

Graphene for Water Treatment

If you find yourself in Manchester, UK, the Museum of Science and Industry is well worth a visit. It has a whole gallery devoted to graphene. In that gallery you'll see exhibits from the continuing story of graphene. One of these is a simple filter. It looks like a fairly ordinary piece of filter paper, but is worth closer inspection, read on...

It starts with a filter

These ordinary looking small white filter samples are coated in graphene oxide.



Image courtesy of G20 Water Technologies Ltd

The coated filters can separate salt and oil from water and were made by a start up company called G20 Water Technologies Ltd. founded by the equally remarkable Tim Harper, a serial high tech entrepreneur.

So, why did these filters attract my attention? Well, this product is an exercise in pragmatism. The filter membrane samples you can see in the image are a set of perfectly ordinary polyamide filters, except for the fact that they are coated in graphene oxide. They look slightly different, the colour difference is due to the degree of oxidation of the graphene coating. Graphene is black and the more it is oxidised the lighter and more yellow the material becomes.

G20 has a granted patent "Ultrathin, molecular-sieving graphene oxide membranes for separations along with their methods of formation and use" Because the coating method is straightforward this means they also have a scalable manufacturing process. This coating enhances its properties in a number of ways. Let's look at treating water contaminated

with oil.

Taking oil from troubled waters

Everyone knows that oil and water don't mix. Well that is not quite true. Get the oil droplets small enough and they form something called an emulsion and this is surprisingly hard to separate. A familiar example is milk, which is an emulsion of fatty droplets in water.

The standard polyamide filters have a good initial performance for separating oil and water emulsions but this declines with time because the filter becomes blocked at the surface. This is called fouling and this paper describes the problem.

What G20 have discovered is that coating the surface of the filter with graphene oxide reduces this fouling problem making the filter perform better for longer. The graphene oxide coating allows water to pass through but prevents the oil. As further oil droplets accumulate on the filter they normally block it. The graphene oxide coating makes the oil droplets coalesce forming bigger drops, which float away from the filter and rise to the surface of the water. This makes the oil easier to remove and also improves the performance of the filter.

The market

Oil in water emulsions are a problem for industry. Everything from the obvious oil and gas industry to food processing and car washes have to deal with the problem of separating oil from water. The global market segment is called industrial water treatment and is worth \$146.81 Billion in 2016 with a growth rate of 5.4% in 2016. Within this is a sub market segment of industrial water and wastewater treatment that is estimated to be worth \$26.77 Billion with a growth rate of 5.8%.

More than oil in water

G20 have found that graphene oxide coatings can improve the performance of a wide range of other membranes used in the water treatment sector. They can prove a four-fold increase in the membrane operation times of Polyether Sulphone (PES) membranes that are used in bioreactors for wastewater treatment.

All this work would be impressive enough, but the company has also found that their graphene oxide coating can improve the performance of desalination membranes. The graphene oxide coating improves the permeability of pure water through the membrane while increasing salt rejection.

Why this is important

What this all means is that G20 has developed a scalable method for coating graphene oxide on to standard filter media. The coating improves the performance of water treatment filters. This enhances the performance of the filter and potentially reduces the costs of operation too. Waste water treatment is a large global market, measured in the \$Billions, with a growth rate over 5%. We'll continue our watch on graphene activity in this sector in general and G20 in particular.