Synthesis and characterization of graphene/nickel nanocomposites obtained by polyol method

Eduardo G. C. Neiva[1] (PG), Luiz H. Marcolino Jr.[1] (PQ), Aldo J. G. Zarbin[1] (PQ)*.

1- Department of Chemistry, Federal University of Paraná (UFPR), CP 19081, CEP 81531-990, Curitiba – PR.

Email: aldozarbin@ufpr.br

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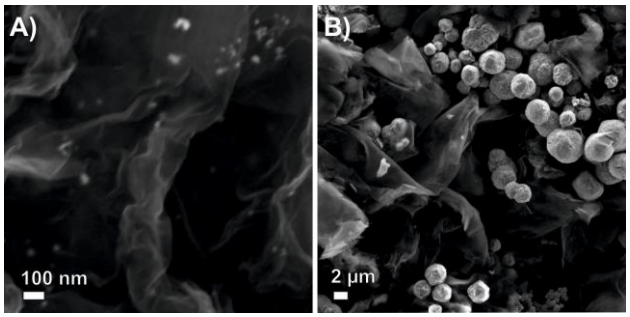
Introduction

Nickel nanoparticles have been the focus of many articles in the literature due their versatility, since it is successfully applied in different areas like sensors, magnetic devices, batteries, fuel cells, supercapacitors, and others.[1] Graphene has been applied in several areas and used to synthesize different nanocomposites due their exceptional characteristics, which improve many properties of these nanocomposites like surface area, conductivity, optical transmittance and thermal stability. For these reasons, the synthesis of nanocomposites between nickel nanoparticles and graphene is very advantageous, since graphene can avoid structural modifications that can happen with nickel during long term applications, besides the many others properties that the graphene can confer to the nanocomposite.

In this work, we report the obtaining of graphene/metallic nickel nanocomposites through the polyol method.

Results e Discussion

In this route, 5 mg of dried graphene oxide (GO) obtained by modifications in Hummers method[2] was first dispersed in 20 mL of ethylene glycol in a bath ultrasound by 60 min. Then, the metal precursor ($Ni(OAc)_2 \cdot 4H_2O$) was added to this dispersion and the round flask was coupled to a reflux system under continuous stirring. After reached 198 ºC, the system was kept under these conditions by 2 hours and then cooled to room temperature naturally. The obtained material was filtrated, washed with milli-Q water and dried at 70 ºC by 2 hours. Two nanocomposites were prepared using a mass proportion of 1:0.1 and 1:0.5 GO:Ni^{+2}, and the synthesis was also carried out in the absence of the nickel precursor. All the materials obtained were characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), energy dispersive X ray spectroscopy (EDS), Fourier transform infrared spectroscopy (FT-IR), thermogravimetric analysis (TGA) and Raman spectroscopy. The results indicated that both GO and nickel ions were reduced to reduced graphene oxide (rGO) and face centered cubic metallic nickel (fcc-Ni), respectively, which was confirmed by XRD, Raman spectroscopy, TGA and FT-IR. The use of different GO:Ni^{+2} ratios result in fcc-Ni nanoparticles with different sizes, where the 1:0.1 and 1:0.5 proportions led to particle sizes between 10 and 40 nm and 0,5 and 5 μm, as seen in the SEM images showed in the Figure 1A and 1B, respectively. However, the macroparticles obtained in the higher nickel ratio present a irregular surface and many porous, indicating that these particles could be originated by the coalescence of nanoparticles, which was confirmed by the XRD, where the use of the Scherrer law showed the presence of nanocrystals in both samples.



Conclusions

Nanocomposites between reduced graphene oxide (rGO) and face centered cubic metallic nickel (fcc-Ni) were obtained using the polyol method. The use of different GO:Ni^{+2} ratios led to different particles sizes, where the smaller ratio led the smaller sizes and the increase of nickel proportion led to a coalescence of the nanoparticles to macroparticles.

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