Starbons Ltd, originally a spin out from the University of York, became an independent company in December 2017 when IP was transferred to the company from the University.

Starbon® materials ("Starbons") form the basis of a platform technology with broad and substantial potential. There are over 50 peer reviewed papers on the use of Starbons in a diverse number of applications mostly centred around separation or capture of substances.

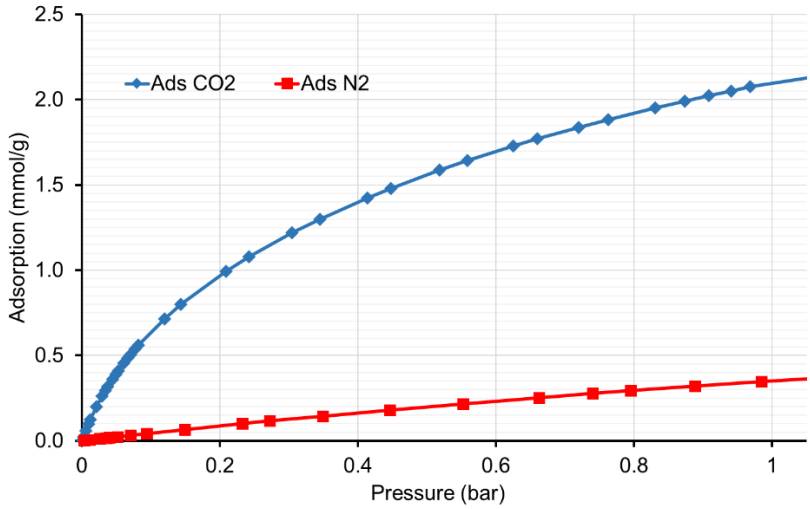
A video to introduce this novel technology can be found on the Home page of the company's website: www.starbons.com

## *Starbon® materials for carbon capture*

Starbon® patented technology enables low energy carbon capture using a material derived from sustainably sourced materials (biomass). How is this achieved?

- Carbon dioxide is captured and released through pressure rather than temperature swing which is less energy intensive.
- Carbon dioxide is captured through physisorption rather than the industry standard solvent based chemisorption.

Starbon® materials have been found to physisorb up to 50% more carbon dioxide (and to show 3–4 times better selectivity for carbon dioxide over nitrogen) than microporous activated carbon. The adsorption and desorption of carbon dioxide is rapid (around 30 seconds) and the selectivity for carbon dioxide versus nitrogen is 30:1. Furthermore, this performance is enhanced by new developments in Starbon® technology.




***Industrial performance of Starbon® A800 adsorbing $CO_2$ at 25 °C***

## *Next generation activated Starbon® material*

The carbon capture performance of Starbon® can be further improved via activation. The activation process introduces large amounts of microporosity into the materials whilst retaining their mesopores, to give 'Generation 2.0' Starbon® materials which are capable of adsorbing twice as much carbon dioxide (up to 130 g / Kg at 1 bar and 35 $^{o}$C) as the unactivated Generation 1.0 precursors. They also adsorb and desorb carbon dioxide very rapidly (less than 1 minute for both complete saturation and release) and do so with a selectivity of >50:1 for carbon dioxide versus nitrogen.

## *Comparison with other technologies*

The most developed alternative methodology for carbon capture uses aqueous solutions of amines to capture carbon dioxide by chemisorption at low temperature and then release it at higher temperature in a temperature swing system. However, this is a highly energy intensive process and additional problems can be caused by the corrosive nature of aqueous solutions of amines and the tendency of the aqueous amines to decompose to highly toxic nitrosamines under the carbon capture reaction conditions. The use of solids to physisorb carbon dioxide is an intrinsically much more energy efficient process as the binding of carbon dioxide to the adsorbent is much weaker than in chemisorption, so less energy is required to subsequently release the carbon dioxide. Many solid adsorbents have been investigated including: zeolites, mesoporous silicas, MOFs, COFs, metal oxide frameworks and carbon based materials. Carbon based materials (including Starbon®) have advantages including low cost of material and rapid kinetics. Starbon® technology in particular allows sustainable carbon based adsorbents to be prepared on a large scale from waste biomass.

## *What next?*

Starbons Ltd is committed to sustainable, bio-derived and reusable technical solutions for its customers. The business has been engaging in raw material sourcing plus manufacturing process scale up and optimisation studies.

The company's objectives are to source all key raw materials locally (ideally from the UK) and to increase existing production capacity to realise economies of scale.

Material is currently produced at a pilot plant housed at the Biorenewables Development Centre near York, UK. Here Starbon® materials are currently produced at a multi 10-100's kgs/year scale. Options are being evaluated to scale up to multi 1000's kgs/year (or greater). The intention is to utilise the assets and expertise of contract manufacturers wherever possible; an asset light model which benefits the existing manufacturing sector and minimises CAPEX requirements.

To that end the company is seeking collaborators for prototype testing and investment.

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