'Custom' nanoparticles could improve cancer diagnosis and treatment

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Researchers have developed "custom" nanoparticles that show promise of providing a more targeted and effective delivery of anticancer drugs than conventional medications or any of the earlier attempts to fight cancer with nanoparticles. Designed at the molecular level to attack specific types of cancer without affecting healthy cells, the nanoparticles also have the potential to reduce side effects associated with chemotherapy, the researchers say.

Their study was described today at the 231st national meeting of the American Chemical Society, the world's largest scientific society.

The particles, considered the next generation of cancer therapeutics, are the most uniform, shape-specific drug delivery particles developed to date, according to researchers at the University of North Carolina (UNC) in Chapel Hill. Other potential benefits of the tiny uniform particles include enhanced imaging of cancer cells for improved diagnosis and use as delivery vehicles for gene therapy agents, they say.

To date, the UNC researchers have produced a variety of custom nanoparticles from biocompatible organic materials using techniques they adapted from processes used by the electronics industry to make transistors. In cell studies, they have shown that the uniform nanoparticles can attach to specific cell targets, release important chemotherapy drugs inside cells, and hold MRI contrast agents. Animal studies began recently and human studies are anticipated, the researchers say.

"I think this will transform the way one detects and treats disease," says study leader Joseph DeSimone, Ph.D., a chemistry professor at UNC and director of the school's Institute for Advanced Materials, Nanoscience and Technology. He has co-founded a company, Liquidia Technologies, to develop and produce the nanoparticles.

Researchers have been experimenting with nanoparticles as drug delivery vehicles for years but have had only limited success in cell and animal studies, DeSimone says. Each carrier has drawbacks with regard to stability in the bloodstream or ability to be directed toward a specific cancer site. In addition, there has been no general method available that allows precise control of the particle's size, shape and composition, which are considered key features for the success of targeted drug delivery, he says.

Now, DeSimone and his associates at UNC have developed a new fabrication technique that allows, for the first time, unprecedented control over the structure and function of drug delivery nanoparticles. Called PRINT (Particle Replication In Non-wetting Templates), the technique is similar to injection molding and uses principles borrowed from the electronics industry for transistor fabrication, they say. The technique was first detailed last June in the online version of the Journal of the American Chemical Society.

The manufacturing process starts with a silicon wafer that is etched with the shape and size of the desired nanoparticle, resulting in a template. Next, nonstick liquid fluoropolymers are poured into the template and cured to form a fixed mold. The finished mold is then injected with organic materials that can contain imaging agents, anticancer drugs, DNA (for gene therapy) and other materials, depending on the intended function, DeSimone says. The new manufacturing technique uses gentler processing methods that are less likely to harm important organic components than traditional nanoparticle manufacturing techniques, he

adds.

The resulting nanoparticles can be as small as 20 nanometers, or thousands of times smaller than the width of a single human hair. The shapes of the particles can also be made to mimic the shapes of objects found in nature like red blood cells or virus particles, DeSimone says.

Source: American Chemical Society