

The materials science of powder sorbents for CO₂ capture at high temperatures

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Carbon capture and storage (CCS) has gained significant interest due to the recognised effects of global warming caused by emissions of CO₂ and other greenhouse gases. The energy research community is exploring the use of powder sorbents as alternatives to liquid amine scrubbing for retrofitting to conventional fossil-fuel power generating plants, and other large point emitters, to reduce CO₂ emissions. Calcium oxide derived from limestone is also used in steam reforming of biomass to produce hydrogen in a sustainable manner. By incorporating a powder sorbent to remove CO₂, the thermodynamics of the steam reforming reaction at ~ 600 °C are improved and H₂ yields increased. To further maximise the overall efficiency of sorbent enhanced steam reforming (SESR), the carbonated sorbent must be capable of thermal regeneration (calcination) ready for the next cycle. For optimal implementation, the powder (CaCO₃) should be heated to 900-950 °C in order to release CO₂ in a form which can be compressed, ready for storage or utilisation. A major limitation to SESR technology is the lack of durability of CaO sorbents, or other oxide sorbents, when repeatedly heated to regeneration temperatures. The presentation will discuss the physiochemical changes which occur during repeated thermal cycling of a CO₂ absorbent powder, and describe approaches to mitigate these changes. New information on nano- and microstructural changes during carbonation-decarbonation reactions will be presented arising from detailed investigations using transmission electron microscopy (TEM), including direct observations obtained by thermal cycling in CO₂-rich atmospheres within an environmental TEM cell. Data on carbonation reactions using temperature-variable X-ray diffraction techniques will also be discussed.

Biography

S J Milne completed his PhD in Solid State Chemistry under the supervision of Professor A R West at Aberdeen University, Scotland. He is an associate professor in Materials Science and has published over 120 papers in international peer reviewed journals, serving as a member of the editorial board of three journals.

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