# Silicon microparticles, gadonanotubes promise big advance for medical imaging

November 10 2010, By Mike Williams

A nest for nanotubes may help magnetic resonance imaging become better than ever at finding evidence of disease.

Scientists at Rice University and other Texas Medical Center institutions and colleagues in Colorado, Italy and Switzerland have discovered a way to trap contrast agents inside a silicon particle that, when injected into a patient's bloodstream, would make them up to 50 times more effective. Contrast agents "light up" damaged tissue in the body in images produced by MRI instruments.

"Making MRIs better is no small matter," said Lon Wilson, professor of chemistry at Rice and one of three senior co-authors of the research paper published online in *Nature Nanotechnology*. In 2007, 28 million MRI scans were performed in the United States, and contrast agents were used in nearly 45 percent of them.

"MRI is one of the most powerful medical tools for imaging, if not the most powerful," he said. "It's not invasive, it's not ionizing harmful radiation and the resolution is the best you can get in medical imaging.

"The sensitivity, however, is poor. So anything you can do to improve performance and increase sensitivity is a big deal -- and that's what this does."

A nano-sized slice of silicon shaped like a hockey puck served as a delivery device for contrast agents in the study. Pores that were mere

nanometers (billionths of a meter) long and wide were created in the discs, called silicon microparticles, or SiMPs.

Three types of contrast agents were drawn into the pores. Magnevist, a common contrast agent used worldwide, was one; the others were gadofullerenes and gadonanotubes, both pioneered by Wilson's Rice lab. All three chemically sequester the toxic element gadolinium to make it safe for injection.

MRIs work by manipulating hydrogen atoms in water, which interact and align with the applied magnetic field from the instrument. The hydrogen atoms are then allowed to return to their original magnetic state, a process called relaxation. In the presence of the paramagnetic gadolinium ion, the atoms' relaxation time is shortened, making these regions brighter against the background under MRI.

SiMPs are small -- about a micrometer (a millionth of a meter) across -- but when they trap both water molecules and bundles of nanotubes containing gadolinium, the protons appear much brighter in an MR image. Because SiMPs keep their form for up to 24 hours before dissolving into harmless silicic acid, the molecules can be imaged for a long time.

The trick is getting them to places in the body that doctors and technicians want to see. Wilson said SiMPs are designed to escape the bloodstream, where they leak and aggregate at the sites of tumors and lesions. "Spherical particles, at least in mathematical models, flow down the center of the vasculature," he said. "These particles are designed to hug the wall. When they encounter a leaky area like a cancer tumor, they can easily get out."

The encapsulation within SiMPs enhanced the performance of all three contrast agents, but SiMPs with gadonanotubes (carbon nanotubes that

contain bundles of gadolinium ions) showed the best results. "The performance was enhanced beyond what we had imagined," he said.

SiMPs may also be functionalized with peptides that target cancer and other cells. SiMPs that contain contrast agents and medications could potentially be tracked as they home in on disease sites, where medications will be released as the silicon dissolves.

Provided by Rice University