Preparation of sustainable graphenes from coke-like wastes with applications in elimination of emergent contaminants in wastewater

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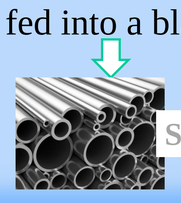
Introduction

Graphene materials exhibit unique properties such as thermal stability, and have with potential application in different areas, as **elimination of Emerging contaminants (ECs) in water** (low levels of removal in conventional wastewater treatment processes, as diclofenac). Graphenes are usually produced from a natural graphite. It will be desirable to produce graphenes directly form residues, as a **carbonaceous waste** usually formed at the inner top section of the **coking oven for the steel industry**. This material must be scraped after several cycles of the oven usage and is outdoor stored causing contamination in surroundings. It is an objective of this work to develop a graphene preparation process which avoids the typical graphitization step (thermal treatment at 2500-3000ºC) at which these coke-like material are usually subjected as a initial step (graphite formation). **The obtained graphenes will be exhaustively characterized and** the results compared with those obtained with a graphene prepared from commercial graphite under the same experimental conditions. Finally, **all GOs will be used to eliminate diclofenac in wastewaters**, in a concentration similar to that reported to be a problem to the Wastewater Treatment Plants

Steel Industry

Coke, fed into a blast furnace



Steel

Oven Scrapping

Industrial wastes
-Low termperature
-High temperature

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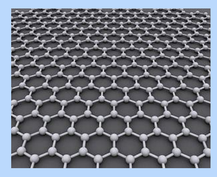


graphene

Objectives

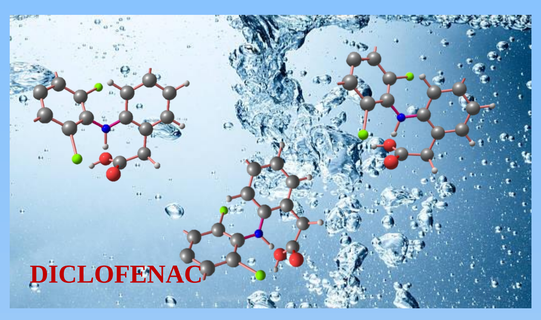
- **To study the preparation of grahene materials using, as raw materials, industrial wastes obtained scratching conventional coking ovens for the steel industry**
- **To optimize the processing and to determine the structural differences between the graphenes obtained from the different industrial wastes**
- **To evaluate the capacity of the graphenes prepared to be used in the elimination of diclofenac (EC) in wastewater**

Experimental Method

Industrial wastes
-High temperature (GW)
-Low termperature (CW)

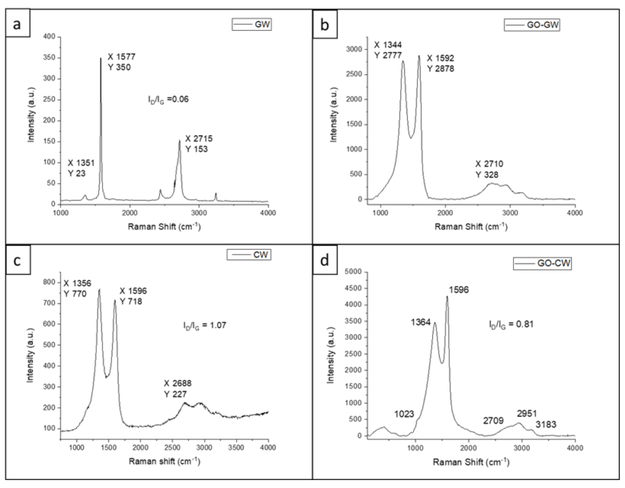
GRAPHENE MATERIALS?

Hummers' Method



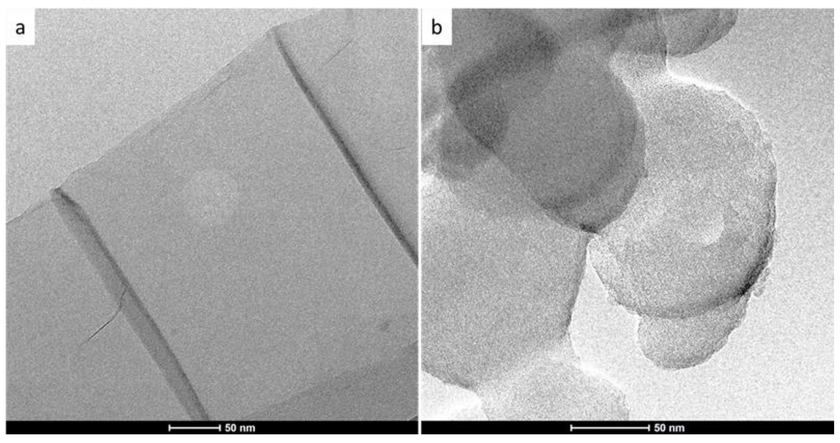
Results & Discussion

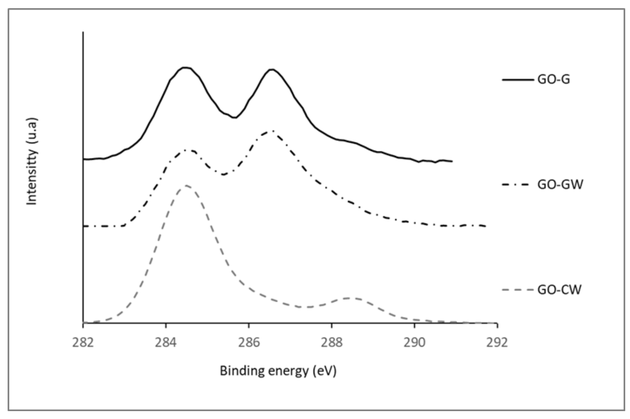
Waste-based graphene characterization



ID/IG intensity ratio of 1 for CW and almost 0 for GW, this in accordance with the most graphitic structure of this later. ID/IG ratio of the GOs are both in the range 0.8-0.9 for GO-CW is even lower than that of raw sample CW.

GO-GW exhibit the appearance of a single layer of high size, similar to the standard GO-G . However, GO-CW is of much lower lateral size and mainly in the form of few layers





GO-G and GO-GW show the typical bimodal distribution of graphene oxides, with maxima at 284.5 eV (C-C bonds) and od 286.7 eV (C-O bonds). GO-CW shows much lower intensity in all the range above 286 eV, confirming the presence of a much less oxidized structure.

Waste-based graphenes in water purification

The prepared graphenes do not have the same capacity for adsorption of the contaminant (100 μM).
The most effective for removing DFC is G-waste-GO. However, the results indicated that waste-H, despite not having undergone the graphitization step, is also better as an adsorbent than ref-GO.
On the other hand, the study of two concentrations of GO in the adsorption experiments indicated that for all graphenes, a higher concentration is more effective in eliminating the contaminant.

	[GO] (ppm)	% DFC sorbed
G-waste-GO	80	92.0
	40	52.4
waste-GO	80	75.5
	40	26.6
ref-GO	80	63.6
	40	12.0

Conclusions

*Industrial coke-like wastes can be effectively used to prepare graphene materials. The utilization of a low temperature waste conditions affects the morphology of the graphene materials obtained from them.
*The coke-waste graphenes prepared can be used very effectively for the removal of DCF in water. This represents an important application for the revalorization of the residual material.

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