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Eco-Friendly Production of Functionalized Low-Rise Graphene-Silver Nano Composites Using Goalnut Extract for Antibacterial Applications

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Abstract

Recently, functionalized multilayer graphene (FFG) has received a lot of attention due to its many biomedical applications, including the great interest of researchers. This study systematically investigates the use of goalnut extract (GNE) during the high shear exfoliation process to efficiently convert expanded graphite to FFG. Various parameters such as GNE concentration, graphite concentration, peeling time and rotation speed of the high shear mixer were initially optimized for FFG production. The prepared FFG is of surface functionality and morphology using Raman spectrum, X-ray diffraction (XRD), X-ray photoelectron spectroscopy (XPS), transmission electron microscopy, and scanning electron microscopy analysis. Characterized from a point of view. Furthermore, the binding of FFG and Ag was confirmed by XRD, XPS and energy dispersive X-ray spectra. The Ag-FFG composite exhibited antibacterial activity against both Gram-positive and Gram-negative bacteria by the agar-well diffusion method [1]. This work provides an efficient, economical and environmentally friendly FFG and Ag-FFG production method for biomedical applications.

Keywords: Graphite; (XRD); (XPS)

Introduction

Metallic nanoparticles (NPs) have various advantages in the field of electrochemistry. Due to their small size, nanoparticles can increase the contact area of the electrodes used. In addition, metal nanoparticles can increase the rate of mass transfer and provide fast electron transfer, thus increasing the sensitivity of the electrodes used. Silver nanoparticles (AgNPs) are relatively inexpensive and possess diverse physical and chemical properties that lend themselves to various optical, chemical, and catalytic functions. Nano scale composites of metal nanoparticles and graphene oxide have promising applications in energy storage, super capacitors, and electronics. In their study, researchers attempted to construct GO/AgNP Nano composites under ambient conditions using an energy-efficient off-site approach [2, 3].

Materials and Method

Expanded graphite was obtained from Samjung C & G in South Korea. Silver nitrate (CAS No. 7761-88-8 ≥ 99.8% purity) and goal nut powder were purchased from Samchun Pure Chemical Co. Ltd. in Seoul, South Korea and Ham young Co. in Seoul, South Korea, respectively [4,5].

Preparation of goal nut extract

First, a gornut extract was prepared from 1 g of gornut powder, placed in an electric brewing pot containing 100 ml of distilled water, and boiled at 100 ° C for 90 minutes. The suspended solids were then removed by centrifugation at 13,000 rpm for 20 minutes. The supernatant was stored at 4°C until further use.

FFG scrub with gallnut extract

FFG was prepared from expanded graphite using the L5M laboratory high-shear mixer exfoliation method as described by Paton, with minor modifications. Briefly, graphite was added to a mixing vessel (500 mL) along with gallnut extract (various concentrations) and then the mixing speed was gradually increased. The mixer was run for the specified mixing time. The mixing vessel was kept in a water bath at 10 ° C. to avoid heating the high shear peeling system. A typical mixer with a 32 mm rotor and axial head (100 mm diameter) was used vertically upwards to reduce aeration and maintain heavy insoluble suspended solids in the system [29]. Figure 1 shows a brief schematic of the FFG preparation process. Four different parameters, i. To evaluate the effect of different parameters on the stripping process. The GNE concentration (2-10 g / L), graphite concentration (5-30 g / L), peeling time (2-8 hours) and speed (3000-6000 rpm) of the high shear mixer were investigated. To optimize rotation speed and peeling time, Raman spectroscopy was used to further qualitatively investigate the peeling process and analyse by graphene concentration influenced by GNE concentration and initial graphite concentration **[6].**

Raman spectroscopy and X-ray diffraction analysis

Raman spectroscopy was used to determine the qualitative conversion of graphite to FFG. Here, the peeling time and rotation speed are optimized for FFG preparation. Two characteristic peaks in the graph with different peak shapes and intensities, namely H. G (1350 cm-1) and 2D bands (2700 cm-1) were examined. The Raman 2D spectrum was also used to measure the flock thickness of the prepared FFG suspension. In addition, the crystallinity structures of graphite and FFG were studied using Raman spectra. We evaluated the ratio of the intensity (M) of the 2D bands of the prepared FFGs divided by the wavelength associated with the easily identifiable peak of the first graphite 2D band (ωpeak, Graphite) at 2729 cm −1. Associated with the low-energy shoulder of the early graphite 2D band can be defined as ωshoulder, Graphite=ωpeak, Graphite-30cm-1. To normalize the metric parameters, the FFG intensity ratio was divided by the original [7].

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Results and Discussion

A high shear exfoliation process was used to convert the expanded graphite to FFG. First, graphite was added to the gallnut extract containing tannic acid, which he subsequently exfoliated with an L5M high-shear laboratory blender. The prepared FFG was first characterized by TEM, SEM, XRD and Raman spectroscopy. TEM and SEM analyses were performed to investigate the quality and exfoliation behaviour of the fabricated graphene sheets after graphite exfoliation. Here, we can clearly conclude from the TEM images that the graphene Nano sheets are packed together and well exfoliated, as shown in a smooth plane has no defects and the edges are partially scrolled. This is due to the ultra-thin graphene Nano sheets. Moreover, the thin and irregular curly morphology in the SEM images confirms graphite exfoliation. Moreover, SEM-EDX analysis confirms the presence of carbon and oxygen in the FFG samples, and an additional Ag peak is clearly observed along with these two for the Ag-FFG.

Spin rate effect

First, four different rotational speeds (3000, 4000, 4500 and 6000 rpm) were optimized for shear exfoliation in the presence of GNE. the Raman spectra at various rates of shear delamination. The intensity and shape of the Raman spectra of graphene changed significantly with increasing velocity. From, we can see that the left shift of the 2D tape has a direct effect of rotation speed. The shift of the 2D peak gradually increased as the rpm increased from 3000 to 6000 rpm. Table 1 shows the quality of FFG derived from Raman spectroscopy at different rpm in the GNE solution. It can be clearly observed that the number of FFG shifts decreases with increasing speed, from 8,610 to 5,248. The lowest graphene layer of 5.248 was obtained at the maximum speed of 6000 rpm. Due to the rotational speed limitation of the instrument, 6000 rpm was determined as the optimal rotational speed for further experiment.

Antibacterial Activity Prepared of Ag-FFG

After optimizing the exfoliation process, Ag-FFG was prepared as described in s clearly the presence of elemental Ag peaks on the surface of FFG along with carbon and oxygen, indicating the formation of Ag-FFG composites. Hospital-acquired infections are more likely to select for multidrug-resistant bacteria after treatment. The most common pathogens are Gram-negative bacteria (E. coli and P. aeruginosa) and Gram-positive bacteria (Staphylococcus aureus and Bacillus subtitles). Therefore, these four microorganisms were selected to determine the behaviour of the synthesized Ag-FFG Nano hybrids in terms of bacterial resistance.

Conclusion

In this study, we thoroughly demonstrated a simple, green and effective exfoliation method for converting graphite into few-layer functionalized graphene. FFG was successfully manufactured with a simple one-step green process. All the selected parameters had a significant impact on the FFG yield. Ag was good as XPS analysis revealed a strong interaction between Ag and FFG.

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