Experimental high-throughput screening of liquid and solid sorbents for gas uptake and separation

The major challenges facing the world today include the need for the need for renewable sources of energy and the reduction of greenhouse gas (GHG) emissions, which contribute to global warming. Research efforts have complied with this need, and we have seen a large increase of popularity of gas-related research, e.g., hydrogen and carbon dioxide capture and storage, in the last 10 years.

One of the bottlenecks in the exploration of new sorbent materials for application in gas capture and separation is that phase equilibrium and gas uptake measurements are often difficult and expensive, requiring the use of specialised equipment. The difficulties increase further for multicomponent systems that require disturbing the system by sampling.

In this work we studied the potential of using a modified headspace gas chromatography (HSGC) method for the experimental screening of sorbent materials for single or mixed gas uptake and/or separation selectivity, in a much faster way than allowed by traditional gas solubility/uptake measurements. This method allows for the measurements of a large number of recyclable samples in a short amount of time, whether they are solid, liquid, porous or hybrid sorbents, at pressures up to 5 bar and varying temperatures, simultaneously. We require a small amount gas and sorbent (2-3 mL, less than 1 g), along with commercial HSGC equipment and consumables.

To validate our method, we have determined the gas uptake and gas separation selectivity in standard liquid and solid sorbents with a variety of gases including carbon dioxide, methane, ethylene and ethane and their mixtures, along with screening in a variety of new materials.

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