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NORTHWESTERN UNIVERSITY

October 11, 2005

Tiny avalanche photodiodes target bioterrorism agents

After the anthrax attacks in the United States in 2001 the threat of a larger and more deadly bioterrorism attack -- perhaps from smallpox, plague or tularemia -- became very real. But the ability to detect such biological agents and rapidly contain an attack is still being developed.

In a significant finding, researchers at Northwestern University's Center for Quantum Devices have demonstrated solar-blind avalanche photodiodes (APDs) that hold promise for universal biological agent detection. Once optimized, these sensitive detectors could be combined with the ultraviolet light-emitting diodes (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.

The Northwestern team, led by center director Manijeh Razeghi, became the first to demonstrate 280 nanometer APDs. These devices, based on aluminum gallium nitride (AlGaN) compound semiconductors, have a photocurrent gain of more than 700.

The tiny-sized APDs should be capable of efficient detection of light with near single photon precision. Previously, photomultiplier tubes (PMTs) were the only available technology in the short wavelength UV portion of the spectrum capable of this sensitivity. These fragile vacuum tube devices are expensive and bulky, hindering true systems miniaturization.

The APD technology may see further use in the deployment of systems for secure battlefield communication. Wavelengths around 280 nanometers are referred to as the solar-blind region; in this region, the UV light is filtered out by the ozone layer providing for a naturally low background signal. Solar-blind APDs are intrinsically able to take advantage of this low background level, while PMTs must use external filters to become solar-blind. This makes secure battlefield communication possible utilizing a combination of compact, inexpensive UV LEDs and UV APDs both developed at the Center for Quantum Devices.

The technology for the realization of solar-blind APDs is based on wide bandgap AlGaN compound semiconductors. To date, no semiconductor-based solar-blind APDs have been reported. This is due to numerous difficulties pertaining to the crystal growth of AlGaN compound semiconductors.

The major obstacle in demonstrating high performance solar-blind APDs is the high number of crystalline defects present in the AlGaN semiconductor material. However, researchers at the Center for Quantum Devices have been able to realize high-quality AlGaN so as to demonstrate avalanche gain in the solar-blind region.

Northwestern's results were presented recently by Razeghi at the APD workshop organized by Henryk Temkin, a new program manager at the Defense Advanced Research Projects Agency (DARPA).