Adsorption of emerging organic pollutants on graphene-based materials in the aqueous phase

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Abstract

In recent years, graphene and graphene oxide based materials have attracted considerable attention as adsorbents for water and wastewater purification, due to their outstanding adsorption properties [1-6]. More specifically, graphene and graphene oxide offer large surface area, significant pore volume, high conductivity, reach surface chemistry and low cost production [1-6]. In the case of graphene, the extended, delocalized, polyaromatic π-system plays an important role for the formation of π-π stacking interactions with aromatic rings of several organic pollutants in the aqueous phase [1-6]. On the other hand, graphene oxide has lower π-electron density, and more oxygen containing functional groups (such as carboxyl (-COOH), carbonyl (-C=O), epoxy (C-O-C-) and hydroxyl (-OH) functional groups) for the formation of hydrogen bonds and/or electrostatic interactions with dissolved organic pollutants in the aqueous phase [1-6]. Therefore, in the last few years graphene and graphene oxide have been successfully employed as novel adsorbent materials for the adsorption of inorganic pollutants, such as heavy metals and non metals such as fluoride, as well as for the adsorption of organic pollutants, including pharmaceutical compounds, from water and wastewater [1-6].

The aim of the present work was to study the adsorption of various emerging organic pollutants using graphite oxide and reduced graphene oxide as adsorbent materials in the aqueous phase. Graphite oxide was synthesized by the Hummers and Offeman oxidation method [7], while reduced graphite oxide was synthesized photochemically by the exposure of an aqueous suspension of graphene oxide to ultraviolet irradiation [8]. Graphite oxide and reduced graphite oxide were characterized in detail by various spectroscopic and microscopic techniques, such as XRD, FT-IR, Raman, XPS, and SEM. Moreover, the kinetics and the thermodynamics of the adsorption process of various pharmaceutical compounds, including antibiotics, onto graphite oxide and reduced graphene oxide in aqueous solutions was studied. Several experimental conditions were investigated, such as the contact time, the concentration of the organic pollutants, the temperature, the pH of the solution, and the effect of water matrix. Our results show that graphite oxide and reduced graphite oxide are very promising adsorbent materials for the decontamination of emerging organic pollutants from the aqueous phase.

References

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