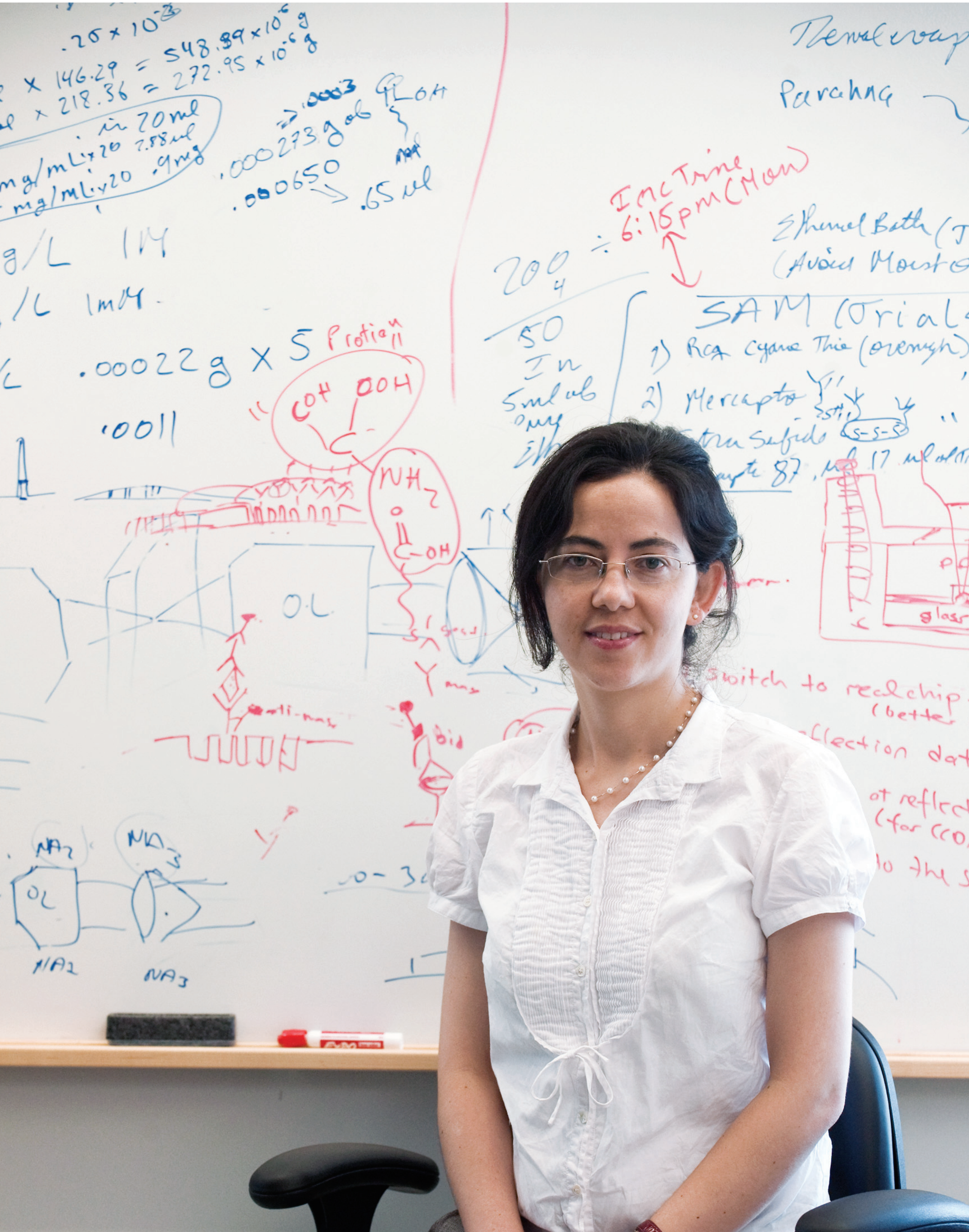
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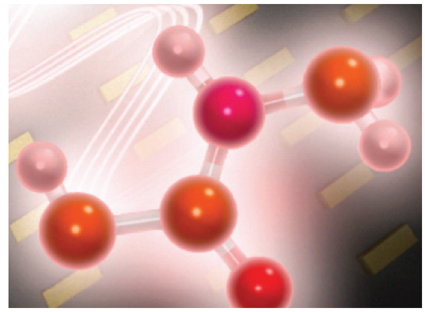
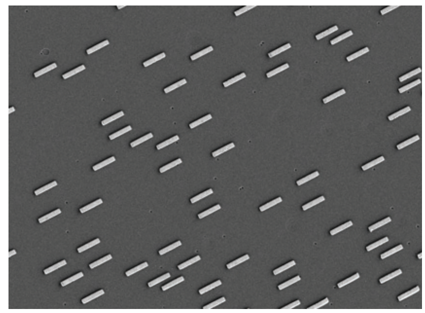
Finding Trouble Before It Starts

NANO TECHNIQUE IDENTIFIES PROTEINS IN A SINGLE LAYER

BY CALEB DANILOFF





Molecules consist of atoms connected to each other by bonds (top), which vibrate at specific resonant frequencies. BU researchers engineered rod-shaped gold nano-antennae (bottom) to increase the vibration signals coming from bio-molecules.

WHEN IT COMES to finding diseases like cancer and Alzheimer's, sooner is always better. Now, thanks to research conducted at Boston University and Tufts University, a new spectroscopy technique is helping scientists do just that, by identifying proteins much faster than had been possible and with much less sample material.

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'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 layer. This ultrasensitive 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, who holds a Peter Paul Career Development Professorship, endowed by Peter T. Paul (GSM'71). "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, research associate Ahmet Ali Yanik, and graduate student Ronen Adato (ENG'13), along with Tufts University bioengineers David Kaplan, Fiorenzo Omenetto, and Jason Amsden (GRS'08) — 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 Kenneth Rothschild, a CAS physics professor and director of the Photonics Center Laboratory of Molecular Biophysics. The discovery also has implications for drug development, Rothschild says, because 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 ultrasensitive vibrational spectroscopy of biomolecular systems." ■

HATICE ALTUG'S new infrared absorption method could illuminate the effect of mutations that lead to diseases such as cancer.

PHOTOGRAPH BY VERNON DOUCETTE