Tin Oxide (SnO2) as a Photocatalytic Semiconductor for CO2 Reduction

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Introduction

Research on the sustainable photocatalytic reduction of CO2 using semi-conducting nanoparticles at atmospheric conditions has been primarily focused on the modification of TiO2. This has been done with the goal of improving its efficiency and photocatalytic ability. After having their size modified and coupling them with graphene oxide, TiO2 nanoparticles have shown a noticeable improvement in their photocatalytic activity (1). However, the products of these reactions have been primarily heterogeneous which creates difficulties when attempting to create reduced higher value products. These difficulties have led to research being done with other semiconducting nanoparticles such as SnO2.

Research Goals

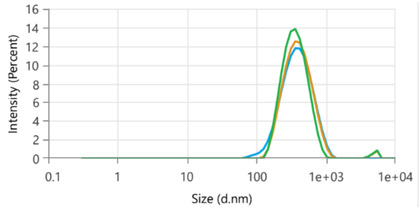
Current research shows that tin oxide (SnO2) has a high selectivity towards formaldehyde in the photocatalytic reduction of CO2 when in the presence of sodium sulfite hole scavenger (2). The goal of this research is to find the optimum size/morphology for the selective reduction of CO2 and to couple this particle size with graphene oxide to test whether this selectivity will be maintained while also attaining the hypothesized increase in photocatalytic ability.

Current Results and Challenges

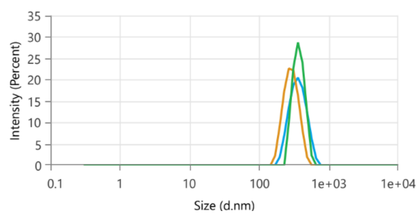
For current research, the sonication has shown positive results in the reduction of particle size as seen in the DLS size graphs. Furthermore, centrifugation has shown to effectively separate the particle sizes of SnO2 nanoparticles. The UV analysis calibration has been finished for SnO2 and can now be used to find the unknown concentration of our solutions. The main challenge currently being faced is a broken gas chromatography machine which is inhibiting the results of the SnO2 reaction with CO2 from being quantified. Another challenge is that the aggregation of SnO2 nanoparticles is severe and after experimentation it was decided that for best results, tests need to be run in the same day as sonication.

Sonication and Centrifugation

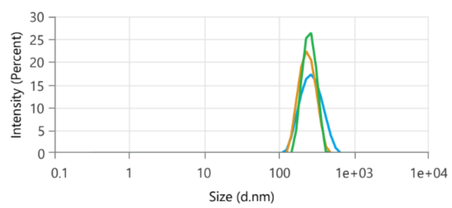
SnO2 100nm unsonicated: 408.3nm



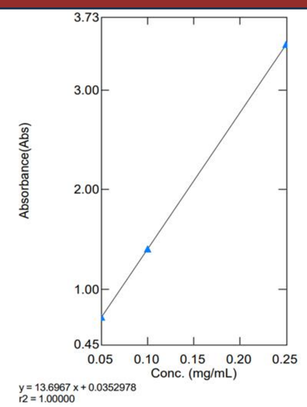
SnO2 100nm sonicated: 346.6nm



SnO2 100nm sonicated and centrifuged at 2500RPM for 7 min: 261.1nm



UV Calibration Curve



Curve tested at 0.175 mg/ml SnO2:
Predicted Concentration: 0.179 mg/ml
Predicted absorbance: 2.483

Research Methods

Sonicate solution to reduce particle size
↓
Centrifuge to separate particle sizes
↓
DLS to check for particle size trends and UV analysis for concentration
↓
Run reaction with CO2 and use gas chromatography to quantify results

Future Work

The immediate goals are to run the reaction of the sonicated SnO2 nanoparticles with CO2 and to quantify the results with the GC to see the impact that particle size has on selectivity and photocatalytic activity. Eventually this will be repeated but when coupled with graphene oxide.

References

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