The emerging nanotechnology revolution

BIG PUNCH IN A SMALL PACKAGE

Developing emerging technology has always been the hallmark of the American economic system. From airplanes to computers, technological innovation has established the U.S. as the preeminent political and economic power in the world.

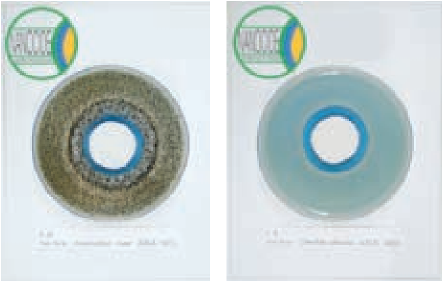
Nanotechnology, which is just making its way into commercial applications, may well be next to change the face of technology, finally moving beyond the hype, and into real-time applications in the healthcare industry.

But what is it?

Nanotechnology is the science of manipulating materials at the atomic and molecular level to develop new or enhanced materials and products. The word nanotechnology is a catchall phrase for materials and devices that operate at the nanoscale. In the metric system of measurement, 'nano' equals a billionth, therefore, a nanometer is one-billionth of a meter. So in reality, nanotechnology means working at a scale one-million-times smaller than a pinhead.

As 'nano' means extremely small, it is nearly infinite in application, and nanotechnology is expected to have an impact on nearly every industry — automotive, electronic, defense, marine, textile, medical and beyond. Its estimated global research and development investment of nearly $9 billion per year is expected to lead to new medical treatments and tools; more efficient energy production, storage and transmission; better access to clean water; more effective pollution reduction and prevention; and stronger, lighter materials.

Recall that term we learned about way back in grade school — matter. Matter often behaves very differently at the nano



A colony of *aspergillus niger*, left, and the fungi *candida aibicans*, right, surround swatches of CMI's Dimensions Nanocide antimicrobial treated fabric. All fungi germs are killed not only on the white treated vinyl but also beyond the treated blue ring area, illustrating the layer killing capability.

scale, and therein lays the vast scientific opportunities of nanotechnology, and their commercial applications.

Most near-term applications of nanotechnology are in the form of nanomaterials, which include materials such as lighter and stronger nanocomposites, antibacterial nanoparticles, and nanostructured catalysts.

These materials make possible self-laundering and permanently antistatic clothing, and 'smart clothes' in which nanotechnology is used, to embed tiny electronics to monitor the wearers' health, deliver drugs at specific times of the day, and self repair tears and holes in the fabric.

Plastic nanocomposites are also being used for stronger, lighter, and rustproof car components. Toyota uses these nanocomposites in bumpers making them 60-percent lighter and twice as resistant to denting and scratching. And the biomedical field is manufacturing artificial bone composites from nanocrystalline calcium phosphates — made of the same mineral as natural bone, yet with the strength in compression equal to that of stainless steel.

Nanoparticles on the surfaces of many new refrigerators, air conditioners, and laundry machines act as antibacterial and antifungal agents, and U.S. military and police agencies are employing the technology in socks, armored vests and even helmets.

Hi-O silver!

Silver has long been known for its natural antimicrobial properties. By combining silver's natural antimicrobial properties with today's nanotechnology, researchers and industry have strengthened, intensified and vastly improved upon its capabilities.

For example, say you have enough silver weight to cover the surface of a regular playing card. With nanotechnology, this same silver weight now in nanoparticles would have the surface area of four football fields. Get the picture?

The healthcare industry will be directly and positively influenced by new products offered through this cutting edge synergy.

First, silver is naturally antimicrobial when activated in aqueous fluids, working in a number of ways to disrupt critical functions in microorganisms. To wit, it has a tendency to bond with negatively charged polymers, ideally, altering the molecular structure to render the a new polymer that is worthless to the cell or its invading germ — effectively inhibiting growth or more often killing the microorganism is killed.

"Silver at the nanoscale allows manufacturers to innovatively add antimicrobial capabilities to an ever expanding range of products," says Marlene Bourne, president and principal analyst of Bourne Research LLC in Scottsdale, Ariz. "Even better, with this approach there's a greater assurance of longevity and performance. Since the germ-fighting properties won't wear off in a short period of time, the healthcare environment can confidently make the capital investment necessary for this kind of next generation infection control."

One of the largest obstacles in nanotechnology is keeping the 'nano-silver' in an aqueous solution, which is necessary to avoid the formation of agglomerates that produce a larger micron size — as silver is heavier than water, it tends to 'fall out' or settle to the bottom of the barrel.

The smaller the particles, the more they tend to stick to each other, which in turn increases the particles from nano size to micro size, thereby rendering the product ineffective as it loses its surface area application. In addition, precise and exacting colors — very important in the textile industry, are jeopardized and unattainable at the micron size.

"In the R&D process our eureka moment came when we developed nano silver in a small enough distribution size that made it both very effective and not cost prohibitive. This made the surface area of our silver very large, thus increasing the killing efficiency," says Mike Jobe, vice president of sales and marketing, CMI Enterprises.

Infection control is of paramount concern within the medical and healthcare industry. It is acknowledged that the most common means of transmission are the hands. However, if you reduce initially the amount of bacteria present on surfaces such as bedding, chairs, benches and gurneys, human hands are less likely to be contaminated.

The innovative nanoparticles of nanotechnology are unique in the fact that the bacteria does not have to ingest or absorb the biocide, rather the bacteria is killed when it comes into contact with the surface ion field. Silver ions at the nanoparticle size release and break open cell walls, as with methicillin-resistant staphylococcus aureus and kill the bacteria. It is nonselective and affects many different functions of the microbial cell, resulting in antimicrobial activity against a broad spectrum of medically relevant bacteria. And for certain bacteria, as little as one part-per-billion of silver may be effective in preventing cell growth. ■

Reducing the amount of bacteria present on surfaces in exam rooms can consequently reduce the potential of transmission.