Exploring Variables in Aqueous Synthesis of Zinc Oxide Nanoparticles

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Abstract: This research explores aqueous synthesis of zinc oxide nanoparticles towards the goal of water purification applications. While previous studies have experimented with reactants such as zinc sulfate and zinc acetate, the focus here was on using zinc chloride. This exploratory research examined many variables: zinc chloride molarities (0.005-0.05), sodium hydroxide molarities (0.05-0.5), presence or absence of guar gum, and time for mixing were all altered in a controlled fashion. The passivating agent guar gum was included as one of the variables in order to in inhibit growth and limit particle size. To analyze the product, X-ray diffraction, particle size and fluorescence data were collected on the samples. Analysis showed consistent synthesis of zinc oxide, but none of the trials resulted in nanoparticles; smallest sizes were on the order of 1-3 μm, and typical sample size averages were 25-50 μm. Measured pH, dependent on sodium hydroxide amount, showed no correlation to particle size, but smaller particle sizes tended to favor lower molarities of both zinc chloride and sodium hydroxide. With regards to temperature, warmer temperatures (room temperature compared to approximately 70 °C) led to larger particle sizes and thereafter experimentation was restricted to room temperature. Measurement of fluorescence for several samples indicated two emission spectra groups with identical peak positions, one group with much larger peaks around 500 nm attributed to defects, lower in energy than zinc oxide band emission just below 400 nm. Exploratory synthesis with water has enabled development of fundamental knowledge in the field of crystal growth from aqueous solutions, moving forward the potential for use of inexpensive, abundant water as a solvent for technological materials.