The Effectiveness of Guanidine Functionalized Polymers in Carbon Dioxide Capture and Utilization

Al Abdullatif, Sarah

Due to increasing use of fossil fuels, carbon dioxide levels in the atmosphere are expected to exceed 700 ppm by the year 2050. This initiated innovative scientific research into carbon capture and utilization. This apprehension can be done using guanidine polymers which adsorb CO2 from the atmosphere due to their nucleophilic properties. It's hypothesized that these polymers may also act as catalysts in the synthesis of cyclic carbonate through the coupling of epoxide and CO2. This novel research project focuses on synthesizing functionalized guanidine polymers with alkyl or aryl groups and assessing their catalytic efficiency by examining the product formation via crude Nuclear Magnetic Resonance (NMR). Four total polymers were synthesized and then tested for catalyst activity. Then the polymer with the highest conversion rate was tested for the following optimal catalytic reaction conditions: catalyst loading, temperature, pressure, time substituted substrates, and the use of a solvent. It's determined that the optimum conditions for this reaction that gave >99% conversion were 30 mg of alkyl substituted protonated guanidine polymer at 100°C with 4 equivalent epoxide and 4 atm CO2 for 24 hours with no solvent. These conditions were successful with the following substituted epoxides: styrene oxide, 2,3-Epoxypropyl phenyl ether, Epichlorohydrin, and 1,2-epoxyhexane. Also, 1 mmol of CO2 can produce 1 mmol of cyclic carbonate. Under the experimental conditions tested, alkyl substituted protonated guanidine polymers act as cheap, efficient, green catalysts to the coupling of CO2 and epoxide, with promise in applications such as biodegradable containers, pharmaceuticals, batteries, or intermediate chemicals.

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