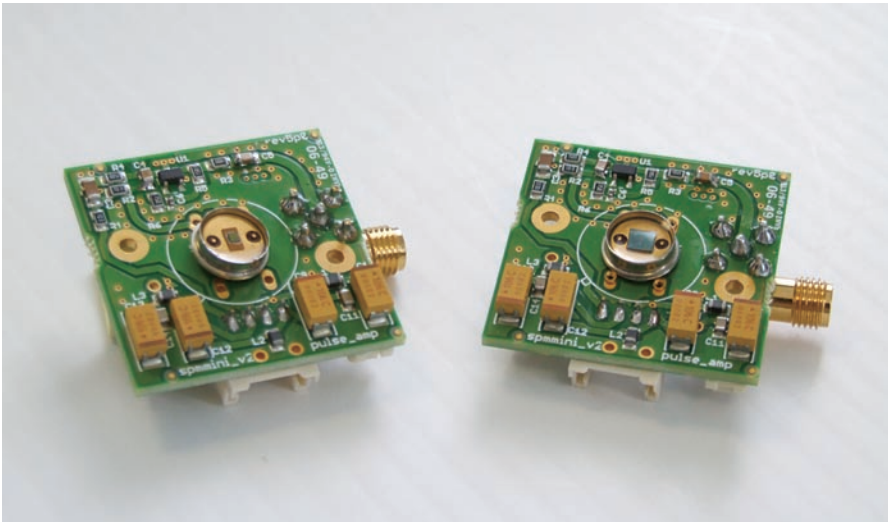
Photodetectors

A wide variety of photodetectors are available to suit applications spanning from telecommunications to single-photon counting. **Neil Savage** takes a look at some of the recent offerings.

Detectors for capturing photons play a vital role in almost any optical system. Whether a particular application uses a standard photodiode or more sensitive devices such as an avalanche photodiode (APD) or a photomultiplier tube (PMT), depends on a variety of parameters, in particular the strength, wavelength and duration of the incident light. For example, in scientific studies where it's important to detect a single photon, APDs are a popular choice, whereas for less demanding applications, such as scanning barcodes, a standard photodiode is usually preferred.

Ken Vensel, a regional sales manager at Opto Diode, says growth in scanning of digital codes, which are used on everything from personal cheques to foods in supermarkets, is pushing sales of photodiodes for barcode readers. Even though photodiodes are not a new technology, Vensel says that there's always a demand to optimize them for specific uses. "They've been around for decades, but there are continually new applications for these products."

Opto Diode also makes space-qualified photodiodes for use in encoders on satellites as well as making bi-cells, which are two photodiodes packaged together with a separator between them. Bi-cells are used for alignment, for instance for paper being fed into a printer. When the signal in the two photodiodes matches correctly, it means the object is aligned. "One of the hot areas in the military is what's called quadrant detectors," Vensel says. These are bi-cells paired together to provide alignment in two directions. They can be used to improve the aiming of missiles at a target.



SENSL

PRODUCT ROUND-UP

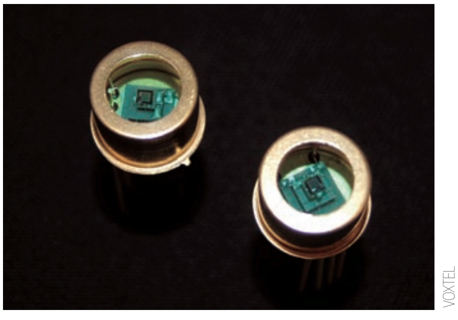
The SPMScint from **SensL** (Cork, Ireland) is a high-performance silicon photomultiplier designed for scintillator-based measurements of radiation. The device offers single-photon sensitivity and can be placed less than 1 mm from a scintillator crystal's emitting surface. The solid-state detector consists of an array of Geiger-mode APDs known as 'microcells', which are individually coupled to integrated quench resistors. The company says the SPMScint has a gain and quantum efficiency comparable to that of a PMT but with the benefits of conventional silicon detectors including compactness, insensitivity to magnetic fields, a low operating voltage, robustness and tolerance to overexposure. Tests with a lutetium oxyorthosilicate scintillator crystal, $3 \times 3 \times 15$ mm^3 in size, have shown an energy resolution of 12.5% at 511 keV. The device is available with an active area of 1×1 mm^2 or 3×3 mm^2, with microcells of either 20 μm or 35 μm in size, to suit a particular application's requirements for detection efficiency and dynamic range. The detector is housed in a TO-5 package and covered with a 300-μm-thick layer of transparent epoxy resin, which protects the detector surface and allows it to be in close proximity to a crystal, optical fibre or other waveguide facet. The detector is designed for use in equipment for nuclear medicine, homeland security, nuclear radiation detection, environmental monitoring, high-energy physics and X-ray detection.
www.sensl.com

The PDB-C216 from **Advanced Photonix** (Camarillo, California, USA) is a blue-enhanced linear-array silicon photodiode containing 16 elements. A borderless design means that numerous arrays can be strung together to make the detector surface as long as necessary. Designed for use in card readers, baggage scanners and optical character recognition, the photodiode array has a typical dark current of 5 nA (50 nA maximum). Its shunt resistance is typically 200 MΩ with a minimum value of 100 MΩ. The spectral range of operation is from 350 nm to 1,100 nm. The detector has low noise equivalent power of 2×10^{-14} W Hz$^{-1/2}$, and the typical response time is 190 ns at 0 V and 13 ns at 10 V. The operating temperature is from −20 °C to 75 °C and the storage temperature is from −40 °C to 100 °C.
www.advancedphotonix.com

AMS Technologies (Munich, Germany) is distributing a series of photodiodes for optical communications applications up to 10 Gbit s^{-1}, manufactured by OSI Optoelectronics (Hawthorne, California, USA). The photodiodes are made from either InGaAs for use at wavelengths of around 1,310 nm

and 1,550 nm or gallium arsenide and silicon for use with 850-nm applications. The silicon photodiodes offer dark current of less than 10 nA and rise time of less than 1 ns for devices with an active area of 10 mm^2, and rise time of less than 2.5 ns for an active area of 30 mm^2. The InGaAs devices have a typical dark current ranging from 0.02 nA to 0.2 nA and have a high responsivity for wavelengths between 1,100 nm and 1,620 nm. They are designed for high-speed telecom and datacom networks. Gallium arsenide photodiodes coupled with transimpedance amplifiers are designed to act as high-bit-rate receivers in local-area, metropolitan-area and other high-speed communications networks that operate at 850 nm. The devices come in industry-standard packages with antireflection-coated windows or lenses to enhance coupling efficiency.
www.ams.de

Voxtel (Beaverton, Oregon, USA) has introduced a design of linear-mode APD that it says combines the low-noise performance of silicon with the infrared sensitivity of InGaAs. Monolithic APD wafers are grown epitaxially on an InP substrate, using only lattice-matched III–V alloys. This is in contrast to methods that fuse a silicon multiplier onto a III–V absorber. The company says its design achieves a low ionization-coefficient ratio of 0.02, compared with a ratio of 0.4 for APDs based on InGaAs absorbers. And where conventional InP APDs have an excess noise factor of about 9.2 at a gain of $M = 20$, the Voxtel device has a noise factor of around 2.3. The noise performance was measured for multiple samples at from 77 K to 295 K and was found to be independent of temperature. The company has a selection of ultralow-noise APDs in different packages with high quantum efficiency within the 900 nm to 1,700 nm spectral range. Packaging options include a broadband, double-sided, antireflection-coated flat window; a 1,550-nm filter; or a lensed cap to enhance coupling efficiency. Applications for the APDs include free-space optical communications, laser range finding, optical coherence tomography, optical time-domain reflectometry, fluorescence measurements, spectroscopy, chromatography and electrophoresis.
www.voxtel-inc.com



VOXTEL

The S10362-11 series of multipixel photon counters, from **Hamamatsu** (Tokyo, Japan) uses a Geiger-mode APD structure to achieve ultralow-level light detection. The photon counters are designed as replacements for PMTs, and operate at voltages less than 90 V and are insensitive to magnetic fields. Potential applications include positron-emission tomography, high-energy physics, DNA sequencing, fluorescence measurement, nuclear medicine, drug discovery, medical diagnostic equipment and environmental analysis. The devices offer high photon-detection efficiency with peak sensitivity at a wavelength of 400 nm. Each device has an active area of 1×1 mm^2, and each pixel contains a quenching circuit so that simultaneous photon events can be counted separately and with a high degree of accuracy. According to Hamamatsu, the devices have typical gain values from 250,000 to several million, depending on the number and size of the pixels — available configurations are one hundred 100-μm^2 pixels, four hundred 50-μm^2 pixels or sixteen hundred 25-μm^2 pixels. Hamamatsu has also introduced the G10342 series of 10-Gbit s^{-1} InGaAs PIN photodiode receivers. The receivers operate at up to 11.3 Gbit s^{-1} and are designed for the transmission of high-speed data within networks using synchronous digital hierarchy (STM-64 or SONET OC-192) or 10 gigabit Ethernet. They are compatible with the miniature device multi-source agreement (XMD-MSA) and can be used in XFP transceivers.
www.hamamatsu.com

HAMAMATSU

Neil Savage is a freelance science and technology journalist based in Lowell, Massachusetts, USA.