Photodegradtion of organic pollutants under visible light using Graphene oxide nanosheets

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Abstract

Graphene Oxide and GO Nanocomposites have great potential and a range of applications for wastewater treatment and purification for different impurities and effluent compositions. In the present work, Graphene Oxide nanosheets were synthesized using modified Hummers method. The synthesized material was then characterized using X-ray diffraction(XRD),Raman spectrophotometer and Transmission Electron Microscope (TEM).Further, the photocatalytic activity of GO was investigated for the degradation of organic dye Methyle blue (MeB) as a function of time under visible light. The optimal GO loading for the degradation of methyl Blue and the stability of the photocatalysts is being investigated. The effect of concentration of pollutant, temperature and pH of solution was also optimized. It was observed that the GO nanosheets show excellent adsorption ability at high pH under room temperature. Formulation of a mechanism responsible for the enhancement of the photocatalytic activity is also underway. The results indicate that GO nanosheets as an excellent candidate for the treatment of contaminated water and effluent under visible light.

***Key Words*— Graphene Oxide, Nanocomposites, Wastewater treatment, Environment and Photocatalytic activity.**

Introduction

The recent change in environment has attracted much attention worldwide due to the rapid spread of toxic and non-biodegradable heavy metal ions [1]. Industrial wastewater is one of the most important sources in the pollution of the environment. Over the last few years Graphene Oxide has been recognized as a potential candidate in many applications including energy [2], industrial applications [3] and sensors [4] .The large surface area, presence of reactive functional groups like hydroxyl, carboxyl, carbonyl, epoxide and the large adsorption capacity makes it a very promising candidate for an application in water treatment and other environmental applications [5, 6]. Different derivatives of graphene for the removal of dyes [7], heavy metal ions [8], and pharmaceutical compounds [9] from aqueous solutions have been reported earlier. In this present work, we report that GO can be directly used as an adsorbent for the removal of textile dyes. The adsorption capacity of GO nanosheets was examined for the degradation of methyl blue (MeB) dye. The adsorption capacity was also optimized by varying the concentration of GO.

Experimental

Synthesis of Graphene oxide –

Graphene Oxide has been synthesized by a modified Hummers method [10, 11]. Briefly, 2 g of Sodium nitrate was added into 100 mL of sulfuric acid and, followed by stirring at 70°C for 30 min. After that 2 g of graphite powder was added to the mixture, followed by stirring at 70 °C again for 45 minutes. Then the mixture was kept below 5 °C in an ice bath, and 12 g of potassium permanganate was slowly added into the mixture. After being heated to 35 °C, the mixture was stirred for another five hours. 184 mL of deionized water was added to the above mixture during a period of 30 min, and then the mixture was kept at 98 °C for another one hour. Finally, 560 mL of hot deionized water and 20 mL of 5% hydrogen peroxide were added into the mixture to stop the reaction. The solution was kept overnight on magnetic stirrer. The resultant solution was washed and centrifuged with 5% HCL and several times with water and finally with ethanol. The final solution was dried at 60 °C in a petri dish.

Characterization

- In FIG.1 The crystalline phase structure of synthesized Graphene Oxide (GO) was analyzed using XRD (D2 Phaser Brucker). A sharp intense peak at 2Ɵ = 10° was observed indicating crystalline nature of GO and 2Ɵ = 26.8° indicates the presence of Graphite
- Morphological and structure analysis of the synthesized GO nanosheets were examined by TEM. Figure 2 shows the TEM image of GO nanosheets. The image reveals the flexible, wrinkled sheets of different sizes ranging from hundreds from thousand of nanometers.

FIG. 3. AFM image of GO sheets

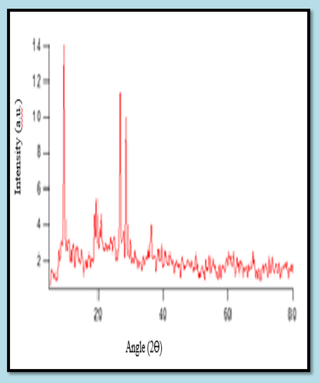


Fig.1 XRD image Graphene Oxide

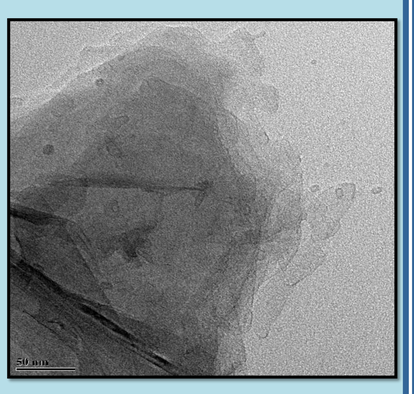


FIG. 2 TEM image of GO nanosheets

- The surface morphology and structure of synthesized GO sheets were studied using AFM. Figure 3 shows the AFM image of GO sheets.

Results and Discussion

- The photocatalytic activity of GO nanosheets was assessed by monitoring the decolorization process of methylene blue under Visible light conditions and UV-illuminator. In FIG.4 The photo degradation efficiency was calculated using relative concentration of dye as a function of time. In the absence of photocatalyst no degradation was observed. However, 79% of dye was degraded in the presence of GO within 100 min.

- The effect of GO on DYE removal and pH were studied FIG. 5 and FIG.5.1 gives effect of GO on percentage removal under UV and Visible light. FIG.7 gives the values for effect of GO on pH and Fig.8 gives percentage removal with respect to pH change.

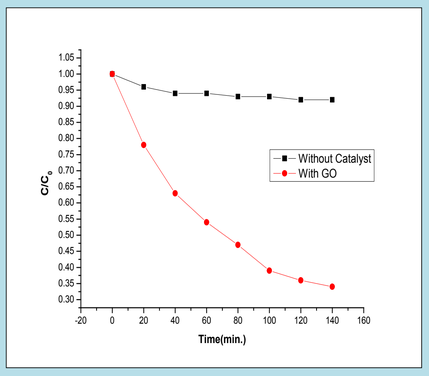


FIG.4 photocatalytic degradation of MeB dye In visible light and UV light

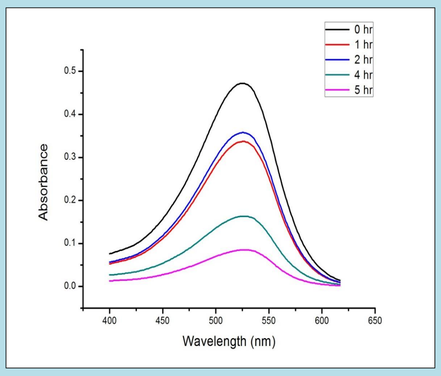
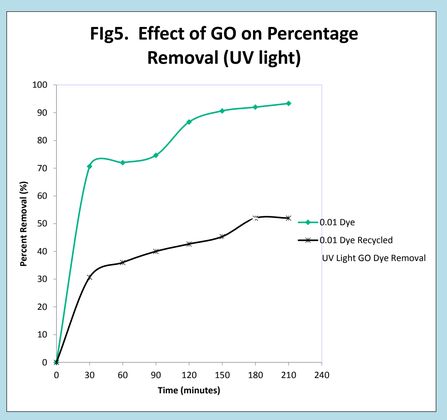
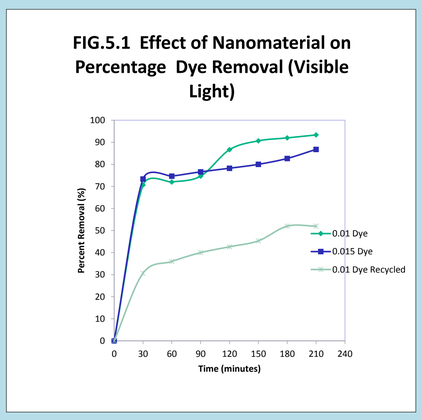
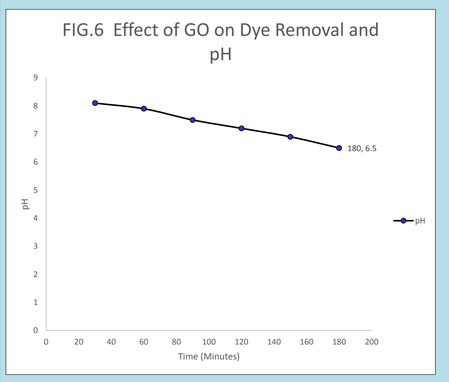
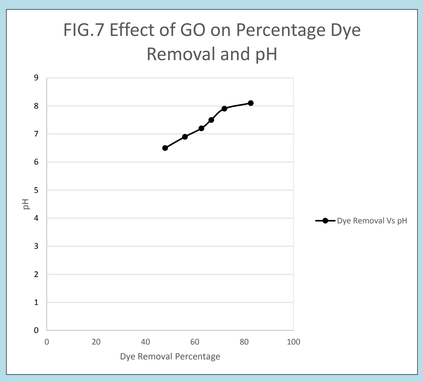


FIG.8 UV Vis absorbance spectra at intervals of 1 hour









- Thus, it was found that the given material is highly applicable for the removal of MeB dye under UV and visible light conditions.

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