

Fig. 1 A SEM of NiAl-LDH/GO; B XRD pattern of NiAl-LDH/GO; C EIS of NiAl-LDH/GO

Experimental result

For exploring the electrochemical response of the bare GCE and the modified electrode to the oxidation of VB6, we used the electrochemical methods of I-T to qualitatively investigate in a 0.15 M NaOH solution. The I-T curves for the oxidation of VB6 by bare electrode and NiAl-LDH/GO modified electrode are shown in Fig. 2A. In the presence of 10μM VB6 as electrochemically active substances, the current response for the bare GCE is very small. Under the same conditions, there is a obvious increase of the modified electrode of NiAl-LDH/GO after adding10μM VB6. The result shows that the electrocatalytic activity of NiAl-LDH/GO. Under the optimal conditions, I-T detection was implemented for VB6 at NiAl-LDH/GO/GCE. The current response of the NiAl-LDH/GO/GCE to VB6 with different concentration displayed in fig. 2B. As shown in fig. 2C, there is linear relationship between the gradually addition of 0.08-500μM VB6 and the current response of the modified electrode in the NaOH solution. Ip (μA) = 0.4994 + 0.00888C (μM) (R^2 = 0.998) was the linear regression equation. The detection limit was estimated as 0.027μM (S/N = 3). A good work linear range and an excellent detection limit are indicated in this work.

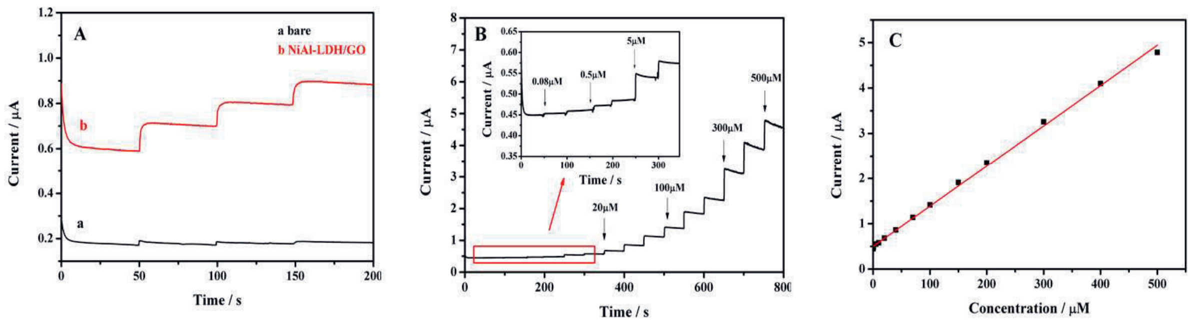

Fig.2 A I-T of 10 μM VB6 on bare GCE and NiAl-LDH/GO/GCE; B I-T of VB6 in the concentration range from 0.08 μM to 500 μM on NiAl-LDH/GO/GCE; C the linear regression of VB6 on NiAl-LDH/GO/GCE.

This work is supported by the National Natural Science Foundation of China (No. 21671132)

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