GRAPHENE OXIDE AND ITS APPLICATION IN WATER PURIFICATION

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Abstract-

Graphene Oxide is a 2-Dimensional material, decorated with Oxygen-containing functional group. The Graphene Oxide was successfully prepared via the Modified Hummers method. The suspension of graphite flakes was sonicated repeatedly with the help of centrifugation;hence graphene oxide was prepared. Characterization of Graphene Oxide films were conducted. The structural and physiochemical properties of Graphene Oxide were investigated with the help of XRD, RAMAN SPECTROSCOPY, UV SPECTROSCOPY, FT-IR. UV-visible spectra of Graphene Oxide exhibits maximum absorption peak at ~237nm shows π-π^* transition of the atomic and carbon-carbon bonds. Water bodies are heavily polluted due to contamination of heavy metal particles, toxic dyes, and other harmful wastes. Graphene is used for the removal of harmful contaminants present in water bodies. In this paper, the preparation methods of Graphene Oxide membrane are reviewed. We measured that the percentage of impurity in graphene based purified water is much lower than that of wastewater. Finally, the application of Graphene membrane in water treatment was discussed.

Key words: Graphene Oxide, XRD, Hummers, FT-IRAbsorption, Membrane

INTRODUCTION

Nanoscience and Nanotechnology in particularly deals with the exploration, synthesis, and characterization of Nanomaterials. Graphene is a carbon material, atomically-thin, a 2-D sheet of sp^2 carbon atoms in a honey comb lattice structure gives it many extraordinary characteristics, such as one of the lightest, transparent and being the strongest material in the world. Graphene could also be obtained using BOTTOM UP METHOD. Some recent results demonstrated that the structure graphene which we called it a “wonder material” has many properties such as electrical conductivity, high mechanical strength.Graphene Oxide is an oxidized form of graphene containing hydroxyl (OH), alkoxy (C-O-C), carbonyl (C=O), carboxylic acids (-COOH) and O-based functional group. These oxygenated groups are accountable for many advantages over graphene which includes higher solubility aside from the synthesis. The oxidation of graphite in protonated solvents forms graphite oxide, which consist of multiple stacked layers of graphene oxide.

It has high electrical properties and electron transport (200,000 cm^2/v.s.), excellent thermodynamic properties (5300w/m.k.) and large surface area (2600m^2/g), while the carbon nanotubes have a surface area of 1000m^2g. There is a strong Vander Waals force between the graphene sheets.

The two important characteristics of GRAPHENE OXIDE: -

(1) Highly Hydrophilic.
(2) Cost effective chemicals are used with a high yield.

Researchers use nanomaterials in the form of nanotubes, nano-adsorbents, semi permeable membrane which are made from nano fibres, nanoflake, catalysts in nano-sized, etc. Graphene naturally repels water, but when small narrow pores are made in it, quick water permeation occurs. Graphene sheets which are having perforated holes are studies as a method of water filtration because of their ability to pass the water molecules but block the passage of contaminants. Graphene's small size and small weight make it ultra-light Hydrophilic property of graphene oxide is one of the most useful features for water treatment as it has large negative charge.

Graphene oxide is synthesized by certain methods including Hummers Method, Modified Hummers method, Staudenmaier, Hoffmann, Brodie. Hummers method is one of the adequate as well as faster method for the preparation of graphene oxide. Another advantage of this method is producing graphene oxide with high carbon – oxygen ratio Graphene Oxide is commonly sold in powder form, or as coating on substrates.

OBJECTIVE AND METHODOLOGY

OBJECTIVE

The main objective of this paper is to study synthesis techniques of graphene oxide, characterization of graphene oxide by spectral and microscopic data and its application in H_2O purification.

MODIFIED HUMMERS METHOD

➢ CHEMICALS REQUIRED: -

I. Graphite Flakes
II. Concentrated H_2SO_4
III. Potassium Permanganate
IV. Hydrogen Peroxide
V. Hydrochloric Acid

➢ This method of synthesis involves both oxidation and exfoliation of graphite sheets due to thermal treatment of solution.
➢ The stepwise synthesis method given as follows: -

(1) Graphite flakes (2gm) were mixed in 50ml concentrated H_2SO_4 (98%) in 1000 ml volumetric flask.
(2) Then the mixture was cooled under ice water-bath with continuous stirring and the suspension was obtained.
(3) Then 6 gm of oxidizing agent Potassium Permanganate ($KMnO_4$) was added moderately into the suspension under controlled temperature below 10^0C.
(4) The suspension was then stirred at room temperature for 145min to 1 hour, followed by sonication in an ultrasonic bath for 8 min.
(5) Then 250 ml of distilled water was added into mixture with repetition of stirring- sonication process 10 times at 450 rpm.

(6) After that 30ml of H_2O_2 was added to exfoliated graphite oxide achieved by ultrasonication of dispersed solution for 1 hour. Then the solution is centrifuged at 10,000 rpm.

(7) Then graphene oxide was washed with 2M HCl to remove excess of metal ion to make it neutral.

(8) The resulting mixture was washed repeatedly by distilled water or deionized water several times until the pH comes to~7. (pH-neutral)

(9) Then graphene oxide was washed with 2M HCl to remove excess of metal ion to make it neutral.

(10) The resulting mixture was washed repeatedly by distilled water or deionized water several times until the pH comes to~7. (pH-neutral)

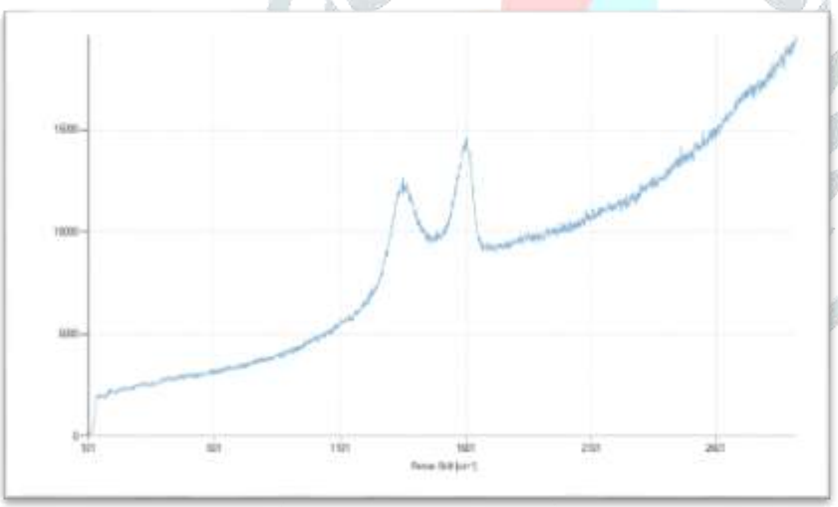
(11) The resulting graphene oxide precipitates were then dried at room temperature for 24hr to graphene oxide powder.

RESULTS AND DISCUSSION

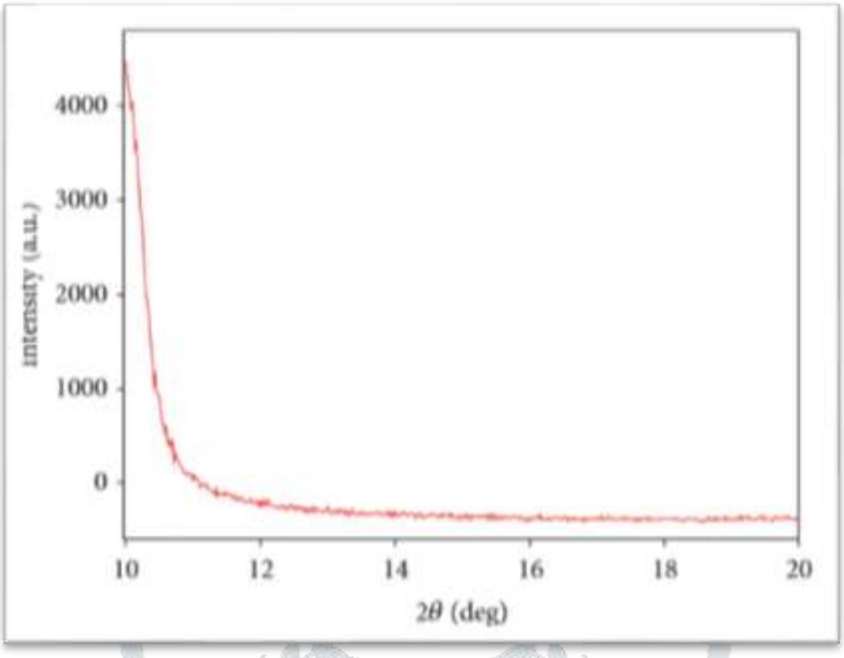
Experimental yield of GRAPHENE OXIDE prepared = 1.48gm

CHARACTERIZATION:

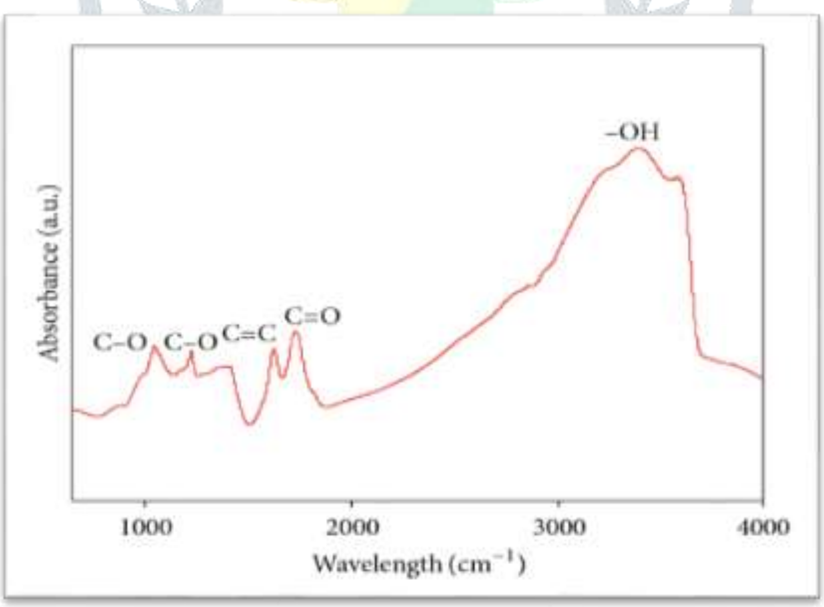
RAMAN SPECTRA:



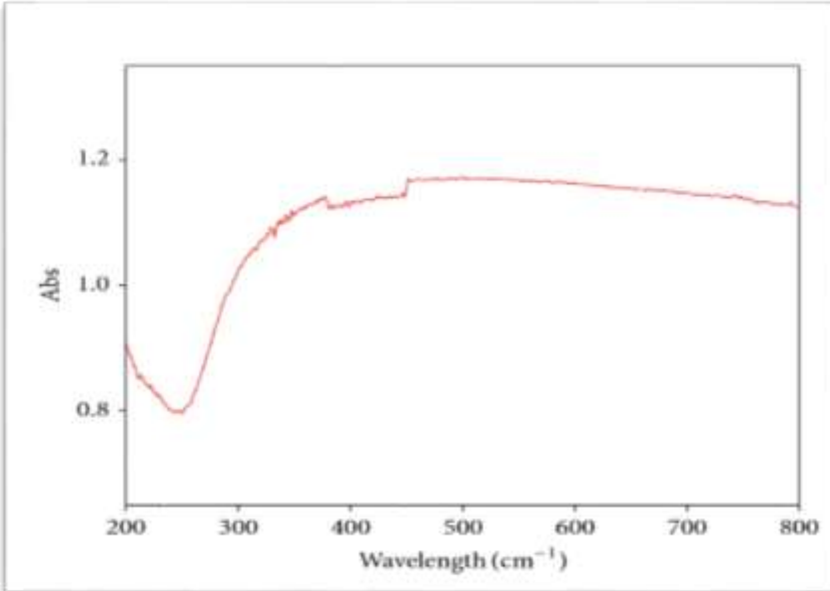
XRD SPECTRA:



FT-IR SPECTRA:



UV-VIS SPECTRA:



VARIABLE PARAMETERSS

VARIABLE PARAMETERS OF WASTEWATER:

PARAMETERS	SAMPLE1	SAMPLE 2	SAMPLE 3	SAMPLE 4	SAMPLE 5
Ph	5.5	5.8	6.3	7.3	8.2
ELECTRICAL CUNDUCTIVITY (mS/cm)	218.6	229.5	246.2	254.1	267.6
DO (mg/L)	3.1	3.5	4.3	4.1	5.3
BOD (mg/L)	2102	2275	2570	2650	2772
COD (mg/L)	2900	3412	3812	3902	4005
CALCIUM HARDNESS (mg/L)	15.5	12.2	10.5	8.4	7.2
MAGNESIUM HARDNESS (mg/L)	5.3	6.6	7.2	8.7	9.1
TOTAL HARDNESS (mg/L)	22.3	26.1	27.3	31.8	35.3

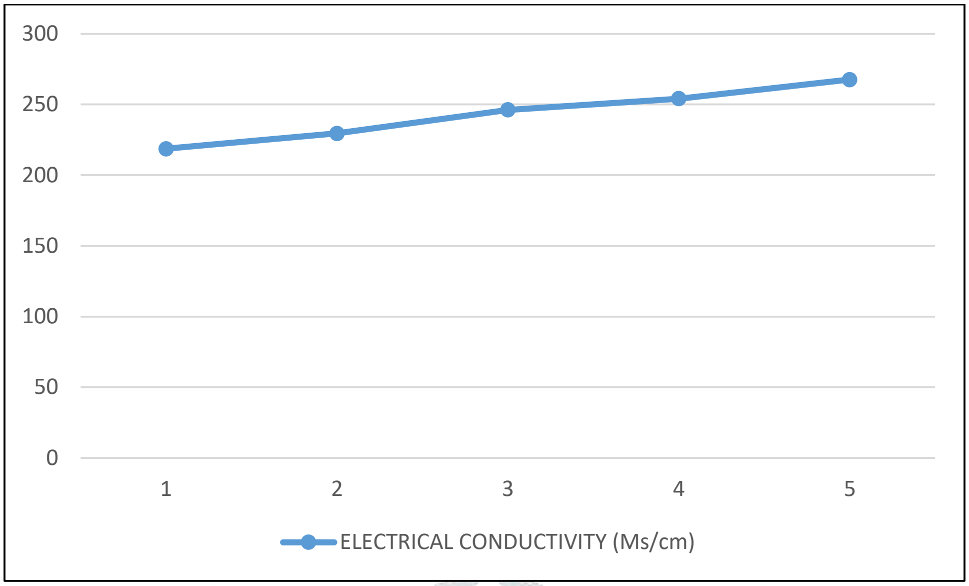


Figure1: ELECTICAL CONDUCTIVITY Vs SAMPLE

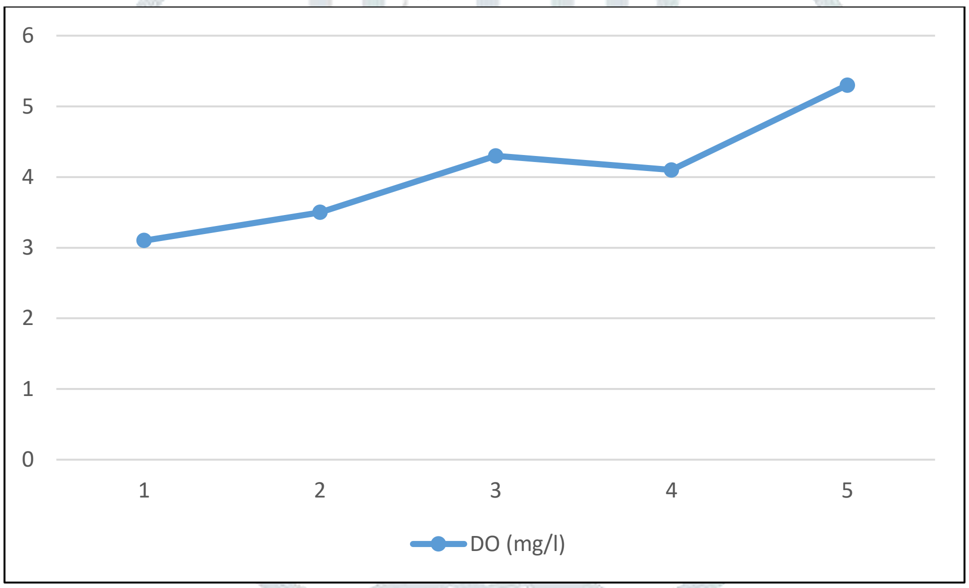


Figure2: DO Vs SAMPLE

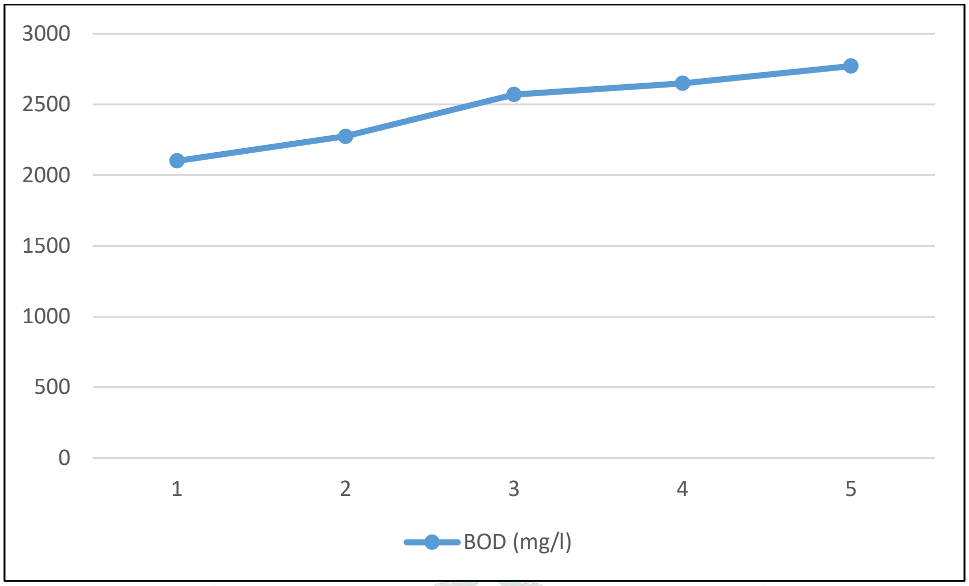


Figure3: BOD Vs SAMPLE

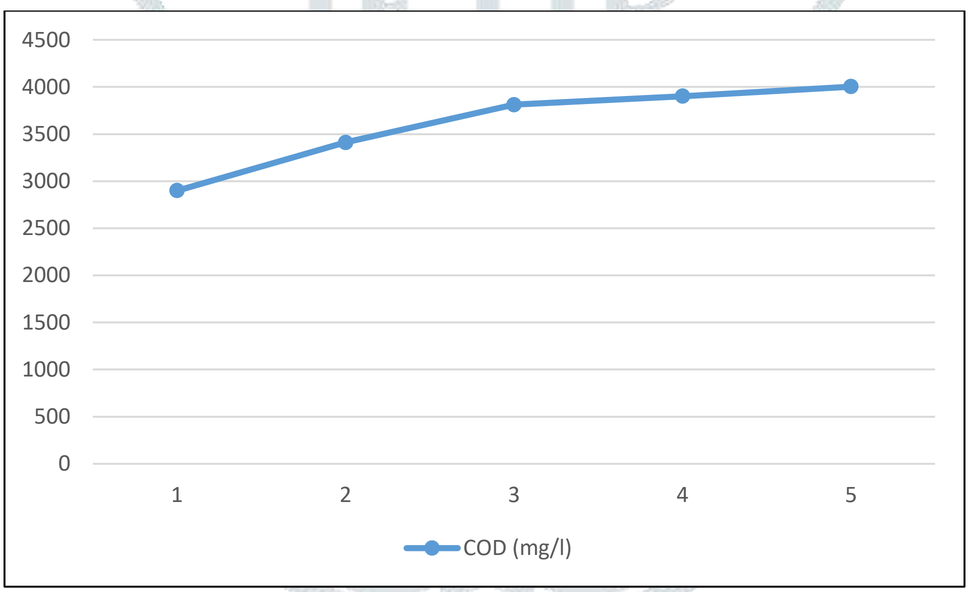


Figure4: COD Vs SAMPLE

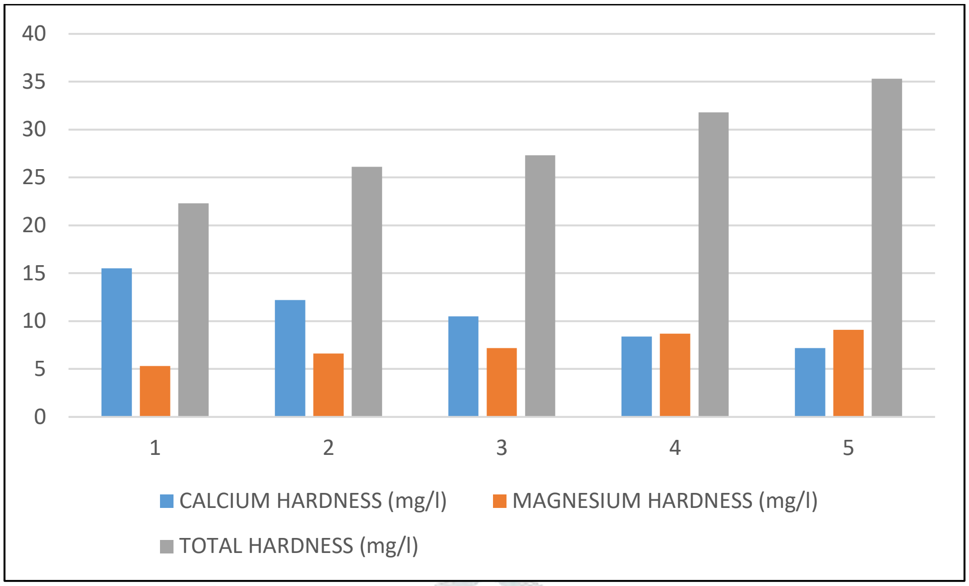


Figure5: HARDNESS Vs SAMPLE

VARIABLE PARAMETERS OF PURIFIED WATER USING GRAPHENE:

PARAMETERS	SAMPLE1	SAMPLE2	SAMPLE3	SAMPLE4	SAMPLE5
pH	7.4	7.2	8.0	8.3	10.1
ELECTRICAL CONDUCTIVITY (mS/cm)	150.2	162.8	168.0	179.2	193.0
DO (mg/L)	6.3	6.8	7.1	7.5	8.1
BOD (mg/L)	1750	1802	1882	1949	2005
COD (mg/L)	1734	2100	2312	2400	3210
CALCIUM HARDNESS (mg/L)	7.3	6.8	5.7	4.9	3.3
MAGNESIUM HARDNESS (mg/L)	1.8	2.3	3.4	4.8	5.2
TOTAL HARDNESS (mg/L)	9.3	8.7	7.4	6.5	5.1

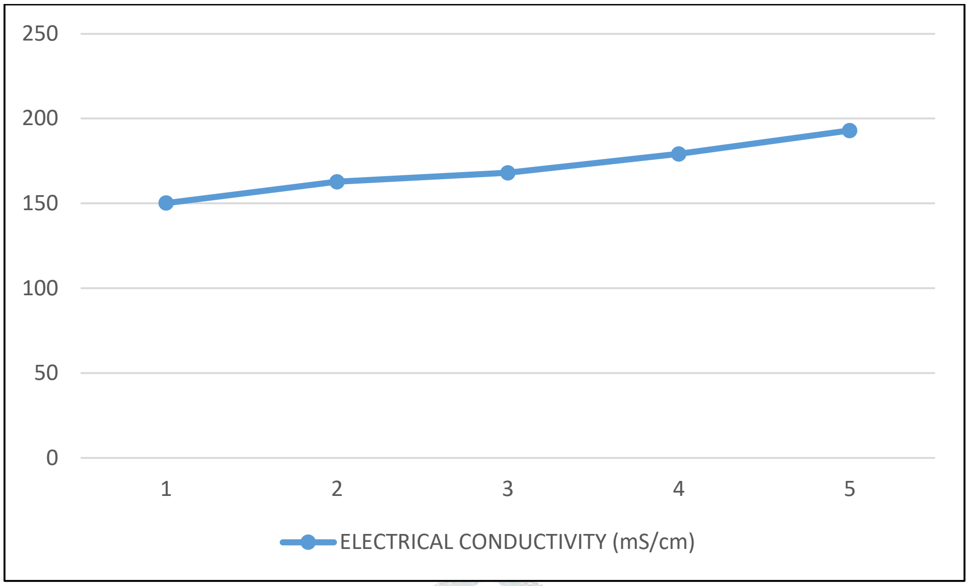


Figure6: ELECTRICAL CONDUCTIVITY Vs SAMPLE

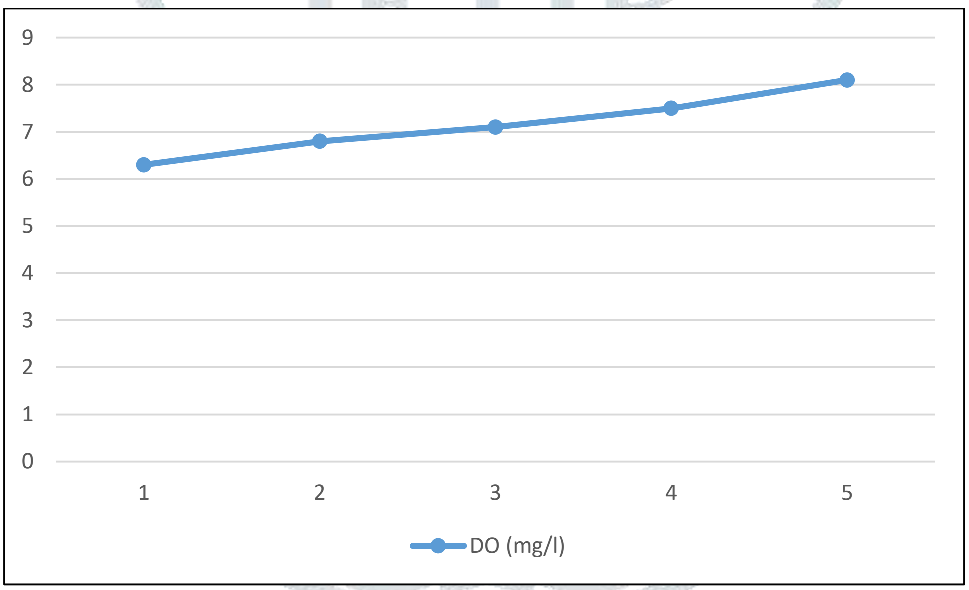


Figure7: DO Vs SAMPLE

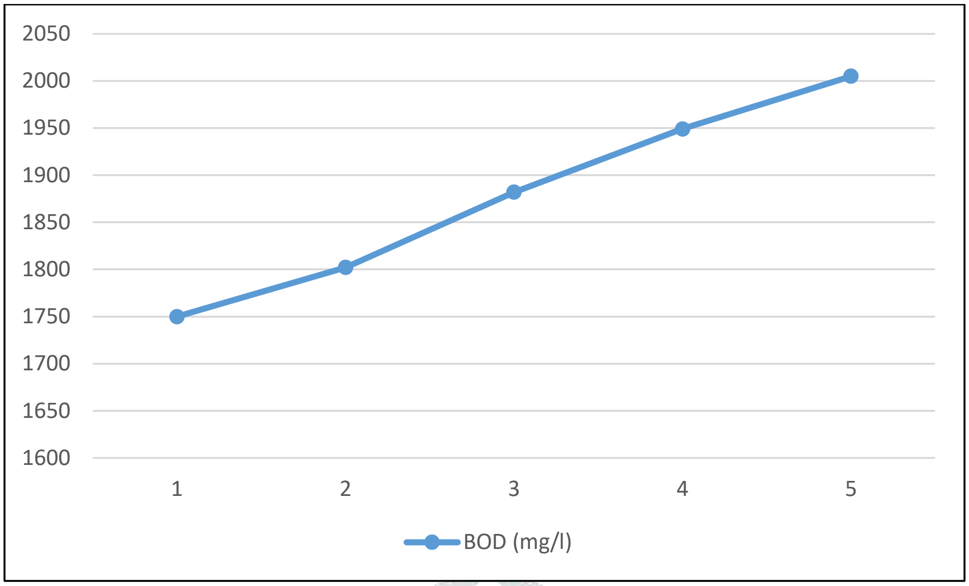


Figure8: BOD Vs SAMPLE

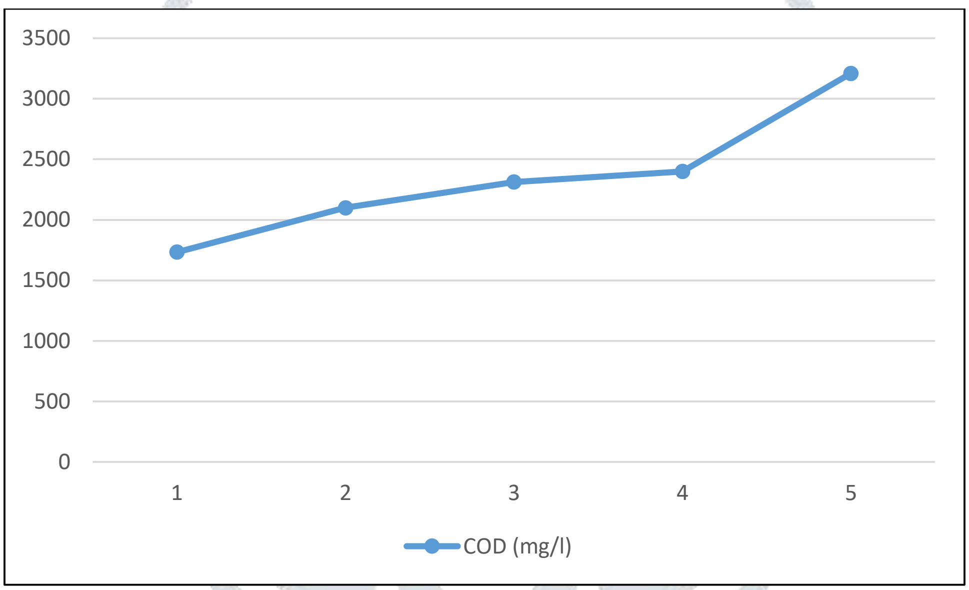


Figure9: COD Vs SAMPLE

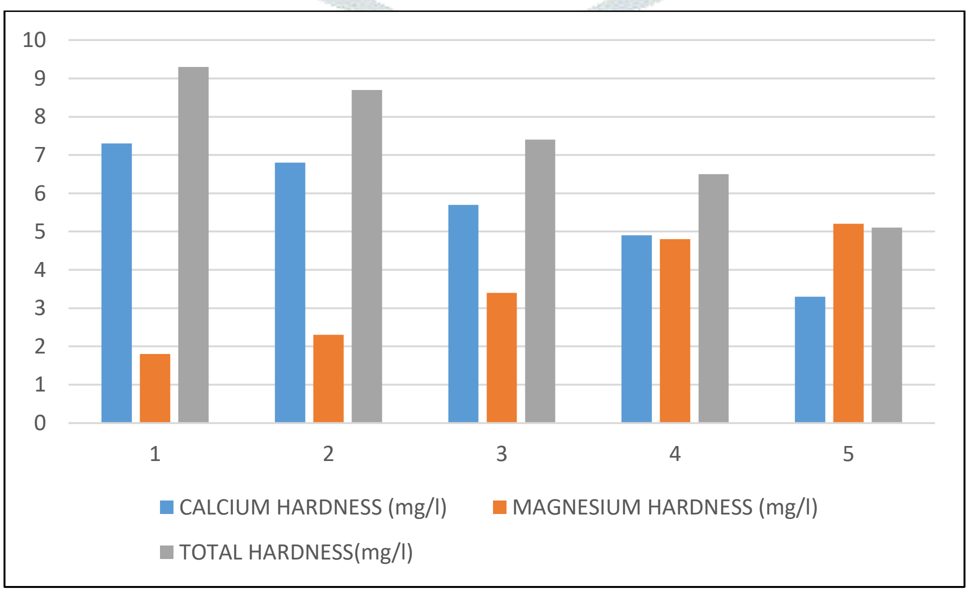


Figure10: HARDNESS Vs SAMPLE

From the above-mentioned data, we measured that the percentage of impurity in graphene based purified water is much lower than that of wastewater.

CONCLUSION

Water pollution and shortage of water is a major problem of the world. It is to be noted that 700 million people in the world do not have the access to clean water. The contaminated water that people were drinking gives rise to many diseases, which may lead to death. In this regard, Graphene has found to be a miracle in the field due to its peculiar structure of high permeable density. The studies discussed in this paper pointed out that Graphene-based water treatment process can be carried out in a much shorter time and at a much lower cost. These results are of importance for the environmental application of Graphene Oxide nanocomposites for the removal of inorganic and organic pollutants from larger volumes of aqueous solution and effluents. The presence of Oxygen-containing functional group and characterization peaks in XRD, AFM determined the preparation of Graphene Oxide sheets.

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