European Commission

Science for Environment Policy

New nanomaterials could purify water contaminated with heavy metals

Researchers have analysed the ability of two organic nanomaterials to remove the heavy metal chromium from water. In the laboratory, the nanomaterials successfully took up around 95% of the chromium. Further work is needed to confirm the feasibility of using these nanomaterials to purify water in real-world conditions.

Reliable access to clean water is vital for public health and economic growth. However clean water supplies are under threat from urbanisation, industry and agricultural development. Although there is a very high compliance rate for EU drinking water (99.98 %)[1], meaning there are few problems for EU consumers, the researchers say that over 26 million people may be dying globally from unsafe water due to the presence of toxic heavy metals such as lead, nickel, cadmium and arsenic, and organic chemicals such as dyes and surfactants. Chromium is a heavy metal used in industrial processes, such as leather tanning and textile dying. The EU Drinking Water Directive[2] specifies a maximum of 0.05 milligram/litre (mg/L) of chromium in drinking water.

Advances in nanotechnology have introduced a potential method to purify water cost-effectively. Nanosorbents — nanoscale particles able to absorb substances — have been used successfully to remediate water contaminated with chromium. However, inorganic nanosorbents can also be toxic to humans and the environment if they enter into waterways or the food chain. Nanocellulose is a nanosorbent with structural properties that makes it highly suitable to remediate chromium. Nanocellulose is produced by bacteria, or derived from plants, it is therefore more environmentally friendly and potentially cheaper to produce than synthetic nanomaterials.

This study examined the ability of two functionalized[3] nanocellulose materials — paraben-modified nanocellulose (PNC) and (2,3-epoxypropyl) trimethylammonium chloride-modified nanocellulose (EPTMAC-NC) — to remove chromium from streams. The researchers assessed the functionality of PNC and EPTMAC-NC to remove chromium, including the mechanism for absorbing the heavy metal. PNC and EPTMAC were synthesised within the laboratory. Experiments were then carried out on two common forms of chromium (*trivalent* — essential for humans in trace amounts; and *hexavalent* — a much more toxic, and carcinogenic, form of chromium) to quantify the sorption of chromium by the nanocellulose (sorption refers to both the absorption and adsorption — the physical adherence of molecules to a surface — of a substance).

The nanosorbents were assessed at different concentrations (0.1 to 1 g in a sample of 500 millilitres (ml)) at a constant concentration of chromium (25 mg/L). The process was also repeated several times to ensure replicability and the surface area and particle size of the nanosorbents was assessed following the process, as this indicates how much of the chromium was absorbed by the nanocellulose. Microscope images in 2D and 3D were also taken to show changes to the nanocellulose following sorption.

Continued on next page.

14 September 2017
Issue 495

Subscribe to free weekly News Alert

Source: Jain, P., Varshney, S. & Srivastava, S. (2016). Functionalized nanobiomaterials: high-performance sorbents for chromium remediation from water streams. *International Journal of Environmental Science and Technology*. 12: 2893-2904. DOI:10.1007/s13762-016-1115-z.

Contact: dei.shalinisrivastava@gmail.com

Read more about: Biotechnology, Chemicals, Environment and Health, Waste, Water

To cite this article/service: "Science for Environment Policy": European Commission DG Environment News Alert Service, edited by SCU, The University of the West of England, Bristol.

1. Synthesis Report on the Quality of Drinking Water in the Union: COM (2016) 666

2. http://ec.europa.eu/environment/water/water-drink/legislation_en.html

European Commission

Science for Environment Policy

New nanomaterials could purify water contaminated with heavy metals *(continued)*

14 September 2017
Issue 495

[Subscribe](#) to free weekly News Alert

Source: Jain, P., Varshney, S. & Srivastava, S. (2016). Functionalized nanobiomaterials: high-performance sorbents for chromium remediation from water streams. *International Journal of Environmental Science and Technology*. 12: 2893-2904. DOI:10.1007/s13762-016-1115-z.

Contact: dei.shalinisrivastava@gmail.com

Read more about: Biotechnology, Chemicals, Environment and Health, Waste, Water

Chromium was shown to efficiently adhere to and be absorbed by PNC and EPTMAC-NC, with chromium absorbed by around 95% for both materials within 40 minutes. The surface area of the two nanocellulose materials was estimated as 110.76 m^2/g for PNC and 121.08 m^2/g for EPTMAC-NC. After chromium remediation, the surface area of PNC and EPTMAC-NC had decreased to 94.25 and 101.48 m^2/g, respectively, due to the sorption of chromium ions. The imagery used to examine the nanocellulose also clearly showed substantial impregnation of the material's surface with chromium.

The researchers say that PNC and EPTMAC-NC had superior sorption abilities compared to other nanomaterials previously studied. This is likely due to the high surface area of PNC and EPTMAC-NC. This is one of the first studies to assess the use of these nanocellulose materials for remediation of water polluted with chromium. The study also found that the two nanocellulose materials were more reusable than previously studied nanomaterials because of their greater stability.

Although at an early stage of development, these results indicate that the materials studied have high potential for the remediation of water supplies polluted by chromium. Further field-based and economic analysis will be required in order to understand their effectiveness in real conditions.

3. Nanocellulose is not highly suitable for remediation of anionic metals. Therefore a functionalization approach was needed within the study. **Functionalization** is when new functions, features, capabilities, or properties are added to a material by changing its surface chemistry.