CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY

Name(s)

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Project Number

S1116

Project Title

Water Purification by Photoactivated Degussa P25 Nanoparticles to Eliminate Chemical and Microbiological Impurities

Abstract

Objectives/Goals

Globally one billion people lack clean drinking water. 3.4 million people die from water borne illnesses each year, making it the leading cause of death in the world. The purpose of this project is to find a practical way to purify water, using nanoparticles as a photocatalytic agent. This provides an economic, eco-friendly treatment method to purify chemicals and microbiological contaminants from water.

Methods/Materials

The photocatalytic properties of Nano-TiO2 were used to degrade Methylene Blue and E. Coli. Methylene Blue and E. Coli serve as proxies for chemical and microbiological contaminants in drinking water and industrial wastewater. 96 well assay trays were set up using impurity solutions and various dilutions of a Nano-TiO2 suspension. Images of the assay tray were taken using the IVIS photon emission-imaging camera, to determine the Fluorescence and Bioluminescence of Methylene Blue and E. Coli respectively. The fluorescence images were taken at 2 minute intervals for 10 minutes, and the bioluminescence images were taken at 5 minute intervals for 20 minutes. The images were analyzed using LivingImage.

Results

It was proven that the majority of Methylene Blue was degraded within 2 minutes of UV exposure. After 10 minutes of UV exposure, 99.04% of Methylene Blue had been mitigated. After 20 minutes of UV exposure, 92% of E. Coli was eradicated. Nano-TiO2 proved to be most effective in the 0.0625mg/mL concentration. The results show that Nano-TiO2 is an extremely effective and efficient water purification agent.

Conclusions/Discussion

Since Nano-TiO2 is a photocatalytic agent, it is activated by light. In the presence of light, Nano-TiO2 reacts with water to form hydroxide radicals, which repeatedly hit the surface of Methylene Blue and degrade the molecule#s structural integrity. The hydroxide radicals permeate through the cell membrane of E. Coli and interfere with the cell#s metabolic processes, releasing potassium ions and causing lipid peroxidation. The cell then loses its structural integrity, and dies.

Further Research: Once immobilized with Activated Charcoal, Nano-TiO2 can be used in a "trap-n'-kill" filter. The physical filtration properties of Activated Charcoal would trap impurities, and the Nano-TiO2 would degrade them, resulting in a sustainable, self-cleaning filter. Such a filter would be an economical, Eco-friendly, and effective solution to the worldwide water problem.

Summary Statement

The photocatalytic properties of Nano-TiO2 were used to create a cost effective, energy effective, and environmentally friendly solution, to degrade chemical and microbiological impurities from drinking water and industrial wastewater.

Help Received

Lab equipment used at Stanford University under the supervision of Dr. Jonathan Hardy.