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SODIS: Etching Titanium Dioxide before Adding Gold-Nanoparticles

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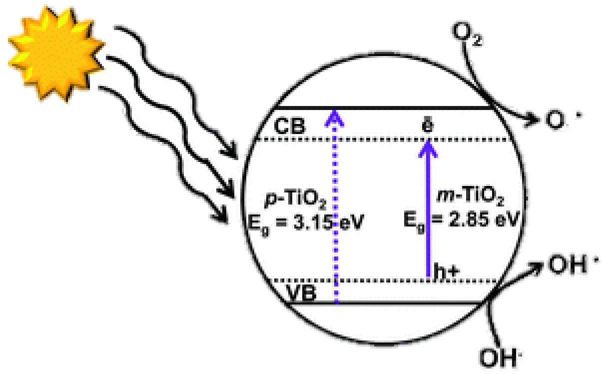


The semiconductor TiO_2 works because of its energy bandgap and reaction of molecules.

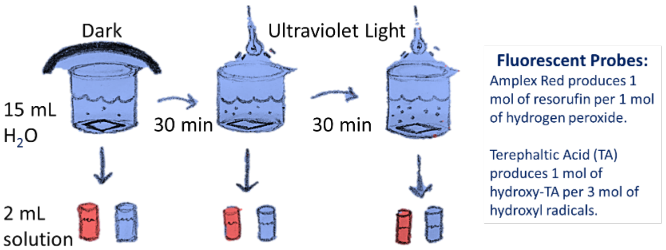
SODIS: Etching Titanium Dioxide before Adding Gold-Nanoparticles

Elizabeth Amedee, Chemical Engineering Junior

Nearly one billion people worldwide lack access to clean water, but titanium dioxide (TiO_2) helps water disinfection efforts due to its photocatalytic properties. Optimizing TiO_2 can aid water treatment and improve the lives in developing countries. Instead of using a flat titanium dioxide surface, a rough surface may allow for improved interaction with the gold nanoparticles for more efficient solar disinfection.

To confirm that etching and gold nanoparticle evaporation has occurred when assembling films, the spectrophotometer records absorption in the 200 to 600 nm wavelength range by passing through a lens and into a white integrating sphere.

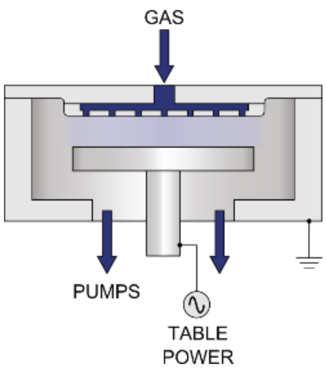
To understand how well the films work to disinfect water, a synthesis runs by placing 1 square-inch films in beakers, and the fluorometer detects collected samples, as shown below. The six tubes are filled with fluorescent probes: Amplex red produces 1 mol of resorufin per 1 mol of hydrogen peroxide, whereas terephaltic acid (TA) produces 1 mol of hydroxy-TA per 3 mol of hydroxyl radicals. A fluorometer measures wavelength/intensity of fluorescence. Measuring the amount of hydrogen peroxide or other reactive oxygen species (ROS) will determine how much disinfection is likely to happen.



Process of testing 1-inch-by-1-inch nanofilms to determine efficiency of disinfection

More sunlight absorbed means more electrons are excited, which means more superoxide is formed to create reactive oxygen species (ROS). Fortunately, hydrogen peroxide has a longer lifespan than hydroxyl radicals and is an antiseptic that damages bacteria cells' or virus' walls.

Clean water is not readily available to many people around the world. Yet, many do not know the full extent of this issue. Some existing ways for obtaining drinkable water are boiling water, solar water disinfection in small quantities for large periods of time (i.e. on a roof in water bottles), and rainwater. By understanding the solar disinfection rate of different surfaces of titanium dioxide, a more effective disinfection process can be derived. Etched nanofilm with gold nanoparticles attached on top can increase the solar disinfection rate. The cost of gold nanoparticles is relatively low, costing as little as a few pennies. Spin-coating, dip-coating, or spraying the titanium dioxide sol-gel onto a surface will have a beneficial impact on the cost of solar-disinfection material. Finally, a reactor can assist in the process of solar disinfection by using the sun's energy to heat the water in order to rid it of bacteria.



TiO2 is etched with an Oxford reactive ion etching inductive couple plasma chamber.

In addition to these processes, to understand why etched TiO_2 films with gold-nanoparticles are important, atomic force microscopy or scanning electron microscopy on films can measure topology and calculate roughness from the pictures acquired. Researchers can implement a flat-film reactor and add bacteria to understand a more direct approach to topical use. For industry, calculations of cost to produce films for public use and scaling the production to create larger films will be considered. These TiO_2 films are inexpensive and can be used continuously anywhere sunlight is present.

If nothing else, acting beyond understanding the breadth of wasteful water use and third-world problems is necessary. Organizations like UNICEF, the Thirst Project, and Living Water International invest in solving these problems. Other charities may also want to help build titanium dioxide nanofilms for outreach to third world countries with less available clean water, and ordinary people can help them reach out to achieve clean drinking water for everyone.

Sources:
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