Shifting sound to light may lead to better computer chips

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A plasma is generated by a laser pulse similar to how sound is converted to light.

By reversing a process that converts electrical signals into sounds heard out of a cell phone, researchers may have a new tool to enhance the way computer chips, LEDs and transistors are built.

Lawrence Livermore National Laboratory scientists have for the first time converted the highest frequency sounds into light by reversing a process that converts electrical signals to sound.

Commonly used piezo-electric speakers, such as those found in a cell phone, operate at low frequencies that human ears can hear.

But by reversing that process, lead researchers Michael Armstrong, Evan Reed and Mike Howard, LLNL colleagues, and collaborators from Los

Alamos National Laboratory and Nitronex Corp., used a very high frequency sound wave - about 100 million times higher frequency than what humans can hear - to generate light.

"This process allows us to very accurately 'see' the highest frequency sound waves by translating them into light," Armstrong said.

The research appears in the March 15 edition of the journal Nature Physics.

During the last decade, pioneering experiments using sub-picosecond lasers have demonstrated the generation and detection of acoustic and shock waves in materials with terahertz (THz) frequencies. These very same experiments led to a new technique for probing the structure of semiconductor devices.

However, the recent research takes those initial experiments a step further by reversing the process, converting high-frequency sound waves into electricity. The researchers predicted that high frequency acoustic waves can be detected by seeing radiation emitted when the acoustic wave passes an interface between piezoelectric materials.

"This is a fundamentally new phenomenon and it can be used to probe structural properties of nanoscopic materials," Armstrong said. "This method has the potential to characterize semiconductor devices more accurately than other nondestructive methods."

Very high-frequency sound waves have wavelengths approaching the atomic-length scale. Detection of these waves is challenging, but they are useful for probing materials on very small length scales.

But that's not the only application, according to Reed.

"This technique provides a new pathway to generation of THz radiation for security, medical and other purposes," he said. "In this application, we would utilize acoustic-based technologies to generate THz." Security applications include explosives detection and medical use may include detection of skin cancer.

And the Livermore method doesn't require any external source to detect the acoustic waves.

"Usually scientists use an external laser beam that bounces off the acoustic wave - much like radar speed detectors - to observe high frequency sound. An advantage of our technique is that it doesn't require an external laser beam - the acoustic wave itself emits light that we detect," Armstrong said.

Source: Lawrence Livermore National Laboratory