

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

Stefani, Agustina

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 4-30°C). 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.

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