XIV ENCAT
Encontro de Catálise do Norte, Nordeste e Centro-Oeste
Catálise: Impulsionando a transição energética para um futuro mais sustentável
17-19 novembro 2024 • Fortaleza
SBCAT
SOCIEDADE BRASILEIRA DE CATÁLISE

ÁREA: Síntese e caracterização de catalisadores e adsorventes

SYNTHESIS OF GRAPHENE OXIDE VIA ELECTROCHEMICAL EXFOLIATION OF GRAPHITE FROM BATTERIES

Georgia J. B. Araújo[1,*], Camila da C. de Morais[1], Lívia I. F. de Melo[1], Crislânia C. O. Morais[1], Keurison F. Magalhães[1], Suely S. L. Castro[1]

[1]Electrochemistry and Analytical Chemistry Laboratory, State University of Rio Grande do Norte (UERN), Mossoró-RN, 59625-620, Brazil

**E-mail: georgiajully@alu.uern.br*

Abstract

The use of graphene-based nanomaterials has attracted increasing interest for various catalytic applications (photocatalysis, electrocatalysis, etc.) due to the high catalytic activity exhibited by these materials, which is related to the high surface/volume ratio, adsorption capacity, chemical stability, thermal and electrical conductivity, among others. In parallel, researchers are also increasingly concerned about environmental sustainability. In recent years, the disposal of solid waste into the environment has increased significantly, and among these are dry batteries, which can cause environmental problems. When dismantled, the graphite rods are not reused and harm the environment. On the other hand, graphene obtained from graphite exfoliation demonstrates exceptional properties but faces technical difficulties and high costs. A promising technique for minimizing these problems is electrochemical exfoliation. Thus, this study evaluated the use of graphite rods from dry cells to produce graphene oxide (GO) by electrochemical exfoliation, aiming at its electrocatalytic application, in addition to contributing to ways to promote the reduction of solid waste disposal in the environment (Ferella; Michelis; Vegliò, 2008).

The study began with the removal and preparation of graphite rods from new and used AA batteries (1.5 V). First, the rods were sanded and immersed in a 5% H_2SO_4 solution to remove the remaining electrolytic paste and were then used as electrodes in the manufacture of GO. The synthesis optimization was carried out with new rods, and the optimized experimental condition was applied for the tests with the used rods. For the synthesis, the rods were immersed in 50 mL of H_2SO_4 solution, at different concentrations (0.1, 0.2 and 0.3 mol L^{-1}). Exfoliation was performed in direct current and different voltages and times were evaluated. The produced material was filtered, washed until reaching neutral pH and dried in an oven. For the characterization of the produced GO, the samples were dispersed in ultrapure water and analyzed by UV-visible spectrophotometry. Their catalytic activity was evaluated by cyclic voltammetry at 50 mV/s, in which a glassy carbon electrode (CVE) was modified with GO (CVE/GO) and used as a working electrode. The absorption spectrum revealed bands between 220 and 230 nm, characteristic of GO, attributed to the π-π* transitions of the C=C bonds of the aromatic rings in the material, and a soft band between 350 and 450 nm, indicating n-p* transitions attributed to the presence of carbonyl groups in the GO nanosheets (Protopapa et al., 2022).

The results showed that the synthesis in H_2SO_4 0.1 mol L^{-1} was more efficient and the produced GO was used to modify the surface of an GCE, which was tested in a 7.0 x 10^{-4} mol L^{-1} solution of potassium ferrocyanide in 0.10 mol L^{-1} of KCl. In the electrocatalytic study, the cyclic voltammograms showed a significant increase in the redox peak currents of the ferro/ferricyanide pair, as well as a decrease in ΔEp, when compared to the results obtained using the GCE without modification. This behavior highlights the effectiveness of GCE/GO as an electrochemical sensor platform, which is attributed to the high electrocatalytic capacity, excellent support for electron transfer, and high surface area of GO. This study demonstrates the potential of the electrochemical approach to produce GO, as well as the electrocatalytic activity of this nanomaterial, which can be used as a platform for the development of sensors; it also shows the relevance of research on the use of solid waste as a form of environmental protection.

Keywords: graphene synthesis, carbon nanoparticles, electrochemical synthesis

Referências

Ferella, F.; Michelis, I. de; Vegliò, F. Process for the recycling of alkaline and zinc–carbon spent batteries. Journal of Power Science 183 (2), 805-811, 2008.

Protopapa, M.L. et al. Changing the Microstructural and Chemical Properties of Graphene Oxide Through a Chemical Route, Appl. Spectrosc. 76(12), 1452–1464, 2022.

Agradecimentos

G.J.B.A. gratefully acknowledge the CNPq-PIBIC fellowship.