Synthesis and characterization of nanocomposite of RGO@Ag@Au for Photocatalytic degradation of Rhodamine B

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Abstract

In this work, we developed novel method for obtaining nanocomposites of reduced graphene oxide (rGO) and gold and silver nanoparticles (RGO@Ag@Au). Initially, we prepared Graphene oxide (GO) using Hummer´s method [1] and we synthetized the nanocomposite of RGO@Ag@Au by laser ablation of AgNp an AuNp inside of the bulk of solution of GO (Figure 1). For laser ablation was used the second harmonic (532 nm) of a Nd:YAG laser at 10 mJ/pulse, 10 Hz and 8 ns of temporal width. The ablation products were subject to sonication a microwave irradiation to reduce the GO to RGO and generating core-shell Ag@AuNp. The nanocomposite prepared was lyophilized to be used as photo-catalyst [2].
Nanocomposite Au@Ag@rGO was characterized by X-Ray Diffraction, Raman, X-ray Photoelectron Spectroscopy and Transmission Electronic Microscopy. Figure 2a show a microscopy photograph of the nanocomposite sheet where it is possible to observe AgNp an AuNp on RGO surface. Similarly, DRX evidenced the presence of signals at 2θ=38,43° (111), 44.59° (200), 64,8° (220), 75.47° (311) y 77.77° (311) corresponding to fcc crystalline structure of Ag and Au. Additionally, we observed the 002 plane at 22,2°, corresponding to crystalline structure of GO [3]. The XPS spectra (not shown) show peaks corresponding to C=C/CC (284.4eV) of aromatic rings, CO (285.2eV) of epoxy groups, CO (288.5eV) and OC=O (289.3eV) groups. Also, it is observed the XPS spectra of the Ag 3d and Au 4f electrons. The Raman spectrum of RGO exhibits the characteristic G band (1594 cm^{-1}) and the D band (1354cm^{-1}) with a D-to-G intensity ratio of about 0.79 and 0.83 for RGO@Au and RGO@Ag, respectively. The G band arises from the vibration of the sp^2 bonded carbon atoms, and the D band is attributed to structural disorder at defect sites, with the D/G ratio usually taken as a measure of the quality of the graphitic structures, because for highly ordered pyrolitic graphite, this ratio approaches zero. The nano-composite shows that the D/G ratio increase to 0.9464, indicating an increase in the degree of disorder and defect sites. Finally, for examining the photocatalytic activity of nanocomposite RGO@Au@Ag for degradation of Rhodamine B (RB) dye, we used visible light of tungsten lamp at 5 mW, 1 mg of nanocomposite, 9µl of H_2O_2 as initiator, in 3 ml of solution of the dye at 10 ppm. We obtained a degradation efficiency of approximately 90% in the first fifteen minutes.

References

[1] Hummers, William S.; Offeman, Richard E. (March 20, 1958). JACS. 80(6) (1958) 1339.
[2] Werner, D., et al. J. Phys. Chem. C. 112(43) (2008) 16801.
[3] Kumar V., et al. CARBON 80 (2014) 290

Figures

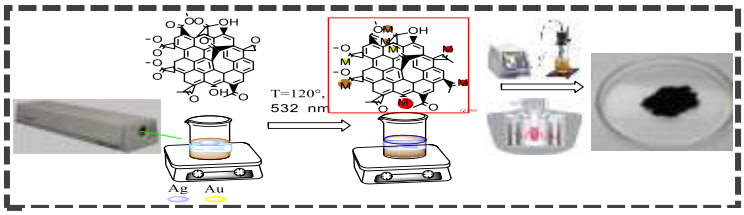

Figure 1. Synthesis of nanocomposite RGO@Ag@Au

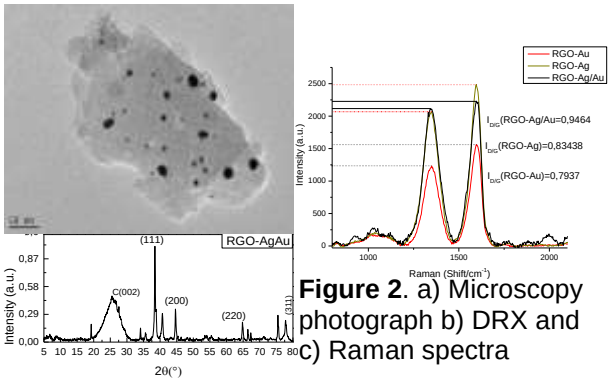

Figure 2. a) Microscopy photograph b) DRX and c) Raman spectra

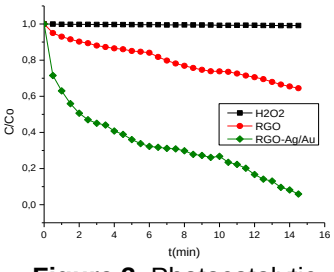

Figure 3. Photocatalytic degradation of RB