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New Nano Technique Could Help Detect Disease

Research team harnesses photonic technology

By Caleb Daniloff


Assistant Professor Hatice Altug (ECE)

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Earlier detection of diseases such as cancer and Alzheimer's could be a step closer thanks to BU researchers.

Along with colleagues from Tufts University, they have helped develop a new spectroscopy technique that can identify proteins using less sample material, opening up the possibility of accelerated drug development as well as detecting diseases sooner.

The researchers, led by Hatice Altug, a College of Engineering assistant professor of electrical and computer engineering, created the highly sensitive infrared absorption technique, exploiting recent advances in nanophotonics, a branch of optical engineering that studies light behavior at the scale of one-billionth of a meter. Altug was selected in 2008 for a Peter Paul Career Development Professorship, endowed by a gift from entrepreneur and philanthropist Peter T. Paul (GSM'71).

Altug's method harnesses infrared light to excite the bonds that connect atoms within molecules, causing them to vibrate at a specific frequency. By examining the frequencies of light absorbed by a material, scientists can determine the bonds it contains, and identify what it is.

Because absorption signals are often weak, conventional infrared spectroscopy requires large samples of target molecules in many layers, resembling "a piece of baklava," as one researcher puts it. So Altug's team uses tiny gold nanoparticles as antennae to amplify the signal received from a single protein molecule. This ultra-sensitive approach allows scientists to cull more accurate and useful data.

"Our technique enhances the signal by a factor of up to 100,000," says Altug. "The sensitivity can be high enough to provide spectroscopy at the single-molecule scale, and a single-molecule response can be very different from that of an ensemble of molecules."

Altug and her collaborators — Shyamsunder Erramilli, a College of Arts & Sciences physics professor, Mi Hong, a CAS physics research professor, graduate student Ronen Adato (ENG'13), and research associate Ahmet Ali Yanik, along with Tufts University bioengineers David Kaplan, Fiorenzo Omenetto, and Jason Amsden — reported on their achievement in the online edition of the Proceedings of the National Academy of Sciences on October 30. The National Science Foundation featured the development as well.

The technique could illuminate how protein molecules interact, including the effect of mutations, which can lead to diseases such as cancer, says Ken Rothschild, a CAS physics professor and director of the Photonics Center Laboratory of Molecular Biophysics. The discovery also has implications for drug development, he says, since the impact of external forces on a protein's shape and behavior will be easier to determine.

"If you're a pharmaceutical company and you want to study the effects of a drug that's targeted at defective proteins, you have to have a way of looking at the details of the interaction," he says. "This discovery will be a breakthrough in terms of increasing the sensitivity to look at a whole host of different types of biomolecules and how they function."

"Our plasmonic method is quite general and can be adapted to enhance the infrared fingerprints of other biomolecules, such as nucleic acids and lipids," Altug says. "It therefore provides a general purpose tool kit for ultra-sensitive vibrational spectroscopy of biomolecular systems."