SACCHARUM OFFICINARUM DERIVED GRAPHENE OXIDE REDUCED BY TAGETES ERECTA EXTRACT: A NOVEL APPROACH TO REDUCED GRAPHENE OXIDE/COBALT OXIDE NANOCOMPOSITE

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ABSTRACT

This study presents a novel method for synthesizing reduced graphene oxide (rGO) using Saccharum officinarum (sugarcane) derived graphene oxide (GO) and Tagetes erecta (marigold) extract. The investigation focuses on the development and characterization of rGO/CoO nanocomposites for super capacitor applications. The Tagetes erecta extract acts as a green reducing agent, offering an eco-friendly and cost-effective alternative to conventional chemical reducing agents. The synthesized nanocomposites were analysed using X-Ray Diffraction (XRD) and UV-Vis Spectroscopy to determine their structural and optical properties. The rGO/CoO nanocomposites exhibited impressive super capacitive behaviour, highlighting the potential of this novel approach in energy storage applications. This research contributes significantly to the advancement of sustainable materials.

KEYWORDS: Reduced graphene oxide, Cobalt oxide, Saccharum officinarum, Tagetes erecta, X-ray diffraction, UV-Vis spectroscopy.

INTRODUCTION:

The quest for renewable and efficient energy storage systems has driven significant research into the development of advanced materials. Graphene-based materials have garnered attention due to their exceptional electrical conductivity and surface area. In this manuscript, we explore a sustainable approach for producing reduced graphene oxide (rGO) using Saccharum officinarum derived graphene oxide (GO), reduced by Tagetes erecta extract. This green synthesis method aims to replace harmful chemical reductants with plant extracts, contributing to environmentally friendly manufacturing processes. The resulting rGO, when combined, with cobalt oxide (CoO), forms nanocomposites with enhanced electrochemical properties

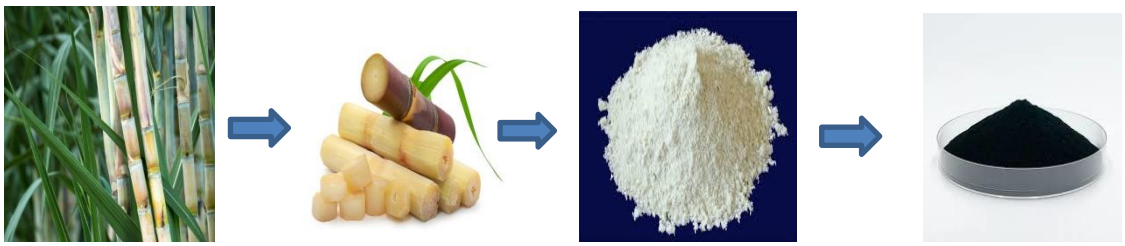
AIM OF THE STUDY:

- ✓ To synthesize graphene oxide from saccharum officinarum, through oxidation process.
- ✓ To synthesize tagetes erecta extract.

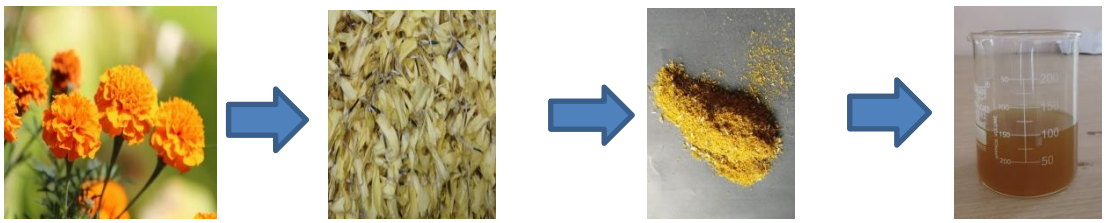
- ✓ To synthesize reduced graphene oxide/cobalt oxide nanocomposite, using tagetes erecta extract as reducing agent, by thermal reduction process.
- ✓ To study the structural, optical properties and also to find band gap energy of rGO/CoO_3 using XRD and UV-Vis Spectroscopy.

MATERIALS AND METHODOLOGY:

Saccharum officinarum bagasse grinded well into fine powder + Ferrocene as Graphene Oxide, Tagetes erecta extract from the petals to reduce the graphene oxide, Cobaltous nitrate hexahydrate as a metallic salt to be anchored with rGO, Deionized water to prepare the solutions. The characterization techniques used were X-Ray Diffraction (XRD) for structural analysis, UV-Vis Spectroscopy for optical studies and band gap energy.1 g of well ground sugarcane powder is mixed with 0.2 g of ferrocene and kept in muffle furnace directly. Graphene oxide is obtained through oxidation process and used for further analysis.



Petals of marigold are finely cut and dried under sunlight for 4-5 days. The dried petals are grinded well into fine powder. About 5 g of marigold powder is mixed in 100 mL of distilled water and heated for about 20 minutes. The extract is strained and is used as a reducing agent.



0.28 g of the synthesized GO is dispersed in 100 mL of distilled water and is stirred for about 30 minutes and then 8 g of cobaltous nitrate hexahydrate mixed in 100 mL of distilled water, and 100 mL of the marigold extract with 3 g of NaOH, are added with the GO dispersion and is stirred for about 3 hours at 95^{o}C. In this process, the cobaltous nitrate is reduced to cobalt oxide using the marigold extract and the pH is maintained using the NaOH pellets. The mixture of Cobalt oxide and GO, is then centrifuged and then placed in a hot air oven for about 4 hours at 120^{o}C. The dried mixture is then placed into muffle furnace for about 10 minutes at 450^{o}C for calcination. A black product is obtained and is sent for further analysis.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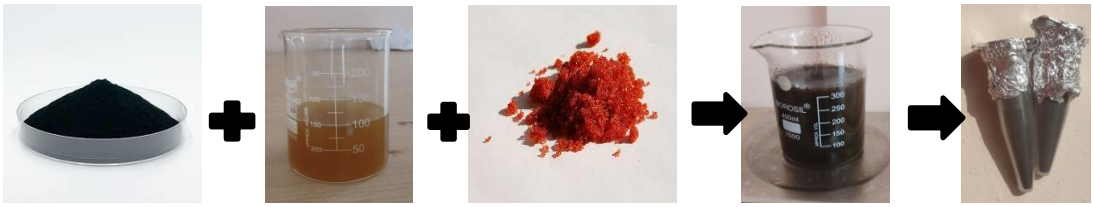
The marigold extract is used to oxidize the cobaltous nitrate into cobalt oxide which is further used in the synthesis of rGO/cobalt oxide.



RESULT AND DISCUSSION:

XRD Analysis: This analysis is used to determine the crystalline size, structural properties and phase of the synthesized nanocomposite, using the JCPDS card number 078-0209 as reference. The average particle size of the nanocomposite is found by using the Debye-Scherrer formula:

$$\mathbf{D = \frac{K\lambda}{\beta cos\theta}\ (nm)} \qquad \mathbf{(1)}$$

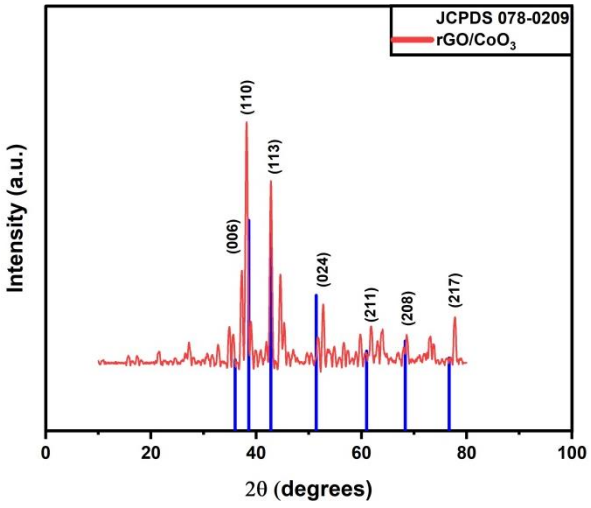
K –shape factor (approximately 0.9)

β – full width at half maximum (FWHM) of a diffraction peak

λ –wave length of the X-ray

θ -Bragg angle

The particle size is found to be 10.32 nm.



The XRD peaks for reduced graphene oxide/cobalt oxide exhibit strong peaks around 2**θ**=25.04º, which indicates the reduction of GO to rGO, 2Θ=42.78º, 2Θ=60.99º and 2Θ=76.67º indicates the presence of CoO. The peak value of rGO, indicate the reduction of GO to rGO, by the marigold extract and the reduction of cobaltous nitrate into CoO.

UV-Vis Spectroscopy:

The band gap energy and the dielectric constant, are found through the following formulae:

$$E_g = \frac{1240}{A} \qquad (2)$$

E_g-energy band gap

A-Absorbance

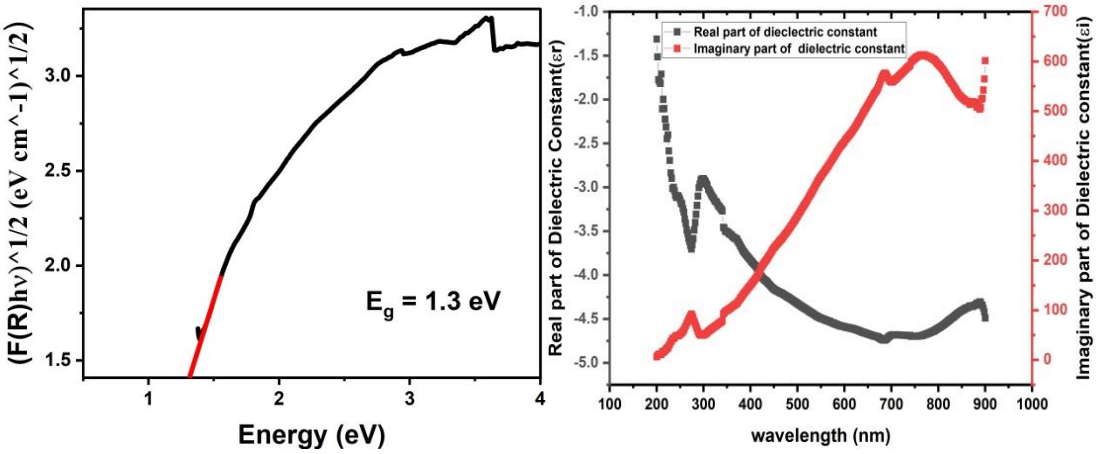
The number 1240, is a conversion factor.

$$\varepsilon r = n^2 - k^2 \text{(real part of dielectric constant)} \qquad (5)$$

$$\varepsilon i = 2*n*k \text{(imaginary part of dielectric constant)} \qquad (6)$$

n –refractive index

k -extinction coefficient



The band gap energy is observed as 1.31 eV. It is a crucial parameter to know about the electrical conductivity and optical properties of the synthesized nanocomposite. The dielectric constant is found to be 12.9 and is used to quantify the ability of the synthesized nanocomposite to store electrical energy, for supercapacitor applications.

CONCLUSION:

The rGO/CoO nanocomposite was successfully synthesized from the saccharum officinarum derived GO through thermal reduction process. The particle size of the synthesized nanoparticle, is found to be 10.32 nm, using the XRD analysis. The band gap energy of the synthesized nanoparticle, is found to be 1.31 eV, using the UV-Vis spectroscopy analysis. The synthesized nanocomposite is observed to have the characteristics of electric double

layer capacitors (EDLC). It can be used in memory backup, energy harvesting and hybrid vehicles.

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