Reduction of CO_2 using Tin Oxide (SnO_2)

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Summary:

The increasing concentration of CO_2 poses serious environmental threats in finding alternative and sustainable solutions. Photocatalytic CO_2 reduction has a promising approach to its ability to operate under ambient conditions utilizing renewable energy sources, such as sunlight. In this study, we focus on the effect of SnO_2 particle size on light interaction and CO_2 photoreduction efficiency. Using a tip sonicator to break down the particle size. then subjected to sequential centrifugation at 5000 rpm and 2500 rpm for varying durations of 10, 20, and 30 minutes to obtain different particle size distributions. UV-Vis spectroscopy and Dynamic Light Scattering (DLS) analyses are performed in parallel to evaluate the optical properties and particle size of each fraction. To reduce fossil fuel usage, air pollution, and carbon footprints while enhancing oxygen production and supporting plant life. This method is also applicable in evaluating the efficacy of drug stability, cosmetics, and material science innovations.

Hypothesis:

The SnO_2 particle size significantly influences light interaction, product activity, and selectivity in CO_2 photoreduction, particularly as the particles approach the quantum confinement region, where enhanced photocatalytic behavior is often observed.

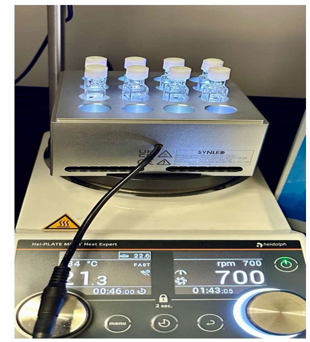
Research methods:

To investigate the effect of SnO_2 particle size on CO_2 photoreduction performance, a 10 mg/mL SnO_2 suspension is first prepared by dispersing the powder in deionized water and stirring for 5 minutes to ensure uniform mixing. The solution used a probe sonicator set at 50% amplitude for 1 hour to effectively break down agglomerates and reduce particle size. The dispersion was centrifuged at different rpm and for different times to obtain fractions with distinct particle size distributions. These fractions are analyzed using Dynamic Light Scattering (DLS) to determine particle size and UV-Vis spectroscopy to evaluate their light absorption characteristics. Finally, the prepared samples are used in CO_2 photoreduction reactions to assess how particle size influences catalytic performance, with a focus on activity and product selectivity.

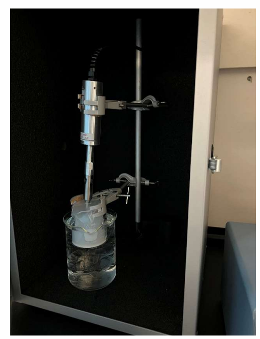
Challenges and Results:

The main constraints in the procedure were the durations of key steps: sonication required 1 hour, centrifugation took 3 hours, and gas chromatography was the most time-consuming step, taking 12 hours. Despite these limitations, the results showed that by breaking down the particle sizes our band gap changes due to the quantum effect.

Sample	Particle size(nm) 030725	Band Gap(ev)
Sonicated	405	3.3
5k rpm -2.5min	197.3	3.75
2.5k rpm-10min	169	4.25
2.5k rpm-20min	146	4.65
2.5k rpm-30min	115	5.1



Reaction setup



Sonication Step

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Dynamic Light Scattering DLS | Malvern Panalytical. (n.d.). Www.malvernpanalytical.com. https://www.malvernpanalytical.com/en/products/technology/light-scattering/dynamic-light-scattering