Docket #: S24-356

Production of Carbon Material from Low Concentration CO2 via Microbial CO2 Reduction and Pyrolysis

Stanford researchers have developed a novel pathway to upcycle waste CO_2 into graphitic carbon nanomaterials. Addressing the urgent challenge of rising atmospheric CO_2 levels, this process transforms dilute CO_2 streams, such as air or flue gases, into an industrially valuable product. Carbon nanomaterials do not readily decompose and can therefore act as semi-permanent carbon storage depending on end-use.

The pathway uniquely integrates biological and thermochemical transformations. It pioneers the use of microbes for CO_2 conversion directly from CO_2 captured in alkaline solution. Powered by H_2, biotrickling filters with alkaliphilic hydrogenotrophic methanogenic archaea and hydrogen-oxidizing bacteria convert CO_2 to methane. The produced methane is then pyrolyzed to form carbon. Compared to alternative CO_2 capture and use pathways, this pathway avoids intermediate product separations and produces high quality carbon from dilute CO_2 feedstocks.

This technology is an appealing solution to convert and store waste CO_2 as valuable carbon nanomaterials, a material in high demand for use in electronics, batteries, and building materials.

See Related Technologies:

[A semi-continuous process for co-production of CO2-free hydrogen and carbon nanotubes via methane pyrolysis]
[Microbial-driven atmospheric CO2 conversion for large-scale carbon sequestration]

Stage of Development: Proof of concept

Applications

- Upcycling waste CO_2
- Sustainability and environmental goals
- Fossil-free, independent carbon material sourcing

Advantages

- Works with a supply of low concentration CO_2
- Produces high-value carbon, such as multiwalled carbon nanotubes (MWCNTs)

Publications

- Grace Callander, Jörg S. Deutzmann, Alfred M. Spormann (2024), Alkaline hydrogenotrophic Methanogenesis in Methanococcus vannielii at low carbon dioxide concentrations, Journal of CO2 Utilization 83, 102788

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