

# DESIGN OF MOLECULAR IONIC COMPOSITE PARTICLES FOR SELECTIVE SEPARATIONS OF CARBON DIOXIDE AND OTHER GASES

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## Abstract

Gas separation is critical for long-duration, crewed-spacecraft mission atmospheres where the accumulation of carbon dioxide (CO<sub>2</sub>) from human respiration can result initially in headaches and ultimately in death. The creation of novel, stable, regenerable and selective CO<sub>2</sub>-capture sorbents through emulsion fabrication of molecular ionic composite (MIC) particles from a rigid, double-helix, sulfonated-polyaramid polymer (poly-2,2'-disulfonyl-4,4'-benzidine-terephthalamide) and ionic liquids (IL) will provide an energy-efficient, high capacity, robust alternative to, for example, existing zeolite systems used on the ISS. The incorporation of spin relaxation agents in these new materials enables the use of natural abundance CO<sub>2</sub> from dry ice in <sup>13</sup>C NMR and NMR diffusometry methods to quantify sorption and transport within a practical testing timeframe. Promising NMR results showed quantifiable CO<sub>2</sub>-loadings of 1-5wt% in liquid (IL) and solid (MIC) samples with minimal impact (<25%) to the CO<sub>2</sub>-transport and absorption when confined in the solid state. Additionally, NMR measured CO<sub>2</sub> diffusion rates are ~10x faster than the component ions in the MICs. The successful generation of emulsion-based MIC particles achieved a primary objective and is an exciting step towards a new sorbent material for gas separation hitherto unexplored using unencapsulated, solid-state IL-based systems. The MIC particles can mitigate slow gas transport without sacrificing IL filling-factor or CO<sub>2</sub>-sorption capacity as seen in conventional capsule-shell materials. These composite-based sorption materials can be tuned based on an improved fundamental understanding of the emulsion processing, material concentrations, and IL chemistry to positively impact CO<sub>2</sub> solubility and selectivity and to aid in predictive materials design for other gas stream separations.