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Charged materials for CO2 capture

Available Technologies

Charged sorbent materials

Such as a hydroxide-functionalised activated carboncloth, rapidly absorb CO2 from ambient air and can be regenerated via resistive heating at <100°C.

Current technologies for CO2 capture are based upon organic amines or inorganic hydroxides, but neither is ideal.

For example, amines are prone to degradation when regenerated, and are therefore expensive to use. Metal hydroxides are more stable but their regeneration from metal (bi)carbonates typically requires very high temperatures.

Charged sorbents combine the stability of hydroxides with a very significant advantage – they can be electrochemically regenerated at much lower temperatures (below 100°C) than either amines or hydroxides.

Technology overview

Some of the most promising materials for removing CO2 are metal hydroxide scrubbers and both aqueous potassium hydroxide and solid calcium hydroxide have been used commercially. However, regeneration (conversion of a metal carbonate back to the hydroxide) requires heating to c. 900°C in both cases.

In this approach from the University of Cambridge, hydroxy-functionalised porous materials are synthesised from carbon electrodes; applying a positive potential when soaked in KOH solutions results in OH- anions impregnating the

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anode material and this can then be removed from the electrolytic cell and used to absorb CO2 and convert it into carbonates.

The charged sorbent effectively removes CO2 from ambient atmospheres with capture rates measured at c. 7 x faster than amine-based sorbents.

The electrically conductive nature of the porous matrix then allows CO2 to be displaced via resistive Joule heating, with desorption occurring at ≤100°C, a temperature well below the degradation temperature of activated carbon, and far below that required to regenerate metal hydroxides.

Benefits

- Rapid removal of CO2 from air under ambient conditions.
- Low temperature and low-cost activation and regeneration of the CO2
- High stability of charged sorbents under operating and regenerating conditions.
- The ability to regenerate using renewable electricity.

Applications

This technology has potential to compete effectively with metal hydroxides and organic amines in both Direct Air Capture (DAC) and large point source capture. The technology could therefore be of interest to companies already working in carbon capture and to those industries which emit large volumes of CO2.

Opportunity

We are seeking industrial experts and partners to advise, to help prototype and pilot the technology and / or to commercialise the technology under license.

Inventors

Dr Alex Forse and fellow co-workers from the Yusuf Hamied Department of Chemistry.