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Direct CO₂ capture from air - What is the best sorbent?**AUTHORS**

Nazila MASOUD / WAGENINGEN UNIVERSITY, BORNSE WEILANDEN 9, WAGENINGEN

Guillermo BORDANABA FLORIT / WAGENINGEN UNIVERSITY, BORNSE WEILANDEN 9, WAGENINGEN

Tomas VAN HAASTERECHT / WAGENINGEN UNIVERSITY, BORNSE WEILANDEN 9, WAGENINGEN

Harry BITTER / WAGENINGEN UNIVERSITY, BORNSE WEILANDEN 9, WAGENINGEN

Corresponding author : Harry BITTER / harry.bitter@wur.nl**PURPOSE OF THE ABSTRACT**

The Paris climate agreement pledged to keep global temperature increase below 2°C compared to pre-industrial times. To fulfil that promise, roughly 800 bn tonnes of CO₂ must be removed from air by 2100.¹ Hence, development of CO₂ capture technologies is of prime importance. A first step is to develop suitable sorbents that are able to capture CO₂ efficiently, to release it with little energy input, and to sustain its performance for a long time. Carbon supported potassium carbonate is a promising candidate for this, although its performance is still not ideal. It has been reported that supported K₂CO₃ can match the energy efficiency of the commercially applied liquid phase amines for CO₂ capture from flue gas.² Notably, amines are expensive, corrosive, and have toxicity issues. K₂CO₃ reversibly reacts with CO₂ in the presence of water, in an endothermic reaction at room temperature to produce potassium bicarbonate. The enthalpy of the reverse reaction is only 38 kJ/mol, and full decomposition of the bicarbonate product could be achieved below 150 °C. Hence, the K₂CO₃ is a green sorbent for CO₂ capture from air.

Here we studied the use of K₂CO₃ as solid sorbent for the capture of CO₂ from air. The use of a solid sorbent (instead of e.g., the liquid amines) is beneficial for practical reasons. To make efficient use of K₂CO₃ it must be dispersed on a support. Carbon based supports were chosen because of their high hydrothermal stability. However the carbons have different structural and chemical properties like different surface area, porosity and surface functionalities. These properties can be tuned, upon production of carbon as support for any specific application.³ However the relation between the carbon properties and their performance, after K₂CO₃ deposition, is currently unknown.

Here we focused on three different commercial carbon supports: CA1, SX ultra, and Ketjen Black. These carbons are different in their porosity and surface functionalities. CA1 and SX ultra are mainly microporous while Ketjen black is mesoporous. CA1 has polar surface functions with point of zero charge of 2 while SX ultra and Ketjen Black show more apolar surface properties with point of zero charge of 7. Figure 1 shows evolution of H₂O, CO and CO₂ from CA1 support upon heat treatment up to 800°C indicating presence of acidic groups while such groups are not present on SX ultra and Ketjen Black supports. Figure 2 shows a breakthrough curve of CO₂ using K₂CO₃ supported on these supports. Only Ketjen Black induced fast sorption kinetics and displayed a high CO₂ uptake capacity of the sorbent. Hence, the support affected the performance of K₂CO₃ via different mechanisms. These will be discussed in more detail in conference contribution.

FIGURES

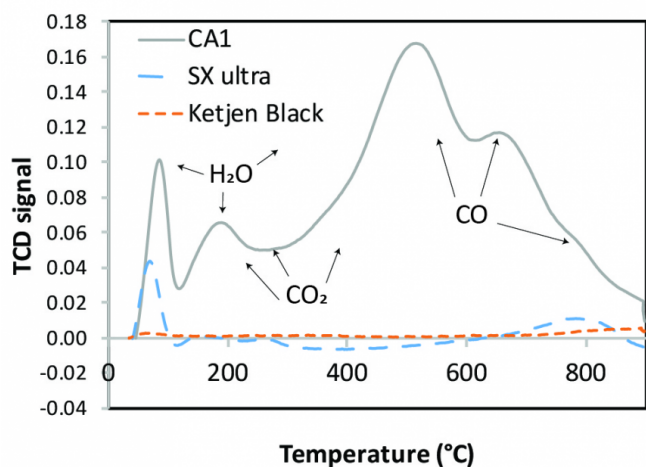


FIGURE 1

Functional groups evolved from different supports upon heat treatment.

Different supports (50 mg) were heated (10°C/min) under flow of He (20 mL/min). Evolved gases were detected by online mass spectrometer.

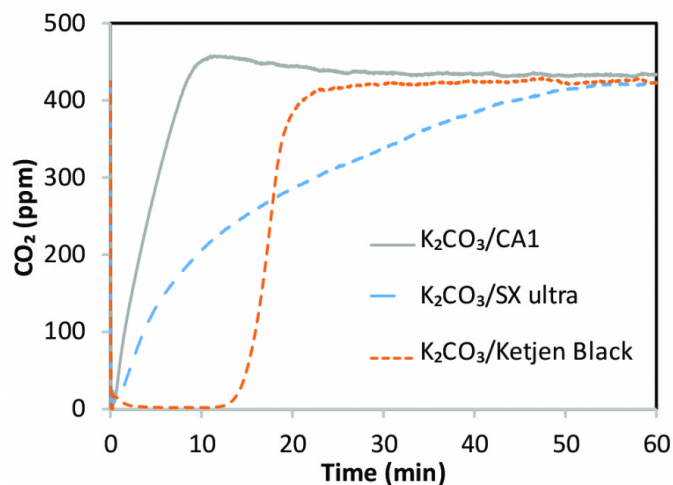


FIGURE 2

CO₂ breakthrough curves during capture from air.

The air passed down-flow through different sorbents (16 wt% K₂CO₃ on CA1 and 10 wt% K₂CO₃ on SX ultra and Ketjen Black, 50 mg), at 60°C, air flow 50 mL/min, water content: 3 wt% (vapor generated at 25°C).

KEYWORDS

CO₂ capture from air | solid sorbent | carbon supports | potassium carbonate

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