Protein-Nanoparticle Material Mimics Human Brain Tissue

July 21 2006

A composite material consisting of a horse protein and metallic nanoparticles displays magnetic properties very similar to those of human brain tissue, scientists have found. The work, published in the June 20 online edition of *Physical Review B*, may help lead to a more thorough understanding of the magnetic behavior of brain tissue and other complex natural materials.

Studying the magnetism of many natural substances, such as rocks, soils, and biological materials, can be difficult because they tend to be a mix of several magnetic components. This means that valuable structural and functional information, which can be obtained from a material's magnetic properties, is often left undiscovered.

"It can be very difficult to separate the different components to study them individually," said the study's lead scientist, geophysicist Ann Hirt, to *PhysOrg.com*. Hirt is a researcher at the Institute of Geophysics in Zurich, Switzerland. "Often, the use of several analysis methods is necessary and, even then, definite conclusions are seldom. Finding and investigating model materials may help remedy this problem."

As a first step, Hirt and her team identified the different components in the brain that produce magnetic signals. They used various magnetic methods, which are normally used to identify magnetic minerals in rocks. They found that the brain tissue, in which the other components are embedded, contributes the strongest magnetic signal, followed by iron in the blood of the brain. Next is ferritin, an iron-carrying protein

found in nanoparticle form. Recently, a fourth component was discovered, but its identity has eluded scientists. It is either the iron-oxygen compound magnetite or a very similar compound, maghemite — or perhaps even a blend of the two. Magnetite and maghemite have such similar magnetic properties that distinguishing between them is very difficult.

“Although the signal from the tissue itself was very strong, we could easily subtract it from the total magnetization,” said Franziska Brem, another Institute of Geophysics scientist geophysicist on the team. “The remaining signal appeared to be a combination of the signals from ferritin and magnetite.”

To confirm this, the group measured the magnetic properties of a model system for which they knew the exact content and that they could study with certainty: a mixture of horse-spleen ferritin and protein-coated magnetite nanoparticles. The results show a striking similarity to the measurements for actual brain tissue.

“Based on these measurements, we can assume that the ferritin and magnetite/maghemite behavior in brain tissue is very close to that of our model material,” Brem said.

By Laura Mgrdichian, Copyright 2006 PhysOrg.com