

Worldwide Coverage: Optics, Lasers, Imaging, Fiber Optics, Electro-Optics, Photonic Component Manufacturing

**PHOTONICS****SPECTRA®**

A Laurin Publication

August 2005

Photonics  
**Technology News**

### InAs/GaSb Superlattice Photodiode Offers Uncooled Mid-IR Operation

Scientists from Northwestern University in Evanston, Ill., the Missile Defense Agency in Washington and the US Air Force Research Laboratory at Kirtland Air Force Base in New Mexico have reported the development of mid-infrared photodiodes that are based on InAs/GaSb superlattices. The two types of devices, which have a cutoff wavelength of approximately 5  $\mu\text{m}$ , are designed to operate at room temperature or at 77 K. With proper design of the superlattice, it should be possible to produce detectors with cutoff wavelengths of between 3 and more than 40  $\mu\text{m}$ , as desired.

A semiconductor superlattice is a periodic structure comprising alternating layers of two semiconductors with different bandgaps. The bandgap of the structure is a function of the thickness of the constituent layers, which can be controlled using precision deposition techniques such as molecular beam epitaxy.

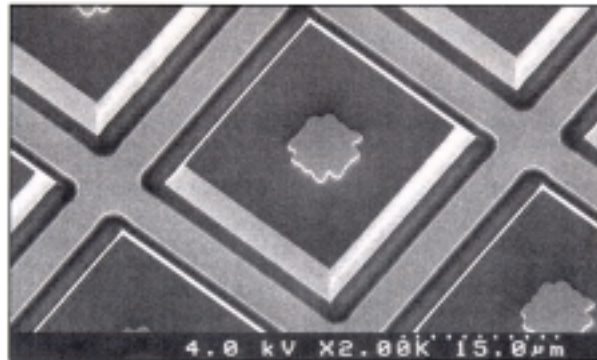
Vaidya Nathan of the Air Force Research Laboratory explained that superlattice detectors are of interest to the military because they promise to outperform the workhorse for infrared imaging applications, HgCdTe.

Specifically, Nathan said, a superlattice detector can offer the same performance as HgCdTe, but it can do so at an operating temperature 10 to 30  $^{\circ}\text{C}$  higher.

The investigators fabricated the PIN photodiodes on GaSb undoped wafers using a solid-source molecular beam epitaxy system from Intevac Corp. of Santa Clara, Calif. Growth and fabrication were performed at Northwestern. The devices designed for room-temperature operation featured eight layers of InAs and 11 layers of GaSb, and those designed for liquid nitrogen operation featured a superlattice of nine layers of InAs and 10 layers of GaSb. The researchers did not passivate or antireflection-coat the completed detectors.

At zero bias, the room-temperature and the cooled devices displayed a detectivity of  $8 \times 10^8$  and  $1.5 \times 10^{10}$   $\text{cm Hz}^{1/2}/\text{W}$ , respectively. The quantum efficiency was of the same order of magnitude for both types, at between 25 and approximately 30 percent, corresponding to a responsivity of approximately 1 A/W. □

Daniel S. Burgess  
*Applied Physics Letters*, June 6, 2005,  
 333106.



Photodiodes based on InAs/GaSb superlattices were designed to have a cutoff wavelength of 5  $\mu\text{m}$  and to display room-temperature operation. Courtesy of Northwestern University.

AUGUST 2005