Tiny technology carries big promise

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Nanotechnology has the potential to revolutionize materials, manufacturing, energy, security and healthcare. At the Research and Development Conference of MIT's Industrial Liaison Program last month, Professor Edwin L. Thomas, director of the Institute for Soldier Nanotechnologies at MIT, discussed the promises and challenges of nanotechnology.
"Nano is huge, with pervasive benefits for society, the economy and national security," said Thomas. In terms of its potential impact, "nano is on par with electricity, transistors, the Internet and antibiotics," he said.

The National Nanotechnology Initiative (NNI), launched in 1996, issued a list of "grand challenges" for nanotechnologists. These include chemical-biological-radiological-explosive detection and protection, manufacturing at the nanoscale, and efficient energy conversion and storage. The NNI's budget for 2005 approaches $1 billion.

With nanotechnology still a young field, the NNI's grand challenges are years from being met in most cases. In the near term, according to Thomas, advances will require a better understanding of the nano world and experimentation with nano-enhanced technologies.

Thomas described the nano world as a little-understood realm between the atomic and bulk properties of materials. Nanoparticles of a material behave differently than bulk amounts of the same material; at the nanoscale, a material may be stronger, lighter, more water-soluble, more heat-resistant, or a better conductor of electricity. At the nanoscale, the color of gold is not really "gold," but several different colors that vary by

the amount of particles present. Medieval stained-glass makers knew this, said Thomas, even though they didn't know about the nanoscale. They put differing, tiny amounts of gold in the glass to yield the various colors found in stained-glass windows.

Similarly, today's scientists and engineers have found that it takes only small amounts of a nanoparticle, precisely placed, to change a material's physical properties. Adding nanoparticles of clay to a polymer used to wrap power lines increases strength and reduces flammability.

Nanocomposites, along with nanocoatings and microelectronics, are among the more immediate nanotechnology applications, what Thomas calls "low-hanging nano fruit." Contrast these with carbon nanotubes, whose extraordinary properties--strength, electrical and thermal conductivity, large surface area--have generated much excitement, but whose high cost ($227,000 per pound) prohibits their large-scale use.

Among the 40 projects being conducted at the ISN are those based on nanocomposites. One research team led by Robert Langer, the Germeshausen Professor of Chemical and Biomedical Engineering, is working to develop tunable surfaces that may help reduce the weight of a soldier's heaviest burdens: ammunition, batteries, and water.

Thomas pointed out that the U.S. does not dominate the field of nanotechnology. Only 25-30 percent of papers at nanotech conferences come from the U.S.; many more come from Europe. China is another competitor.

Safety issues present another challenge. Carbon nanotubes are similar in form to asbestos fibers, and there is concern that they could pose a similar risk to lung health. The evolution of nanotechnology will likely involve both testing nanomaterials before releasing them into the environment and taking steps to consider social and ethical

consequences.

Source: Massachusetts Institute of Technology