Assessing improved methods for the removal of polar organic contaminants from water

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Maintaining water quality is essential for societal development. As a consequence of industrial development, water resources are prone to contamination: industrial and agricultural activities cause the release of tonnes of organic (and other) pollutants to the environment, which is either naturally fixed onto soils, removed by plants, separated in wastewater treatment plants or degraded, but part of it still persists in water. The increase of contaminant discharge or deliberate release into water supplies may lead to catastrophic consequences. Improved water treatment and purification technologies may however reduce the impact and threat from waterborne contaminants to human health.

It is well known that carbon is an effective adsorbent for many organic contaminants. However the structure of the material affects its adsorptive capacity and the high degree of hydrophobicity of carbon also hinders its interaction with polar contaminants. This is one limiting factor causing the low efficiency removal of highly polar organic contaminants in sewage effluents. The present research has investigated novel carbons with different degrees of oxidation for the removal of polar organic contaminants in water; from highly ordered sp^2 carbons sheets of oxidised graphite (single- multilayer graphene and nanotubes) to three dimensional carbon structures where the porosity also plays a major role in the adsorption of contaminants. In aqueous media, pH[1], ionic strength and competing species have also been shown to influence the adsorption of contaminants. A range of carbons have been tested to remove emerging contaminants from water, focusing on trace organic contaminants such as estradiol, atrazine or bisphenol A for which current wastewater treatment technologies show low efficiency. In general, adsorption capacity increased according to the following trend: single layer graphene sheets < multilayer graphene sheets < 3D carbonaceous structures. These results are the consequence of an increase in surface area and the presence of nano-sized pores. High adsorptive capacities were found for nanoporous carbons, for example when a nanoporouscarbon (7.6 Å) with a surface area of 1939 m^2/g was shown to remove 641 mg atrazine/g C whereas granulated carbon used in conventional waste water treatment plants, with surface area of 552 m^2/g, only removes 52 mg atrazine/g C. Although new "designer" carbons initially involve higher costs (i.e. infrastructure), their increased adsorptive performance requires less adsorbent material, leading to a lower waste footprint, plus have been demonstrated to be regenerated through a facile steam process without loss of adsorptivity, which increases their lifetime of operation.

References

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