Novel Sulfur-Polymers for Heavy-Metal Capture

Production of highly porous sulphur doped carbons using cheap ‘waste’ sulphur and cheap unsaturated monomers

Reference: Sulfur-Polymers

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

Heavy metal contamination exists in the waste streams of many industries, such as chemical manufacturing, mining operations, waste incineration, and fossil fuel fired power stations. The emitted heavy metals are extremely harmful environmental pollutants as they are widely distributed in the air, water and soil. Mercury is of particular concern for human health because of its relative solubility in water and tendency to bioaccumulate and cause severe toxic effects.

Traditionally, the mining industry follows many environmentally harmful practices for metal extraction, which are energy intensive and use lots of chemicals. Despite such processes a significant amount of metal is left behind in ores. The availability of higher grades of ores has declined and traditional methods may no longer be sufficient for extraction of metals. There is a dire need for alternative methods. There is a need for alternate approaches to the extraction valuable metals such as gold, copper.

Elemental sulfur is readily available and inexpensive, being produced in excess of 70 million tonnes each year as an unwanted by-product of petroleum refining and gas reserves. Sulfur has been utilized most widely for the production of commodity chemicals, such as sulphuric acid, fertilizers, and synthetic rubber via conventional vulcanization. Despite this, supply greatly outweighs demand, creating large unwanted stockpiles and a global issue in the petrochemical industry known as the "excess sulfur problem".

Tech Overview

Researchers at the University of Liverpool have developed a novel sulfur-polymer through "inverse vulcanisation" with the ability to capture heavy metals such as mercury and gold (Figure 1).

The researchers have developed the first catalysis of inverse vulcanization reactions. This catalytic method reduces the required reaction temperature and reaction time, prevents harmful $\text{H}_2\text{S}$ production, increases yield, improves properties, and allows the use crosslinkers that would otherwise be unreactive. Thus, inverse vulcanization becomes more widely applicable, efficient, eco-friendly and productive than the previous routes, not only broadening the fundamental chemistry itself, but also opening the door for the industrialization and broad application of these fascinating new materials.

Benefits

This patented process produces highly porous sulphur doped carbons (MPSC) using cheap 'waste' sulphur and cheap unsaturated monomers. Key features of the invention include:

- Unique readily scalable process based on cheap components
- Process comprises a solvent free (melt) polymerisation step followed by high temperature carbonisation step
- A high available sulphur content (>10% by weight) coupled with a very high surface area (>2200m$^2$/g)
- High and fast adsorption capacity for mercury and gold removal from aqueous solution versus activated carbon.
- High capacity for CO2 adsorption (>10mmol/g) vs commercial carbonised polyacrylonitrile and mesoporous silica.
- High adsorption capacity for hydrogen vs commercial activated carbon.

Sulfur is an industrial by-product, removed as an impurity in oil-refining. This has led to vast unwanted stockpiles of sulfur, as supply greatly outweighs demand, and resulted in low bulk prices. Sulfur is therefore a promising alternative feedstock to carbon for polymeric materials.

**Patents**

- University of Liverpool have 2 UK filings covering the material, method of production and its use in the extraction of metals.