Rapid synthesis of rGO–ZnO nanocomposites with electrochemical properties

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Keywords: *zinc oxide, graphene, microwave-hydrothermal, electrocatalysis*

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ABSTRACT

rGO-ZnO nanocomposites were synthesized using a microwave-hydrothermal and their electrochemical applications for water oxidation were investigated.

Introduction

In recent years, zinc oxide (ZnO) has been attracted great attention in the field of nanodevices as an important semiconductor due to optical and electronic properties, including wide band gap of 3.37 eV at room temperature and a large exciton binding energy of 60 meV [1]. Efforts have been made to improve the performance of ZnO in several applications, such as photocatalysis, electrochemical devices and solar cells. The combination of ZnO with other components including noble metals, doping and inclusion of carbon materials can result in high performance in their activities. Reduced graphene oxide (rGO), a two-dimensional environment of carbon atoms, exhibits novel electronic properties such as zero band gap and fast electron transport [2].

Results and Discussion

We prepared pure ZnO and rGO-ZnO nanocomposites by rapid heating (8.0 min) and low temperature (100 °C) using microwave-hydrothermal method. For simplicity, the nanocomposites prepared from addition of 8.0 and 16.0 mg of GO are referred as 8rGO-ZnO and 16rGO-ZnO, respectively. All diffraction peaks are consistent with the wurtzite ZnO structure, which can be indexed to a standard diffractogram of JCPDS (No. 36-1451), Fig. 1(a). The FEG-SEM images of composites presented regular particles with an average size about of 110 nm distributed on the rGO sheets Fig. 1(b), while images of pure ZnO reveled irregular shapes with size around 124 nm. All Raman analysis for the nanocomposites presented two prominent bands around 1366 cm^{-1} (D band) and 1593 cm^{-1} (G band) assigned to the defects within the hexagonal graphitic structures and phonon vibration of sp^2 bonded carbon atoms in graphene sheets, respectively [3]. FTIR spectra of materials reveled that the bands assigned to organic groups situated at the edges of GO sheets are missing from the FTIR spectra of the rGO-ZnO nanocomposites, which indicate the reduction of GO. Cyclic voltammetric studies of materials showed that samples have sufficient oxidizing power for water oxidation, which the nanocomposite with higher quantity of rGO enhancing oxygen evolution in lower potential (Fig. 2.).

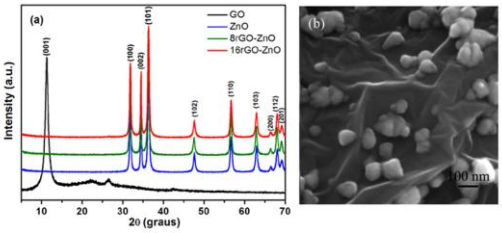

Fig. 1. (a) XRD patterns of the GO , ZnO and rGO-ZnO nanocomposites (b) FE-SEM image of 16rGO-ZnO nanocomposite.

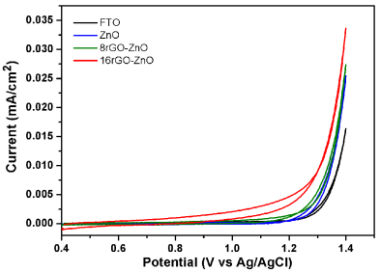

Fig. 2. CVs of the FTO background (black), ZnO and rGO-ZnO nanocomposites in phosphate buffer, pH = 7.

Conclusions

rGO-ZnO nanocomposites were successfully synthesized using microwave-hydrothermal method. The reduced graphene oxide affects the structural characteristics of ZnO, as well as the electrochemical properties. The resulting nanocomposites exhibited electronic interaction between ZnO and rGO sheets, which improved the electrocatalytic oxidation of water.

Acknowledgements

CAPES, FAPEMIG, CNPq, RQ-MG, GQM-UFPR and GMIT.

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