Safe and Affordable Water

Nanotechnology-Based Water Purification and Testing

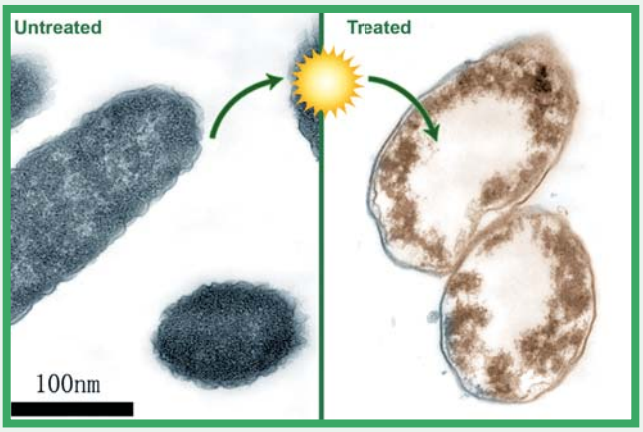
Interested Agencies: CSRESS, DOD, DOE, DOS, EPA, NASA, NIH, NSF, USGS

Clean water is a basic necessity for people and animals and vital to agriculture. The worldwide supply of potable water is limited and demand is increasing. Disease-causing organisms often contaminate water in less developed parts of the world. Gasoline additives, dry cleaning chemicals, and agricultural pesticides sometimes foul the water supply in industrialized countries. Water pumped from deep aquifers often contains high levels of contaminants such as iron, manganese, and even arsenic, or has high salinity.

Many different technologies already exist for removing various contaminants from water, including distillation, chlorination, ultraviolet irradiation, and selective membrane filtration. Each has its drawbacks. Most are energy-intensive. Some generate byproducts that have unfavorable environmental and health impacts.

Nanotechnology could help meet the need for safe, affordable water through inexpensive water purification and rapid, low-cost detection of impurities. Solutions are likely to come from many directions. Some may be applied locally while others will be best suited to central treatment facilities. Nanostructured mixed metal oxides can destroy biological toxins in water through photocatalysis and oxidation. Coatings made from nanomaterials minimize biofilm fouling, a problem with existing membrane technologies.

Progress has already been made. Experiments with palladium-doped iron nanoparticles have demonstrated the capability to remove organic contaminants from groundwater. Magnetite nanoparticles have shown promise for removing arsenic from drinking water. Sensors based on nanostructured surfaces have been used to detect metals, biotoxins, and organic compounds accurately and rapidly. These sensors also could be incorporated into sophisticated control systems for sensing and then treating specific contaminants.



Transmission electron microscope micrograph showing the destruction of *E. coli* bacteria in water using visible light, a process made possible by the presence of nanoscale titanium oxide (courtesy of J-K. Shang and B. M. Pianfetti, University of Illinois at Urbana-Champaign).

Nanotechnology-based membrane materials, impurity-scavenging nanoparticles, and portable devices for on-site detection and diagnosis of contaminants are priorities in water purification research. It will be important to investigate the scale-up of low-impact manufacturing processes for these new systems. Finally, it will be important to ensure that there are no unwanted environmental and health impacts of engineered nanomaterials used in the new purification processes.