Twinkling Nanostars Improve Optical Imaging of Tumors

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(PhysOrg.com) -- Researchers at Purdue University have created magnetically responsive gold nanostars that may offer a new approach to biomedical imaging. The nanostars gyrate when exposed to a rotating magnetic field and can scatter light to produce a pulsating or "twinkling" effect. This twinkling allows them to stand out more clearly from noisy backgrounds such as those found in biological tissue. Alexander Wei, Ph.D., and Kenneth Ritchie, Ph.D., M.Sc., led the team that created the new gyromagnetic imaging method. The work appears in a paper published in the *Journal of the American Chemical Society*.

“This is a very different approach to enhancing contrast in optical imaging,” said Dr. Wei. “Brighter isn’t necessarily better for imaging; the real issue is background noise, and you can’t always overcome this simply by creating brighter particles. With gyromagnetic imaging, we can zero in on the nanostars by increasing signal strength while cutting down on background noise.”

The gold nanostars are about 100 nanometers from tip to tip and contain an iron oxide core that causes them to spin when exposed to a rotating magnet. The arms of the nanostar are designed to respond to a light source and reflect light to a camera when properly aligned. This gives nanostars the appearance of twinkling at rates that can be precisely controlled by the speed of the rotating magnetic field. The unique signature of the twinkling nanostars enables them to be picked out easily from a field of stationary particles, some of which can be brighter than the nanostars.

Any signal that does not have the frequency corresponding to the rotating magnetic field can be suppressed in the images, eliminating background noise, Dr. Ritchie said. “It was surprising how well this method enhanced the imaging. It can improve the contrast of the particles to the background noise by more than 20 decibels and can clearly reveal a gyrating nanostar, whereas with existing direct imaging methods, in many cases you wouldn’t be able to definitively find a particle.”

To perform gyromagnetic imaging, the team placed a sample of cells containing nanostars under a standard microscope equipped with a white light source and a rotating magnet. They then sent light through a polarizing beam splitter and into the sample. The light then reflected back through the beam splitter and to the camera. The camera collected images at 120 frames per second, capturing the signal from the nanostars as they spun at approximately 5 revolutions per second.

The setup is simple and practical for general laboratory use, Dr. Ritchie said. “To translate a new imaging technique into something practical for broad use, it needs to be done without specialized equipment,” he noted. “Many other imaging techniques require expensive equipment or lasers, but this method can be done with a halogen lamp and a $10,000 camera.”

After initial data are collected, mathematical operations such as Fourier transforms can be applied to obtain frequency information from the pulsating light signals, allowing the twinkling nanostars to be easily picked out. Biocompatibility tests failed to find any toxicities associated with the nanostars.

This work is detailed in the paper “Gyromagnetic imaging: dynamic optical contrast using gold nanostars with magnetic cores.” An abstract of this paper is available at the journal’s Web site.

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