

Scientists probe human cells with high-frequency sound

Sound waves are widely used in medical imaging, such as when doctors take an ultrasound of a developing fetus. Now scientists have developed a way to use sound to probe tissue on a much tinier scale. Researchers from the University of Bordeaux in France deployed high-frequency sound waves to test the stiffness and viscosity of the nuclei of individual human cells. The scientists predict that the probe could eventually help answer questions such as how cells adhere to medical implants and why healthy cells turn cancerous.

"We have developed a new non-contact, non-invasive tool to measure the mechanical properties of cells at the sub-cell scale," says Bertrand Audoin, a professor in the mechanics laboratory at the University of Bordeaux. "This can be useful to follow cell activity or identify cell disease."

The work will be presented at the 57th Annual Meeting of the Biophysical Society (BPS), held Feb. 2-6, 2013, in Philadelphia, Pa.

The technique that the research team used, called picosecond ultrasonics, was initially applied in the electronics industry in the mid-1980s as a way to measure the thickness of semiconductor chip layers. Audoin and his colleagues, in collaboration with a research group in biomaterials led by Marie-Christine Durrieu from the Institute of Chemistry & Biology of Membranes & Nano-objects at Bordeaux University, adapted picosecond ultrasonics to study living cells. They grew cells on a metal plate and then flashed the cell-metal interface with an ultra-short laser pulse to generate high-frequency sound waves. Another laser measured how the sound pulse propagated through the cells, giving the scientists clues about the mechanical properties of the individual cell components.

"The higher the frequency of sound you create, the smaller the wavelength, which means the smaller the objects you can probe" says Audoin. "We use gigahertz waves, so we can probe objects on the order of a hundred nanometers." For comparison, a cell's nucleus is about 10,000 nm wide.

The team faced challenges in applying picosecond ultrasonics to study biological systems. One challenge was the fluid-like material properties of the cell. "The light scattering process we use to detect the mechanical properties of the cell is much weaker than for solids," says Audoin. "We had to improve the signal to noise ratio without using a high-powered laser that would damage the cell." The team also faced the challenge of natural cell variation. "If you probe silicon, you do it once and it's finished," says Audoin. "If you probe the nucleus you have to do it hundreds of times and look at the statistics."

The team developed methods to overcome these challenges by testing their

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techniques on polymer capsules and plant cells before moving on to human cells. In the coming years the team envisions studying cancer cells with sound. "A cancerous tissue is stiffer than a healthy tissue," notes Audoin. "If you can measure the rigidity of the cells while you provide different drugs, you can test if you are able to stop the cancer at the cell scale."

[Listening to cells: A non-contact optoacoustic nanoprobe](#) [1]

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