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Making strides in quantum dot infrared photodetectors

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Researchers at Northwestern University have made significant strides in the development of quantum dot infrared photodetectors -- technology that may provide new imaging techniques with applications in medical and biological imaging, environmental and chemical monitoring, night vision and infrared imaging from space.

Conventional infrared photon detector technology for imaging applications typically requires that the detector be cooled to very low temperatures -- approximately 77 degrees Kelvin. This cooling requirement adds significant cost, bulk and power consumption to the imaging systems, therefore limiting their usability. By using nanotechnology to form quantum dots, researchers at Northwestern's Center for Quantum Devices (CQD) are one step closer to achieving the goal of developing high-performance imaging techniques that can operate at higher temperatures.

Quantum dots, also known as "artificial atoms," have been widely investigated as a means of improving a variety of electronic and optoelectronic devices. The small size of quantum dots, usually around 10 nanometers, gives them a unique physical property of three-dimensional confinement, which can enable higher operating temperatures when used in infrared detector design.

"The development of an infrared photon detector that can operate at higher temperatures will enable the use of cheaper, lighter and more efficient cooling methods in the design of infrared imaging systems," said Manijeh Razeghi, Walter P. Murphy Professor of Electrical Engineering and Computer Science and director of the Center for Quantum Devices. "This will allow the use of infrared detectors in a much wider range of applications."

Researchers at CQD made a great breakthrough in the development of high-performance quantum dot infrared photodetectors (QDIP). They have developed a QDIP that operates at room temperature with a peak detection wavelength in the technologically important middle wavelength infrared window -- wavelengths between three and five microns are important because they are not susceptible to absorption by Earth's atmosphere. The QDIP is based on a hybrid indium arsenide quantum dot and an indium gallium arsenide quantum well structure grown on an indium phosphide substrate.

The specific detectivity and quantum efficiency at 150 degrees Kelvin were 4×1010 cmHz1/2/W and 35 percent, respectively. This record high performance was published in the March 26, 2007, issue of *Applied Physics Letters*, Vol. 90 No. 13. In devices developed since publication, the performance was further improved with a quantum efficiency of 48 percent through the optimization of the quantum dot growth, which led to stronger infrared absorption.

Source: Northwestern University