

MS17-P6 In situ studies of materials for high-temperature CO₂ capture and storage

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In order to combat the climate change owing to the ever-increasing concentration of CO₂ in the atmosphere due to anthropogenic emissions, we must change the way by which energy is primarily generated, that is by combustion of fossil fuels. The carbon capture and storage (CCS) scheme offers a plausible solution to the urgent need for a carbon neutral energy source from stationary sources, including power plants and industrial processes, since energy generated from renewable sources such as wind, solar and biomass are unlikely to meet the demand over the next two decades. The most mature technology for post-combustion capture uses a liquid sorbent, amine scrubbing. However, with the existing technology, a large amount of heat is required for the regeneration of the liquid sorbent, which introduces a substantial energy penalty [1]. The use of alternative sorbents for CO₂ capture, such as CaO, has been investigated extensively in recent years [2]. However there are significant problems associated with the use of CaO based sorbents, the most challenging one being the deactivation of the sorbent material. When almost pure CaO sorbents such as limestone are used, the capture capacity of the solid sorbent could fall by as much as 90 mol % after the first few carbonation-regeneration cycles. In this study a variety of *in situ* techniques were employed to better understand the cause of this deterioration from both a structural and morphological standpoint, and to compare its performance with that of recently developed sorbents incorporating Al-based additives [3, 4]. *In situ* synchrotron x-ray diffraction experiments found no bulk structural changes to occur upon reaction for the different materials, with the added phase remaining inert. Further x-ray and neutron PDF studies were employed to better understand the local surface and interfacial structures formed upon reaction, and how the reaction front proceeds through the individual sorbent particles. Finally, *in situ* x-ray tomography experiments were employed to track the morphological changes in the sorbents during carbonation, including the changes in porosity and tortuosity of the particles over different reaction times.

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