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Dye Adsorption Behavior of Graphene Oxide

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Abstract

We demonstrate the use of dispersed graphene oxide (DGO) as dye adsorbents for the degradation of methylene blue (MB) dye. Reduction in absorbance of MB solution in the presence of DGO is studied using optical spectroscopy. A threshold concentration of 0.125 ppm of DGO is found to be required for effective degradation of 1ppm MB solution in water.

Selection and peer-review under responsibility of Conference Committee of the 2nd International Conference on Emerging Materials: Characterization and Application (EMCA-2017).

Keywords: Graphene Oxide; methylene blue; dye degradation

1. Introduction

Water pollution is one of the major problems faced by mankind in 21st century. Industries including chemical, leather, plastic, textiles, food and cosmetics make an extensive use of dyes. These industries release residual dye solutions to rivers, canals etc, thus making water polluted [2]. Several techniques have been employed in past for obtaining potable water. Existing techniques of membrane filtration, photodegradation and charcoal filtration cannot be used for large scale applications due to ensuing cost constraints. Dye adsorption using suitable nanomaterials presents itself as a cost effective alternative if the involved nanomaterials can be synthesized in a cost effective fashion. Graphene Oxide (GO) is one such promising nanomaterial for dye degradation application. It's evident from the literature that activated carbon has promising dye degradation properties [4,5]. In this work we observe the dye degradation characteristics of dispersed graphene oxide (DGO) for methylene blue (MB) dye.

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2. Result and discussions

GO was synthesized using a method based on the work by Marcano *et al* [6]. In these experiments, GO was dispersed in ethanol and different amounts of resulting DGO by volume was added to the MB solution. The dose of DGO in ppm

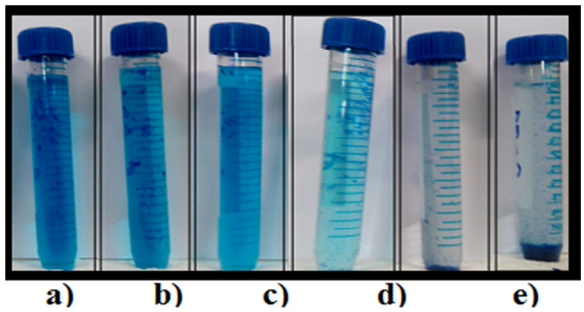


Fig 1. Optical image of GO in MB at different concentration a) 0.00125ppm, b) 0.00625ppm, c)0.0125ppm, d) 0.0625ppm, e) 0.125ppm, f) 0.3125ppm

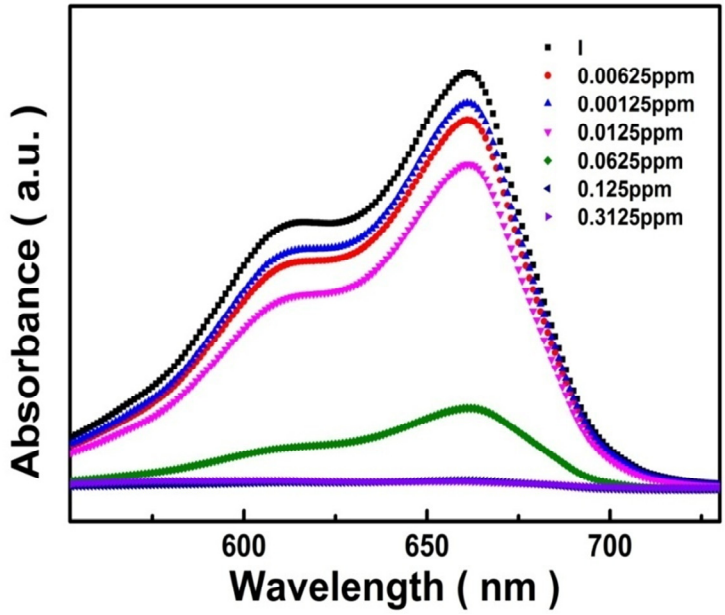


Fig 2. UV-Visible spectrum of GO in MB at different concentration.

required for the complete degradation of 1 ppm MB solution in water was estimated using UV-Visible spectroscopy. Figure 1 shows the optical images of vials containing 1 ppm MB dye solution with different dosage of DGO added. A clear change in color with increasing dosage of DGO demonstrates the gradually enhanced degree of degradation of MB. Figure 2 shows the corresponding absorbance spectra of the MB solution containing different dosages of DGO. Label I correspond to the absorbance of 1ppm MB solution without DGO. We found that 0.125ppm of GO in ethanol is sufficient for quenching of MB absorbance spectra at 609 and 661nm respectively. This signify that dye free water can be extracted at an optimum 0.125 ppm dosage of DGO. To know the equilibrium time for the adsorption process a time based adsorption progress was studied. It was found that the adsorption of MB attains an equilibrium state in 3 min.

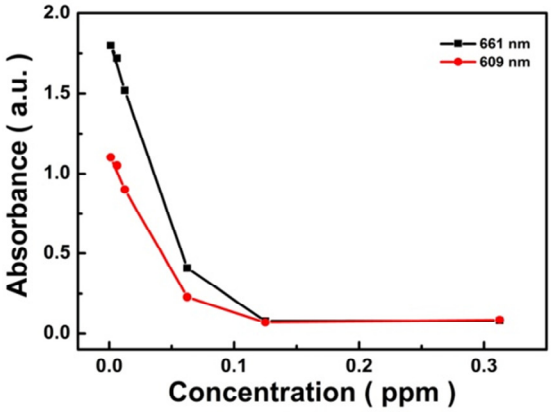
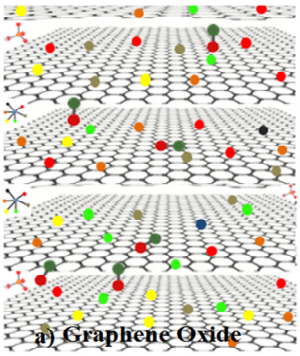
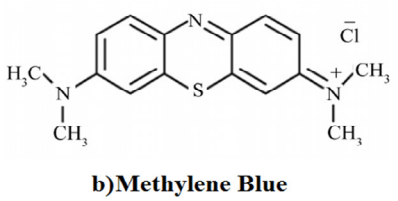


Fig 3. Change in absorbance of MB with different concentrations of DGO at characteristic wavelengths for MB.

Figure 3 shows the gradual change in absorbance with increasing concentration of DGO in 1ppm MB solution. Panels (a) and (b) of Fig. 4 shows the structure of GO and MB. Since methylene blue is a cationic dye and graphene oxide surface is highly electronegative due to presence of variety of functional group at its surface, MB will tend to attach at the surface of GO. Also GO has large surface area which makes it a more efficient material for MB adsorption.





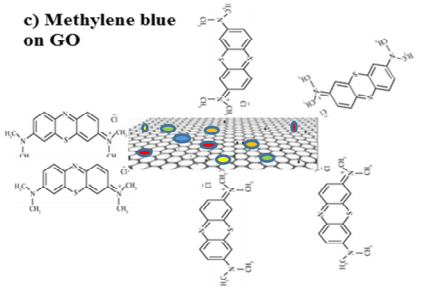


Fig 4. a) Schematic of GO sheets where colored dots represents various functional groups presents at its surface, b) Methylene blue molecular structure, c) Methylene blue on GO.

3. Conclusion

Dye adsorption property of GO for MB dye was observed and the critical DGO concentration for water purification was obtained.

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