Bio-based Mesoporous Materials (B2M2)
BIO-BASED MESOPOROUS MATERIALS (B2M2)

Conversion of bio-waste to high value materials applicable for green technologies.

The Green Chemistry Centre of Excellence (GCCE) has been involved for a number of years in research on the conversion of waste biomass to mesoporous materials. This green approach has provided new technologies for bio-waste utilisation and developing future biorefinery systems.

Mesoporous materials, due to their unique large pore diameter network, have outstanding potential in a wide range of technologically important applications that is critically dependent on the mass transport of chemicals to the carbon surface. In our research we utilise the organisation of natural materials at the nanometre level in biological systems to produce mesoporous materials. It has been shown that this could help to generate systems with the same efficiency and selectivity demonstrated by nature.

STARBONS® TECHNOLOGY

Starbon® technology utilises the natural ability for polysaccharides to retain their organised structure during pyrolysis.\textsuperscript{1,3} Starbons® are a novel family of carbonaceous mesoporous materials derived from polysaccharides that consist of continuum of materials obtained at different temperatures.\textsuperscript{4,5} Depending on the Starbons® preparation temperature the surface functionalities ranging from hydrophilic (low temperature prepared materials) to hydrophobic (high temperature prepared materials).\textsuperscript{5,6}

The technology is:

- **Green**: process avoids the use of harmful chemicals
- **Sustainable**: polysaccharides (starch, alginic acid, pectin, hemicellulose) are renewable resources that are widely available in many countries
- **Simple**: methodology comprises just three stages: gelatinisation, dehydration and controlled pyrolysis
- **Environmentally benign**: non-persistent, non-bioaccumulative and non-toxic
STARBONS® APPLICATIONS

Starbons® have tuneable surface functionality and as such are highly desirable for many applications especially where diffusion of the species within the pore network is essential. The three main areas of Starbons® application are: adsorption, chromatography and catalysis.

Adsorption

Low cost, naturally-derived Starbons® have a great potential for use in both developed and developing countries for specific adsorption of target molecules from gas mixtures (pollution control) and aqueous solutions (water purification). It has been shown recently that the Starbons® interconnected micropores and mesopores network is responsible for the enhanced CO₂ adsorption. Compared to Norit activated charcoal, Starbons® have much lower microporosities (8–32% versus 73%) yet adsorb up to 65% more CO₂. The unique combination of Starbon® porous structure and functionality is also responsible for successfully separated critical metals (Au³⁺, Pt²⁺ and Pd²⁺) from an aqueous mixture of metals.

Chromatography

Starbon® materials derived from alginic acid are particularly attractive chromatographic stationary phase materials, as they present minimal micropore content; this avoids reduction in separation efficiency as a consequence of irreversible high energy analyte adsorption in sub 2 nm pores. We have found that these stationary phases are particularly efficient at separating the sugars glucose (mono-), sucrose (di-) and raffinose (trisaccharide).

Catalysis - Esterification in Water

Starbon® is an excellent support for heterogeneous catalysis where its unique and tuneable surface characteristics are appropriate for many reactions including unexpected esterification reactions conducted in aqueous media. This is particularly important in biomass fermentation reactions, which produce a range of organic acids that can be used as platform molecules in applications such as the production of polymers and higher value intermediates.

Bio-Based Mesoporous Silicas

Biomass has become one of the most commonly used renewable sources of energy in the last two decades. Researchers from the GCCE, EPR Ely Limited and PQ Silicas UK Limited, have developed an efficient way of converting waste ash from a commercial biomass combustion facility into mesoporous structured silica using a biorefinery approach. This has potential high value applications in catalysis, adsorption and separation processes. The improved method of extracting the alkali silicates involves forming alkali silicate solutions, which are then converted into the porous silica, MCM-41, a useful catalyst and molecular sieve.
Starbon® Publications List


Starbon® Patents

1. US 8790548 B2, Carbonaceous materials
2. US 9457338 B2, Polysaccharide derived materials
3. WO 2016042321 A1, Mesoporous materials from nanoparticle enhanced polysaccharides