CageCapture: Removing Toxic Pollutants from the Air Using Nano-cage Technology

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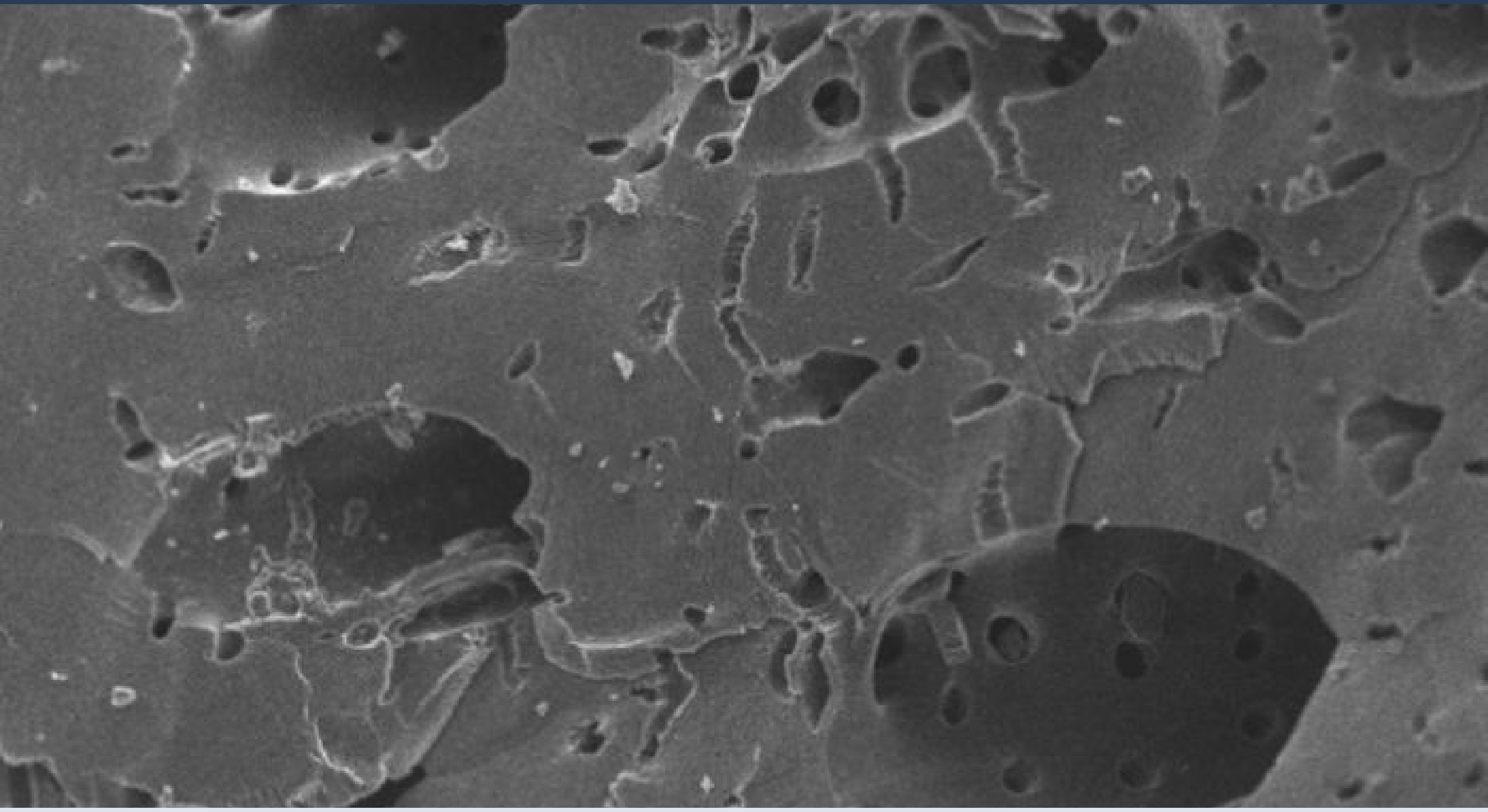

Header image: Activated carbon loaded with cage (Source: University)

IP Status

Patent application submitted

Seeking

Development partner, Commercial partner

About **University of Liverpool**

By facilitating access to our expertise, facilities and networks, the University of Liverpool offers the means to transform ideas into creative solutions, improved performance, new technologies, strategies, applications, products or skills.

Background

Indoor air pollution causes an estimated 3.8 million deaths worldwide per year, according to the World Health Organisation. Formaldehyde, for example, is the most common pollutant in indoor air, and can be emitted from walls, floors, furniture, fabrics and cigarette smoke. Formaldehyde causes various health problems, and has been classified as a Group 1 human carcinogen by WHO. The current approach to capturing indoor air pollutants is usually activated carbon adsorption, but this has low capture capacity and poor selectivity. With awareness of the risks to health from indoor pollutants, and regulations tightening, the need for effective technology is growing.

Tech Overview

Researchers at the University of Liverpool have developed a molecular 'cage' to tackle this important challenge. Cage molecules have been designed and synthesized that efficiently capture low concentration pollutants by a combination of chemical and physical adsorption.

The effectiveness of the material in removing formaldehyde from the air has been demonstrated in third-party testing. In these tests the material reduced formaldehyde levels well below the levels achieved by currently available technologies, even in humid environments.

Based on this technology, it is possible to design and develop new materials for other specific pollutants, and the researchers have demonstrated this in the creating of a cage material for capturing radon - a radioactive gas that increases the risk of lung cancer. The potential therefore exists to expand this technology to capture other toxic indoor pollutants. This presents a huge opportunity to make a real environmental, health and commercial impact.

In order to demonstrate its potential as air filtration material, the researchers have made a prototype air purifier fitted with "cage loaded" air filters. They have also fabricated several cage loaded air filters which are ready to be sent for testing by their industrial partner.

Next steps are to look at the cost of goods and scale-up of manufacture. Synthesis of the material has been scaled up to kilogram levels, and the researchers are in discussions with several parties who have the facilities and ability to scale-up and potentially to supply the material in larger quantities.

Benefits

In comparison to the activated carbon material, which is widely used for domestic formaldehyde capture, these materials have the following advantages:

- Capacity - The overall formaldehyde capture capacity of the material is about 500 times more than that of activated carbon, the most common material used for formaldehyde removal indoors.

- Selectivity - The formaldehyde adsorption capability of activated carbon decreases dramatically under humid conditions, due to poor formaldehyde/H_2O selectivity, whereas this material will actually preferentially adsorb formaldehydes in humid conditions via reactions with functional groups.
- Stability - Physical adsorption can be reversible: activated carbon can release adsorbed pollutants at high temperatures and/or high humidity causing secondary pollution. In contrast, after the chemical absorption of formaldehyde molecules, the cage is robust, and will not generate the absorbed formaldehyde by decomposition until temperatures reach 300 °C. This makes it ideal for use in hot, humid climates that are typical of many equatorial urban environments.
- Compatibility - The cage material is solution processable and can be incorporated into pre-existing filter technologies to give a unique added benefit.

Applications

The most common method to reduce indoor air pollution is through the use of air filtration or purification devices. The increasing awareness of their health benefits coupled with tighter indoor air pollution regulations is fuelling growth in this area. It is estimated that the global indoor air filtration market will reach $19 billion by 2020 and the global automotive air filtration market will reach $6.1 billion by 2020.

In addition, the material has significant potential in the paints/coatings market, which was valued at $141.58 billion in 2015 and is projected to reach $ 190.51 billion by 2021. By adding the cage material, the resulting paints/coatings can help abate the emission of formaldehyde from building materials and other sources of formaldehyde. Traditional adsorbents such as activated carbon or zeolites are generally insoluble in liquids and cannot readily be added as a formaldehyde scavenger into paints/coatings formulations. By contrast, the cage material can be easily incorporated into paints/coatings as a result of its solubility.

Based on this technology, it is possible to design and develop new materials for other specific pollutant scavenging – expanding its capability to capture other toxic VOC's such as benzene. This represents a huge opportunity for a new material to make a real environmental, health and commercial impact.

Patents

- The intellectual property associated with this technology is protected under a patent application (WO2016174468 A1), and the IP is owned by the University of Liverpool, with no encumbrances.