

# Electrosynthesis and characterization of rGO/copper hexacyanoferrate nanocomposite film

Laiz Cristina Diniz Narciso (PG) e Edson Nossol<sup>1\*</sup> (PQ)

<sup>1</sup>Instituto de Química, Universidade Federal de Uberlândia, 38400-902, Uberlândia, MG, Brazil

\*enossol@ufu.br

Keywords: : nanocomposite, electrosynthesis, copper hexacyanoferrate/rGO

## Abstract

This work presents a fast, simple and low cost method for electrosynthesis of rGO/CuHCF nanocomposite thin film.

## Introduction

Graphene is a carbon allotrope that consists of a flat monolayer of  $sp^2$ -carbon atoms bonded and arranged in a honeycomb lattice. The reduction of GO (graphene oxide) is appointed as one of the most promising routes for the mass production of graphene at low cost and high yield. Since only part of pristine graphene properties are restored, the product obtained from this approach is more frequently known as reduced graphene oxide (RGO).<sup>1</sup>

Metal hexacyanoferrates (HCF) have a face-centered cubic lattice with octahedral coordination of the M (metal) ions by  $-NC$  and  $-CN$  ligands. The most common strategy for electrosynthesis involves potentiodynamic cycling between pre-set potential limits of the working electrode in a supporting electrolyte containing both the metal ion ( $M^{n+}$ ) and ferricyanide species.<sup>2</sup> This work involves the electrosynthesis of CuHCF using a rGO/Cu film as the precursor

## Results and Discussion

The synthesis of rGO/Cu film on glassy carbon electrode (GCE) was carried out using a solution containing  $1.0 \text{ mg mL}^{-1}$  of graphene oxide,  $0.05 \text{ mol L}^{-1}$   $\text{Na}_2\text{HPO}_4$ ,  $5 \text{ mmol L}^{-1}$   $\text{CuSO}_4$  and  $25 \text{ mmol L}^{-1}$  of tri-sodium citrate by cycling the potential for 10 cycles between  $-0.5$  and  $-1.5 \text{ V}$  vs Ag/AgCl at a scan rate of  $0.01 \text{ V s}^{-1}$ . Subsequently the electrode was subjected to 15 cycles ( $0.0$  to  $1.0 \text{ V}$ ) in  $1.0 \text{ mmol L}^{-1}$  of  $\text{K}_3[\text{Fe}(\text{CN})_6]$  and  $0.1 \text{ mmol L}^{-1}$  of  $\text{K}_2\text{SO}_4$  aqueous solution to form CuHCF. In Figure 1-a the voltammogram of rGO/CuHCF film in  $0.1 \text{ mol L}^{-1}$   $\text{K}_2\text{SO}_4$  displays three peaks attributed to the couple  $\text{Cu}^{\text{II}}/\text{Cu}^{\text{I}}$  (centred at about  $0.35 \text{ V}$ ) and to the redox pair  $\text{Fe}^{\text{III}}/\text{Fe}^{\text{II}}$  at about  $0.7 \text{ V}$ .<sup>3</sup>

The SEM image of rGO/CuHCF (Figure 1-b) is constructed from nanocubes with a diameter of  $\sim 117 \text{ nm}$  embedded in the multilayers of rGO.

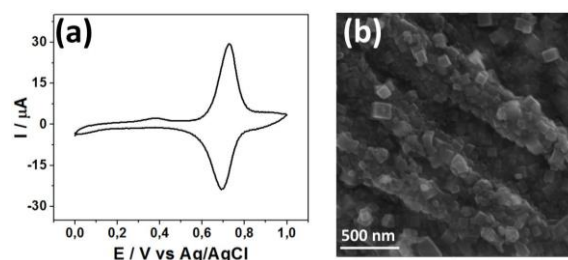


Figure 1. (a) Cyclic voltammogram in  $0.1 \text{ mol L}^{-1}$   $\text{K}_2\text{SO}_4$ ,  $v = 50 \text{ mV s}^{-1}$  and (b) SEM image of rGO/CuHCF nanocomposite film.

Raman spectra of rGO/CuHCF film (Figure 2) displays the typical bands for carbonaceous materials: the D band ( $1332 \text{ cm}^{-1}$ ) related to the disruption of the symmetrical hexagonal graphitic lattice; the so-called G band ( $\sim 1600 \text{ cm}^{-1}$ ), associated with the in-plane stretching motion of symmetric  $sp^2$  C-C bonds.<sup>4</sup> Raman spectrum also contains features that are characteristic of CuHCF (inset), the band in  $2108 \text{ cm}^{-1}$  is typical of the  $\text{Fe}^{\text{II}}\text{-C-N-Cu}^{\text{II}}$  system and in  $2160 \text{ cm}^{-1}$  is probably due to higher oxidation states of iron, since  $\text{Fe}^{\text{III}}\text{-C-N-Cu}^{\text{II}}$ .<sup>3</sup>

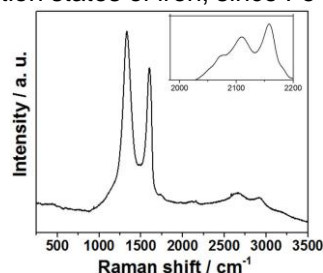


Figure 3: Raman spectrum of rGO/CuHCF film.

## Conclusions

The electrochemical synthesis of rGO/CuHCF nanocomposite film on the surface of the electrode was successfully achieved, using a fast, simple and low cost method. Additional tests are currently under study aiming the application of this material on sensors.

## Acknowledgements

CAPES, FAPEMIG, IQ-UFU, GQM-UFPR, GMIT-MG

<sup>1</sup>Toh, S. Y., et al. *Chem. Eng. Journal*. **2014**, 251, 422-434.

<sup>2</sup>de Tacconi, N. R.; Rajeshwar, K. and Lezina R.O. *Chem. of mat.* **2003**, 15, 3046-3062.

<sup>3</sup>Giorgetti, M., et al. *Phys. Chem. Chem. Phys.*, **2012**, 14, 5527-5537.

<sup>4</sup>Luo, Q.-P., et al. *J. Phys. Chem. C* **2012**, 116, 8111-8117