Electrochemistry Communications 34 (2013) 299–303

Contents lists available at ScienceDirect

Electrochemistry Communications

journal homepage: www.elsevier.com/locate/elecom

Short communication

Co_3O_4 nanorods decorated reduced graphene oxide composite for oxygen reduction reaction in alkaline electrolyte

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ARTICLE INFO

Article history:
Received 30 May 2013
Received in revised form 5 July 2013
Accepted 8 July 2013
Available online 13 July 2013

Keywords:
Co_3O_4 nanorods
Reduced graphene oxide
Oxygen reduction reaction

ABSTRACT

Highly uniform Co_3O_4 nanorods decorated on reduced graphene oxide (rGO) were prepared by a one-pot hydrothermal procedure. During the hydrothermal process, Co^{2+} ions were crystallized to Co_3O_4 nanorods and simultaneously GO was reduced to rGO to form the Co_3O_4/rGO hybrid. The Co_3O_4/rGO hybrid was characterized by scanning electron micrographs, X-ray diffraction, X-ray photoelectron spectroscopy, and Raman spectroscopy. The obtained Co_3O_4/rGO hybrid exhibits excellent electrocatalytic performance for oxygen reduction reaction.

1. Introduction

The cathodic oxygen reduction reaction (ORR) is one of the key challenges in developing alkaline-based fuel cells and metal-air batteries [1]. Recently, transition metal oxides [2–4] as promising cathodic materials, have received considerable attention due to their high catalytic activity, low cost and environmental friendliness. However, these materials also suffer from some disadvantages, such as relatively poor electrical conductivity and lower electron transfer rate, which limited their applications in real devices. It is well known that graphene exhibits notable electronic conductivity and high surface area, which could be an attractive support for metal oxides to form a new class of nanocomposites for ORR [5–7]. Dai's group [8–10] reported a series of nanocomposites consisting of Co_3O_4, Mn_3O_4, $MnCo_2O_4$ nanocrystals deposited on rGO templates as excellent catalysts for ORR. However, it is still a challenge to develop a simple facile deposition approach to prepare quality metal oxide/rGO catalysts for ORR with stable performance. To the best of our knowledge, the fabrication of Co_3O_4 nanorods decorated on rGO supports for ORR has not yet been reported.

In this work, we report a facile route to prepare a Co_3O_4 nanorods decorated rGO hybrid through a one-pot hydrothermal approach showing an efficient pathway for charge transfer. The as-prepared Co_3O_4/rGO exhibits a significant enhancement in electrocatalytic ORR performance in alkaline media, compared with unsupported Co_3O_4 or pure reduced graphene oxide.

2. Experimental

2.1. Synthesis of Co_3O_4/rGO nanocomposite

Graphene oxide (GO) was synthesized by the modified Hummers method [11]. The Co_3O_4 modified rGO was synthesized as the following procedures. Firstly, 2 mmol $Co(Ac)_2 \cdot 4H_2O$ and 2 mmol $CO(NH_2)_2$ as a stabilizer were dissolved into 30 mL distilled water. Then, GO powders (with various mass weights) were added into the above solution and sonicated for 1 h, followed with an addition of 1 mL 6% hydrogen peroxide as an oxidizer and magnetically stirred for 6 h at room temperature. The as-prepared solution was then transferred into a Teflon liner, which was sealed in a steel autoclave. The autoclave was maintained at 190 °C for 5 h and then was allowed to cool down to room temperature by a cool-water system. The resulting precipitate was separated by filtration, and washed with distilled water and absolute ethanol for 5 times. Final black-color Co_3O_4/rGO powders were achieved via vacuum-dry in a vacuum oven at 60 °C for 5 h. For comparison pure Co_3O_4 powder without rGO and rGO without Co_3O_4 were also prepared under identical conditions.

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http://dx.doi.org/10.1016/j.elecom.2013.07.017