

X-RAY AND NEUTRON SCATTERING CHARACTERIZATION OF NANOMATERIALS TO ADDRESS MEASUREMENT CHALLENGES IN CARBON CAPTURE

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Global warming threatens massive negative changes to our environment, violent weather and rising sea levels. Any industrial origin of global warming is considered to arise mainly from CO₂ emissions, much of which comes from coal fired electrical power generation and industrial processes such as cement manufacturing. Low cost capture of CO₂, through the use of multi-scale porous solid sorbent nanomaterials, could mitigate these effects by significantly reducing net CO₂ emissions from stationary sources, perhaps by as much as 90 %. Presently available solid sorbent nanomaterials do not have sufficient carbon capture efficiency and selectivity, adsorption/desorption cycle life, or cost-effective scale-up potential. However, recent research has provided new insights into how such sorbent materials might be better designed and tailored to optimize their CO₂ sorption characteristics, and their incorporation into catalyst separation membranes (separating CO₂ from N₂, O₂ or H₂O) may offer the potential for scale-up to industrial applications. Examples of solid sorbent nanomaterials being considered for carbon capture include porous materials based on zeolites, zeolitic imidazolate frameworks, modified metal-organic frameworks, and flexible polymer/ceramic networks.

The hybrid and dynamic nature of these materials provide challenges for their characterization and for quantifying the relationship between their changeable, complex nanoscale structure and the amount of CO₂ (or other gases) absorbed. X-ray and neutron scattering methods provide an array of suitable techniques for addressing these challenges. However, if significant progress is to be made, these techniques must be used together in complementary experiments, both *ex situ* and under *in situ* CO₂ adsorption/desorption conditions, as well as compared with the results of suitable lab-based methods,. In this paper, we will illustrate these points with neutron and X-ray diffraction, small-angle X-ray and neutron scattering, NEXAFS and inelastic neutron scattering studies of CO₂ sorption in some of the sorbent nanomaterials of most current interest.