It is generally assumed that materials with small pores such as zeolites are best suited for the adsorption of small molecules. This would include CO$_2$ (important for “carbon capture and storage”) and small organic (usually volatile) molecules (important for odour control as well as for trapping valuable compounds). Despite this “state-of-the-art” we have discovered that some small molecules can be very well adsorbed into larger pore materials notably those known as “Starbons®”. This offers some very important advantages notably the ability to make Starbons® from renewable waste materials, the tunability of Starbons® opening the door to selective adsorption, and the ability to desorb from as well as adsorb into porous materials.

Starbons® are a patented class of bio-based mesoporous materials derived from uniquely modified polysaccharides (including waste starches as well as other natural products such as alginites from seaweed, and pectins from citrus waste) and are capable of being tuned to specific applications. The Starbon® range resolves a spectrum of technical challenges by combining high mesoporosity (up to 2.0 cm$^3$ g$^{-1}$) and high surface area (up to 500 m$^2$ g$^{-1}$). It comes in a range of physical forms, with tuneable properties from hydrophilic to hydrophobic and has the ability to adsorb and desorb rapidly.

In this PhD project we will study the use Starbons® to adsorb and desorb small molecules. The list of molecules of interest includes CO$_2$, NO$_x$, NH$_3$, amines, aldehydes, and small sulphides which are targets due to environmental concerns and/or the need to recover valuable molecules from waste streams (e.g from drying fruit). We are particularly interested in understanding the molecular level interactions between the Starbons® and the small molecules so that we can tune the surfaces and pore structures of the materials better to maximize adsorption and desorption. The student will gain experience in green chemistry and materials science and including natural products, and will have the opportunity to use a wide range of modern techniques for characterising porous solids. The project will also involve working in a team with strong interactions with industry.