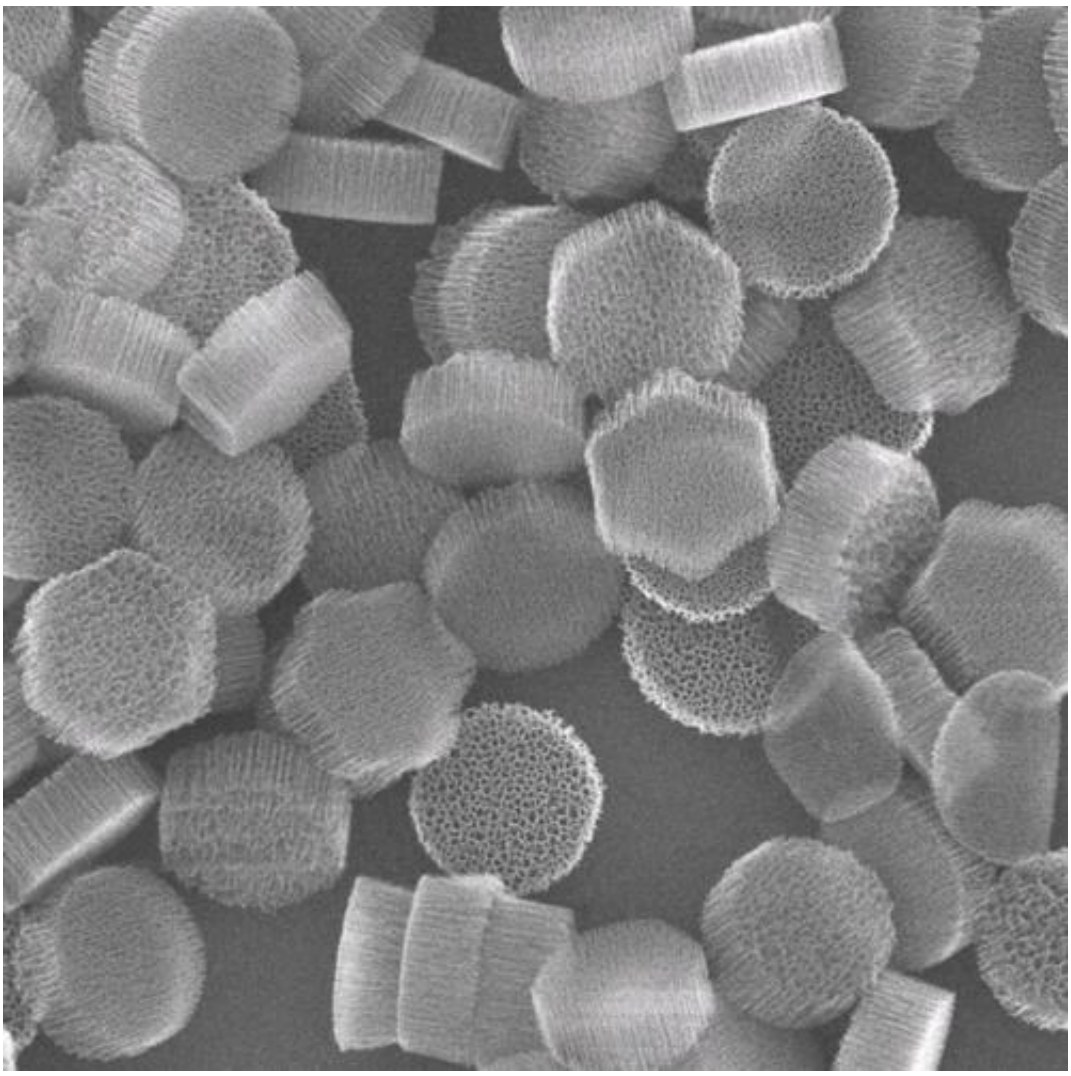
Nanoscale composites improve MRI: Researchers merge magnetic particles to detect, fight disease

June 16 2014, by Mike Williams



Silicon mesoporous particles, aka SiMPS, about 1,000 nanometers across contain thousands of much smaller particles of iron oxide. The SiMPs can be

manipulated by magnets and gather at the site of tumors, where they can be heated to kill malignant tumors or trigger the release of drugs. The particles were created by an international team led by scientists at Rice University and The Methodist Hospital Research Institute in Houston. Credit: The Wilson Group

(Phys.org) —Submicroscopic particles that contain even smaller particles of iron oxide could make magnetic resonance imaging (MRI) a far more powerful tool to detect and fight disease.

Scientists at Rice University and The Methodist Hospital Research Institute (TMHRI) led an international team of researchers in creating composite particles that can be injected into patients and guided by magnetic fields. Once in position, the particles may be heated to kill malignant tissues or trigger the release of drugs at the site.

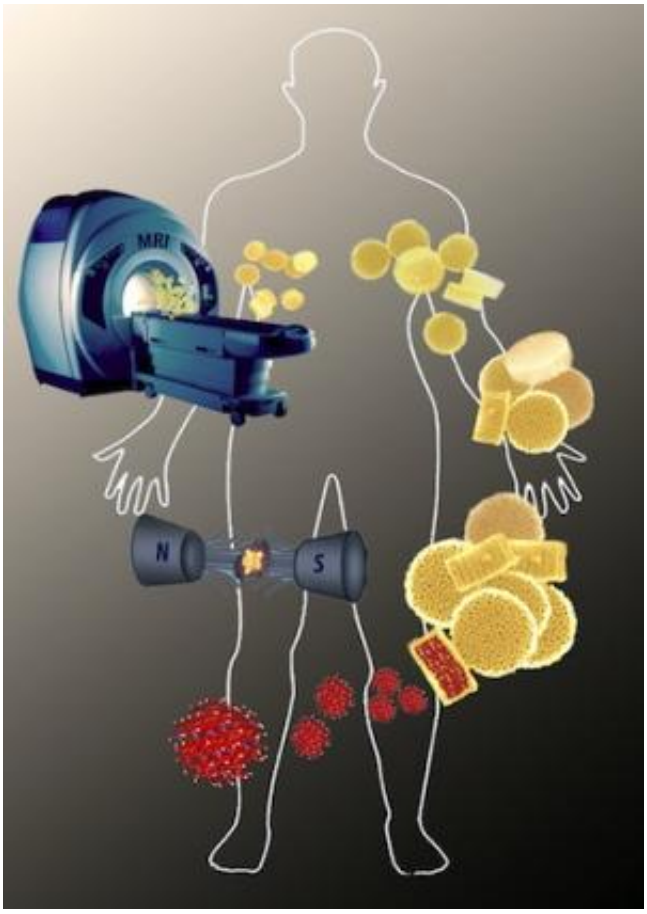
The "nanoconstructs" should fully degrade and leave the body within a few days, they reported.

The research appears online in the journal *Advanced Functional Materials*.

The team led by Rice chemist Lon Wilson and TMHRI scientist Paolo Decuzzi was searching for a way to overcome the challenges presented by iron oxide particles that are good at some things but not others, depending on their size.

Iron oxide particles have many excellent qualities: They can be manipulated with magnets, provide excellent contrast under MRI, create heat when triggered and degrade quickly. But they can't do all that at once. The team needed a way to decouple the functions from their sizes.

The answer was to package thousands of iron oxide particles – with magnetic cores as small as 5 nanometers across – inside larger particles.



Nanoconstructs that contain iron oxide particles could make magnetic resonance imaging a far more powerful tool to detect and fight disease. Credit: Ayrat Gizzatov

The researchers made two such nanoconstructs, embedding iron oxide particles in silicon mesoporous particles (SiMPs) and discoidal polymeric nanoconstructs (DPNs). They knew from previous research that submicron-sized SiMPs and DPNs naturally accumulate within the tumor's blood vessels.

Iron oxide enhances the ability to position and hold the particles in place with magnets, said lead author and Rice graduate student Ayrat Gizzatov. "They get attracted by the magnet, and that induces another dipole-dipole magnetic interaction among the particles and increases their interparticle communication mechanism," he said.

Tests showed iron oxide particles made the nanoconstructs 10 times better than traditional contrast agents with what amounted to significantly lower doses of iron than used in current practice.

The new research also showed that, as a general principle, confining MRI contrast agents (like iron oxide) in geometric structures enhances their relaxivity – the property that makes the agents appear in MRI images. (The shorter the relaxation time, the greater the contrast in the image.)

While the particles are too big to target specific proteins, Gizzatov said it might also be possible to modify them with elements that will increase their accumulation in tumors.

More information: Gizzatov, A., Key, J., Aryal, S., Ananta, J., Cervadoro, A., Palange, A. L., Fasano, M., Stigliano, C., Zhong, M., Di Mascolo, D., Guven, A., Chiavazzo, E., Asinari, P., Liu, X., Ferrari, M., Wilson, L. J. and Decuzzi, P. (2014), "Hierarchically Structured Magnetic Nanoconstructs with Enhanced Relaxivity and Cooperative Tumor Accumulation." *Adv. Funct. Mater.*.
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