

Tiny Avalanche Photodiode Detects Single UV Photons

January 28, 2008

In a significant breakthrough, researchers at Northwestern University's Center for Quantum Devices (CQD) have demonstrated visible-blind avalanche photodiodes (APDs) capable of detecting single photons in the ultraviolet region (360-200 nm).

Previously, photomultiplier tubes (PMTs) were the only available technology in the short wavelength UV portion of the spectrum capable of single photon detection sensitivity. However, these fragile vacuum tube devices are expensive and bulky, hindering true systems miniaturization.

The Northwestern team, led by Manijeh Razeghi, Walter P. Murphy Professor of Electrical Engineering and Computer Science at Northwestern's McCormick School of Engineering, became the world's first to demonstrate back-illuminated single photon detection from a III-nitride photodetector. These back-illuminated devices, based on GaN compound semiconductors, benefit from the larger ionization coefficient for holes in this material. The back-illumination geometry will facilitate future integration of these devices with read-out circuitry to realize unique single-photon UV cameras. Towards that end, the team has already demonstrated excellent uniformity of the breakdown characteristics and gain across the wafer.

The devices are coupled with a quenching circuit and operated under large reverse bias, an arrangement termed in Geiger mode operation. The sensor system presents an effective photocurrent gain greater than 10⁷, single photon detection efficiencies of 23 percent, dark count rates of less than 1 kHz, and no response to visible radiation.

Once optimized, discrete detectors could be combined with the ultraviolet LEDs already pioneered by the Center for Quantum Devices to create an inexpensive detection system capable of identifying the unique spectral fingerprints of a biological agent attack. They can also be paired with UV LEDs to create a new form of non-line of sight UV-communication, secure from remote eavesdropping.

These exciting new results were recently presented at the Defense Advanced Research Projects Agency (DARPA) during the Single Photon Detection Workshop hosted by Dr. Matthew Goodman, and held in Arlington, VA on Nov. 27, 2007 and at the SPIE Photonics West Conference held in San Jose, CA on Jan. 19-24, 2008. This work was also published in the July 23, 2007 issue of the journal *Applied Physics Letters*.

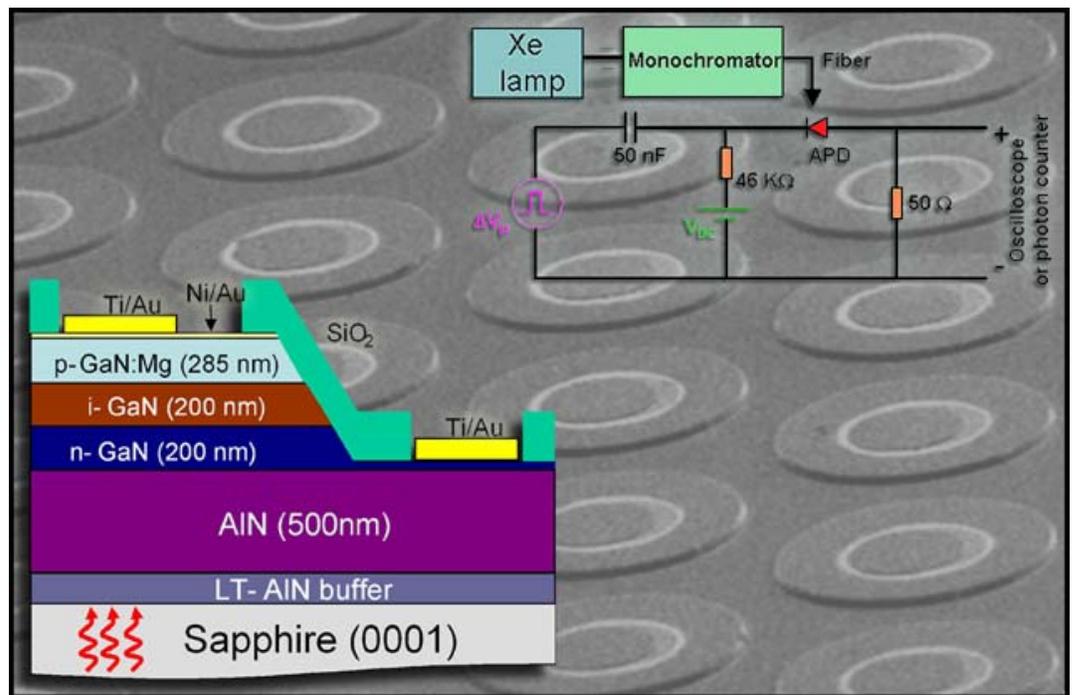


Figure Caption: Lower left, schematic diagram of a back illuminated single photon detector; Upper right, biasing circuit used to drive the single photon detector; Background, scanning electron micrograph of a processed array of single photon detectors.