International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 6 June 2022, pp: 2492-2497 www.ijaem.net ISSN: 2395-5252

Graphene Oxide Nanoparticle Synthesis from Sugar Solution; Its Characterization, Properties and Application in Waste Water Treatment

*[1]Sadisu GIRIGISU, [2] Olaosebikan O., and [3]Olawale, K.O

[1]*Department of Biochemical and Chemical Science, Federal Polytechnic Offa, P.M.B. 420, Offa, Nigeria*
[2,3]*Department of Physics and Electronics, Federal Polytechnic Offa, P.M.B. 420, Offa, Nigeria*

Submitted: 20-06-2022 Revised: 27-06-2022 Accepted: 30-06-2022

ABSTRACT
This paper describes a green method for the synthesis of graphenic material from cane sugar, a common disaccharide. A suitable methodology was introduced to immobilize this material on sand without the need of any binder, resulting in a composite, referred to as graphene sand composite (GSC). It effectively removes contaminants from waste water. These materials offer extraordinarily high surface area, mechanical durability, atomic thickness, nanosized pores and reactivity toward polar and non-polar water pollutants. These characteristics impart high selectivity and water permeability, and thus provide excellent water purification efficiency. This review introduces the potential of graphene membranes for water degradation.

Keywords: Graphene, Beach sand, Sugar, methyl orange, Degradation.

I. INTRODUCTION

Water is one of the world's valuable resources, and only 1% of the global water supply is available for consumption and domestic use. With increasing industrialization activity, large amounts of hazardous chemicals are released into the water ways every day. In recent times, inorganic and organic contaminants, heavy metals and dyes are frequently found in the industrial effluents, which if left untreated become a threat to the environment and public health as they are non-biodegradable and tend to accumulate in living organisms (Shannon, M. A. et al 2010; Ali, I et al 2019 ; Gupta, V. K. & Ali, I. 2002)

Conventional water and wastewater treatment processes such as ponding system (Ahmad & Krimly 2014; Madaki & Seng 2013), biological treatment (Ahmad et al. 2003; Azmi et al. 2014), membrane technology (Azmi et al. 2014; Rupani & Singh 2010), biofilm (Takriff 2014), and chemical coagulation (Igwe & Abia 2007; Wu et al. 2010) resulted in high expenses is the major constraint for developing countries. Consequently, several cost-effective and appropriate remediation that can regulate the amount of these toxic and persistent water pollutants to permissible levels before being discharged to the water bodies. To date, different treatment technologies such as photodegradation (Ma et al 2015; Kaur and Jinda 2018; and precipitation Wang et al 2005; Mbamaba et al 2015) and coagulation & flocculation, membrane separation Neoh et al 2016 and Van der et al 2003),

Water purification technologies have also used activated carbon for removing contaminant including color and heavy metals due to high surface area and large iodine number and this material which is derived from plant sources now adays become the most used adsorbent for water purification and treatment (Ramesha et al 2011 and Goyal et al 2009).This material is also considered the most efficient and affective due to low cost and practicality especially for developing countries. Other method for water purification which is more advanced such as membrane filtration and ion exchange had been used for sometimes. However, the high cost of investment and operation limits the large scale application of the use of the method especially in some countries (Namasivayam and Kavitha 2002). Therefore, a more economical

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 6 June 2022, pp: 2492-2497 www.ijaem.net ISSN: 2395-5252

feasible treatment process –degradation using GSC via adsorption appears to be an attractive option for water and wastewater treatment applications.

II. MATERIAL AND METHODS

The raw materials used for the synthesis were common sugar, river sand, and sulfuric acid. River sand (~0.2 mm particle size) obtained from a beach side at Ejigbo, Osun State. Hydrochloric acid, acetone, methyl orange (HPLC assay 99.9%) was from Sigma Aldrich. No additional purification was done and the solvent generally used was deionised water unless otherwise mentioned.

Preparation of GSC (Graphene Oxide Sand Composites)

GSC was prepared according to the procedure developed by Gao et al (2011). with some modifications. This procedure is basically the combination of graphene oxide with beach sand. The beach sand was purchased from local beach located in Ejigbo, Osun State. It was firstly washed with 10 % HCl before use and continued washing by adding deionised water till neutral pH is obtained.

Preparation glucose sand solution

Molar sugar solution was prepared by adding 100g of sugar in 1 L deionised water. This was mixed with the aid of a glass stirrer in order to obtain a homogenous solution. 30 g of sand (180 micron) was then added to the solution.

Mixing and drying on magnetic stirrer

The beaker containing the solution of glucose and sand was placed on the hot plate magnetic stirrer for 4hrs with continous stirring using a bar magnet at a temperature of 60 ^{o}C till the entire mixture dried up to form a solid product. This was then followed with the addition of 1 g activated charcoal and further treated in an oven for further two hours at 200 ^{o}C. The final product was a black sand adsorbent called Graphene sand composite (GSC). The beach sand and the finish GSC product are illustrated in the Figures below.

Fig. 1 (a) beach sand (b) mixture of glucose with sand (c) Final product GSC. The final product obtained as further milled in order to reduce its particle size

III. RESULT AND DISCUSSION

Synthesis and characterization of GSC

The sample was characterized using X-ray diffraction (XRD) model (Philip W 1800), Fourier transform Infrared FTIR model (Agilent Cary 630).

The XRD result of the GSC sample in the powdered form is shown in fig 2. The characteristic peaks of grapheme obtained at 26.6265, 50.1339 and 50.2836 is an indication that the synthesis was successful

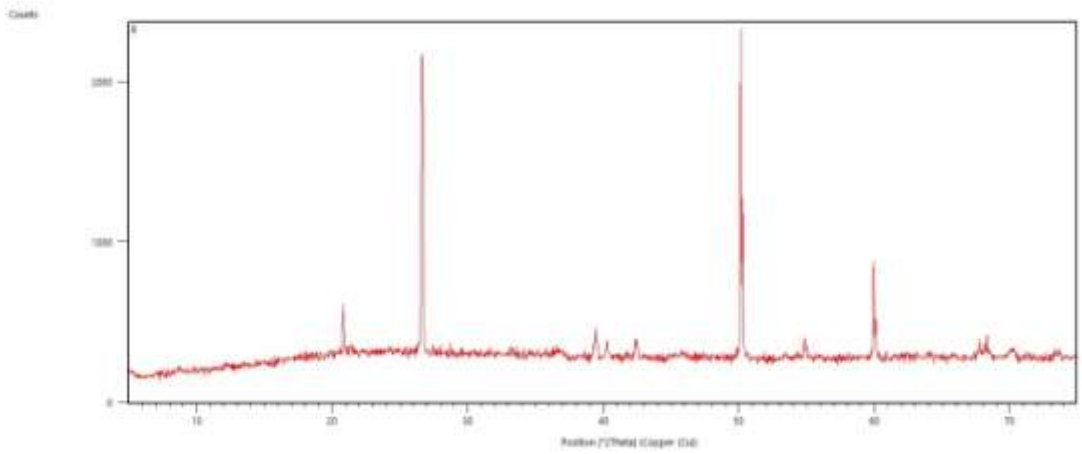

Fig. 1 X-ray diffraction pattern of the synthesized product

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 6 June 2022, pp: 2492-2497 www.ijaem.net ISSN: 2395-5252

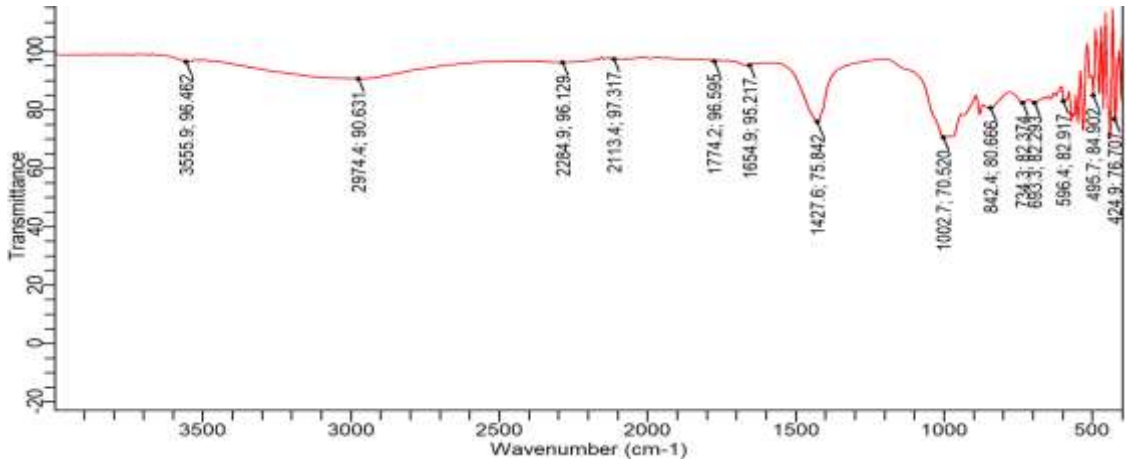

Fig 2: FTIR spectrum of the synthesized product

Also, the FTIR analysis was carried out on the sample as shown in figure 3 above, from the spectrum the major characteristic peaks of graphene observed are absorptions peaks 3555.8, 2113.4 1654.9. 1774.2, which are due to stretching of O–H, − C = C −, C = O (carbonyl), and C = O (Carboxylic acid) bonds, respectively (Bykkam et al. 2013, which provide clear evidences of graphitization of sucrose.

Table 1: Absorption bands of the FTIR spectrum of GSC

Peak number	wave number cm^{-1}	Intensity
1	424.91651	76.70720
2	495.73593	84.90233
3	596.37405	82.91709
4	693.28484	82.91709
5	734.28555	82.37361
6	842.37835	80.66636
7	1002.65388	70.52021
8	1427.57039	75.84218
9	1654.93800	95.21670
10	1774.21281	96.59465
11	2113.40055	97.31696
12	2284.85809	96.12937
13	2974.41559	90.63146
14	3555.88030	96.46244

Catalytic tests

Catalytic tests were carried out in a reactor capacity of 250 ml attached with a condenser. 100 ml of aqueous solution of methyl orange was introduced and 50 mg of graphene sand composite (GSC) produced was added. The reactor was put in the oil bath previously heated and maintained at 65°C. During the reaction, the mixture was continuously stirred using magnetic stirrer (agitation rate 300 rpm) for 1 h. The residual concentration of dye in the aqueous solution was determined each 20 min via UV-vis spectrophotometer at **460 nm**. At the end of the reaction time, the graphene sand composite particles were separated from aqueous solution using centrifuge at 8000 rpm. The graphene sand composite (GSC) particles were recovered then washed with ethanol and water several times and dried at 60°C overnight for reusability.

EFFECT OF SAMPLE CALCINATION

The graphene sand composite sample was calcined at different temperature and the product was use to carry out degradation on methyl orange indicator, the level of degradation is indicated in figure 3. Obviously the GSC calcined at 250 performed better, this might be as a result of elimination of impurities that may hinder the binding sight which helps in total degradation.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 6 June 2022, pp: 2492-2497 www.ijaem.net ISSN: 2395-5252

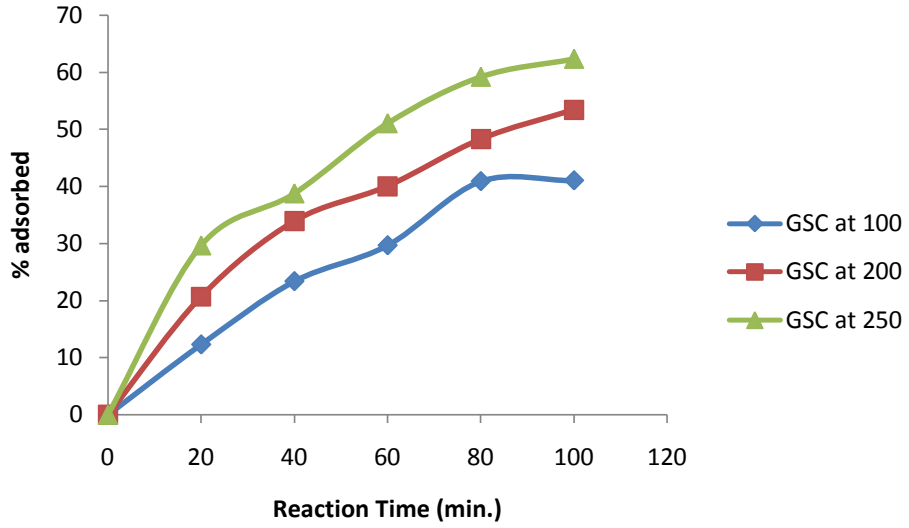

Fig. 3: Effect of calcinations of GSC at different temperature

EFFECT OFSAMPLE DOSAGE

The effect of sample dosage was also carried out in order to determine the amount that will produce effective degradadation, from the plot, it could be observed that the dosage 200mg performed better, this could be attributed to more binding site available for the degradation, therefore the sample with high dosage was used for further studies.

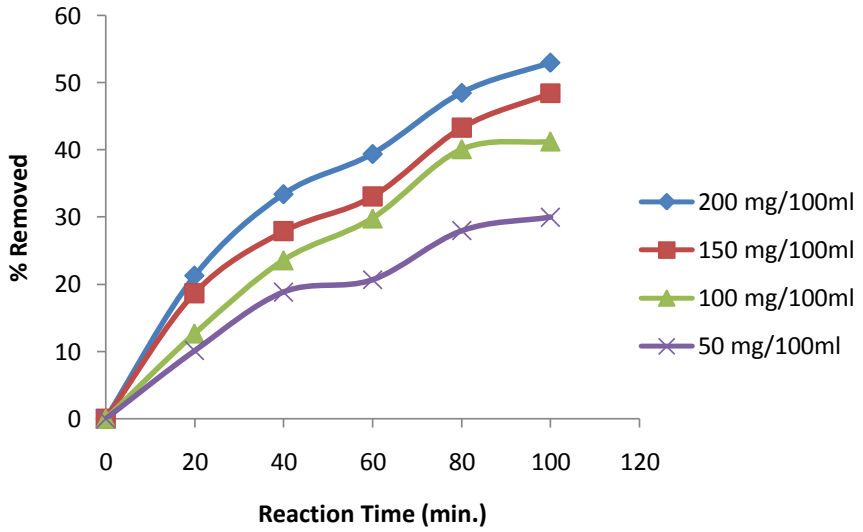

Fig. 3: Effect of sample dosage with reaction time.

Effect of pH

The sample calcined at 250 with the highest dosage was used to carry out the effect of pH, the range of pH carried out is between 1-5, from the plot it could be observed that maximum degradation was obtained at pH of 1.5, this could be connected to the acidic nature of graphene sand composite.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 6 June 2022, pp: 2492-2497 www.ijaem.net ISSN: 2395-5252

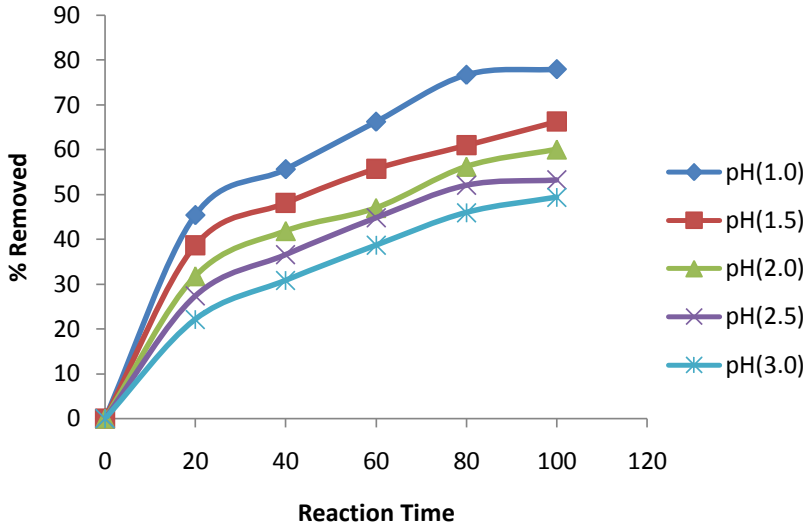

Fig.4: Effect of pH on the degradation of methyl orange

IV. CONCLUSION

Graphene Sand Composite (GSC) was successfully synthesized using sugar and beach sand obtained from local community; this was characterized accordingly using x-ray diffraction (XRD) and fourier transform infra-red spectroscopy (FTIR). The characterization revealed the basic absorption bands that describe the basic component of graphene sand composite. The sample thereafter was used to carry out degradation on methyl orange dye and almost 80% removal was achieved.

V. ACKNOWLEDGMENT

The research group wishes to acknowledge the Tertiary Education Trust Fund (TETFund) and the management of the Federal polytechnic Offa for providing an enabling environment for the conduct of this research. Special thanks go to the Dean Research and Innovation Unit of the Federal Polytechnic Offa in person of Dr (Mrs.) Kortar Grace for letting this research see the light of the day. Gratitude also goes to Mrs. Adeyemi C.O of the Department of Biochemical and Chemical Science for her technical support on this work.

FUNDING

This research work was fully sponsored by the Tertiary Education Trust Fund (TETFund) under the Institution Based Research (IBR) Scheme, Federal Republic of Nigeria.

REFERENCES

[1]. Ali, I. et al. Graphene based adsorbents for remediation of noxious pollutants from wastewater. Environment international **127**, 160–180 (2019).

[2]. Azmi, N. S., Khairul, F. & Md. Y. 2014. Wastewater treatment of palm oil mill effluent (POME) by ultrafiltration membrane separation technique coupled with adsorption treatment as pre-treatment. Agriculture and Agricultural Science Procedia 2 257-264.

[3]. Bykkam, S., Rao, V., Chakra, C. S., and Thunugunt, T. (2013). Synthesis and characterization of graphene oxide and its antimicrobial activity against klebseilla and staphylococcus. International Journal of dvanced Biotechnology and Research., 4(1), 142–146.

[4]. Goyal, M. Bhagat, M. and Dhawan, R. J. (2009) Hazard. Mater., **171**,1009-1015.

[5]. Gupta, V. K. & Ali, I. Adsorbents for water treatment: Low cost alternatives to carbon In Encyclopaedia of surface and colloid science (ed. Arthur Hubbard), 136–166 (Marcel Dekker, 2002).

[6]. Igwe, J. C. & Abia, A. A. 2007. Adsorption isotherm studies of Cd(II), Pb(II), and Zn(II) ions bioremediation from aqueous solution using unmodified and EDTA-modified maize cob. Ecletica Quimica 32(1): 33-42.

[7]. Kaur, K. and Jindal, R. (2018) Synergistic effect of organic-inorganic hybrid nanocomposite ion exchanger on photocatalytic degradation of Rhodamine-B

dye and heavy metal ion removal from industrial effluents. Journal of Environmental Chemical Engineering **6**, 7091–710.

[8]. Ma,X.-C., Dai,Y., Yu, L. and Huang, B.B. (2016) Energy transfer in plasmonic photocatalytic composites. Light: Science &Amp; Applications **5**, e16017, https://doi.org/10.1038/lsa.2016.17.

[9]. Mbamba, C.K., Batstone, D.J., Flores-Alsina, X. and Tait, S. A (2015) Generalised chemical precipitation modelling approach in wastewaterNtreatment applied to calcite. Water research **68**, 342–353.

[10]. Namasivayam, C. & Kavitha, D. 2002. Removal of congo red from water by adsorption onto activated carbon prepared from coir pith, an agricultural solid waste. Dyes and Pigments 54(1): 47-58.

[11]. Neoh, C. H., Noor, Z. Z., Mutamim, N. S. A. and Lim, C. K. (2016) Green technology in wastewater treatment technologies: integration of membrane bioreactor with various wastewater treatment systems. Chemical Engineering Journal **283**, 582–594.

[12]. Ramesha, G.K , Kumara, A.V. Muralidhara, H.B., and Sampath S., (2011) Graphene and grapheme oxide as effective adsorbents toward anionic and cationic dyes, J. Colloid Interface Sci.**361**, 270-277

[13]. Shannon, M. A. et al. Science and technology for water purification in the coming decades In Nanoscience and technology: a collection of reviews from nature Journals, 337–346 (2010).

[14]. Takriff, M. 2014. A review of biofilm treatment systems in treating downstream palm oil mill effluent (POME). Journal of Applied Sciences 14(12): 1334-1338.

[15]. Van der Bruggen, B., Vandecasteele, C., Van Gestel, T., Doyen, W. and Leysen, R. (2003) A review of pressure-driven membrane processes in wastewater treatment and drinking water production. Environmental progress **22**, 46–56.

[16]. Wang, L. K., Vaccari, D. A., Li, Y. and Shammas, N. K. (2005) In Physicochemical treatment processes 141–197 Springer .