New 'metamaterial' device may lead to see-through cameras and scanners

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Devices that can mimic Superman's X-ray vision and see through clothing, walls or human flesh are the stuff of comic book fantasy, but a group of scientists at Boston University (BU) has taken a step toward making such futuristic devices a reality.

The researchers will present their device at the Conference on Lasers and Electro-Optics/Quantum Electronics and Laser Science Conference (CLEO/QELS: 2010), which takes place May 16 to 21 at the San Jose McEnery Convention Center in San Jose, Calif.

Led by BU's Richard Averitt, the team has developed a new way to detect and control terahertz (THz) radiation using optics and materials science. This type of radiation is made up of electromagnetic waves that can pass through materials safely. Their work may pave the way for safer medical and security scanners, new communication devices, and more sensitive chemical detectors.

Scientists and engineers have long sought devices that could control THz transmissions. Such a device would be a technological breakthrough because it would allow information to be sent via THz waves. Like X-rays, these waves can pass through solid materials, potentially revealing hidden details within. Unlike the ionizing energy of real X-rays, THz radiation causes no damage to materials as it passes through them.

The quest to create devices that emit or manipulate THz radiation is often referred to as a race to fill in the "THz gap," since the frequency of

THz radiation on the electromagnetic spectrum falls in between microwave and infrared radiation -- both of which are already broadly used in communication.

This race has often stumbled right out of the blocks, however, because no technologies have proven able to effectively solve the basic problem of manipulating the properties of a beam of THz radiation. Now Averitt and his colleagues have made an important step in this direction by using an unusual class of new materials known as "metamaterials."

Metamaterials are unusual in the way they interact with light, giving them properties that don't exist in natural materials. They have grabbed headlines and captured the popular imagination in recent years after several groups of researchers have used metamaterials to achieve limited forms of "cloaking" -- the ability of a material to completely bend light around itself so as to appear invisible.

Averitt uses these same sorts of metamaterials to interact with and change the intensity of a beam of THz radiation. His device consists of an array of split-ring-resonators -- a checkerboard of flexible metamaterial panels that can bend and tilt. By rotating the panels, his team can control the electromagnetic properties of a beam of THz energy passing by them.

"The idea is that you can manipulate your terahertz beam by reorienting the metamaterial elements as opposed to reorienting your beam," says Averitt.

Arrays of these metamaterial panels could potentially function as pixels on a camera that detects THz radiation, he says. Absorption of THz radiation would cause the panels to tilt more or less depending on the intensity of the THz bombarding them.

"One of the goals, from a technological point of view, is to be able to do stand-off imaging, to be able to detect things beneath a person's clothes or in a package," says Averitt.

Such detection applications, though, would require more powerful THz sources like quantum cascade lasers, which are under development -- though great technological strides have been made in the last few years.

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