

Engineers at USC and UT-Austin boost the sensitivity of night vision goggles by using quantum dots

July 14 2004

Researchers at USC and the University of Texas at Austin have built and tested a device based on nanostructures called quantum dots that can sensitively detect infrared radiation in a crucial wavelength range. The atmosphere is opaque to most infrared, but it is transparent for a narrow “window” between 8 and 12 microns. Night vision goggles, military target tracking devices and environmental monitors utilize this range of wavelengths.

“We have created a detector based on different physics - quantum dot physics - that works at least as well and has the potential to perform better,” Madhukar said.

Madhukar worked with Joe C. Campbell, who holds the Cockrell Family Regents Chair in the UT Austin College of Engineering’s department of electrical and computer engineering. The two engineers described the device in a recent issue of *Applied Physics Letters*.

The device uses self-assembled “quantum dots,” island-like pyramidal structures made of semiconductors. Each dot has a core of indium arsenide surrounded by gallium arsenide and an indium-gallium arsenide alloy. A single dot is approximately 20 nanometers (2 millionths of a centimeter) in base size and about 4 nanometers in height.

The three-dimensional confinement of electrons within these structures

creates unique, characteristic behavior. By using varying proportions of the materials and changing synthesis procedures, engineers can tailor quantum dots for use in lasers, detectors, optical amplifiers, transistors, tunneling diodes and other devices.

“Quantum dots are emerging as the most viable semiconductor nanotechnology for future higher-performance communication systems, biomedical imaging, environmental sensors and infrared detection,” Madhukar said.

Unlike their alternatives, quantum dot infrared detectors strongly absorb radiation shining perpendicular to the plane of an array of quantum dots.

By contrast, the alternate quantum well detectors don’t pick up radiation that shines straight down on them. To achieve this “necessitates additional processing steps,” Madhukar said. This increases the cost of the well detectors.

When the engineers benchmarked the new device using standard tests, its detectivity was nearly 100 times higher than the previously reported peak for quantum dot systems. The new range is competitive with the corresponding values for the well-established quantum well infrared photo detectors.

More information at: www.usc.edu/

Citation: Engineers at USC and UT-Austin boost the sensitivity of night vision goggles by using quantum dots (2004, July 14) retrieved 27 April 2024 from <https://phys.org/news/2004-07-usc-ut-austin-boost-sensitivity-night.html>

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