Carbon Capture and Storage via Silver Nanoparticle Catalyzed Hydration of Carbon Dioxide

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To reverse the rise in atmospheric CO2 content, researchers continue to investigate ways to sequester the greenhouse gas in what is known as carbon capture and storage (CCS). In CCS, CO2 is mineralized to carbonic acid, and later neutralized, however the rate-determining step of this process remains from the hydration of carbon dioxide to carbonic acid. Carbonic anhydrase enzyme can catalyze the reversible hydration of CO2 to H2CO3, however this process is limited by both cost and narrow operating parameters (pH of 7 to 10, at 4-30oC). Bahduri reported the reversible hydration of carbon dioxide, by nickel nanoparticles (NiNPs), in a process that occurs at room temperature, and is pH independent. However, the technology is limited by the toxicity of nickel itself and cannot be used for underground CO2 sequestration. This research uses biofriendly silver nanoparticles (AgNPs) as a metallic catalyst in the reversible hydration of CO2 to carbonic acid. 0.07ml/min of CO2 was bubbled into 1L of deionized water; sequestration of CO2 to form carbonic acid was measured as a function of pH reduction. For 1L of di-water, pH was lowered in 2 hours from 6.8 to 5.01, corresponding to 0.4 mg of CO2 sequestered. Similar experiments were separately carried out for 20mg AgNPs and 20mg NiNPs, each suspended in 1L water with 2% PVA. For NiNP's, pH was lowered from 6.8 to 4.44, corresponding to 1.6mg CO2 sequestered, or 0.08mgCO2/mg NiNP. Finally, for AgNPs, pH was lowered from 6.8 to 3.85, corresponding to 6.2mg CO2 sequestered, or 0.31gCO2/gAgNP.