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Cameras that go infrared in the night

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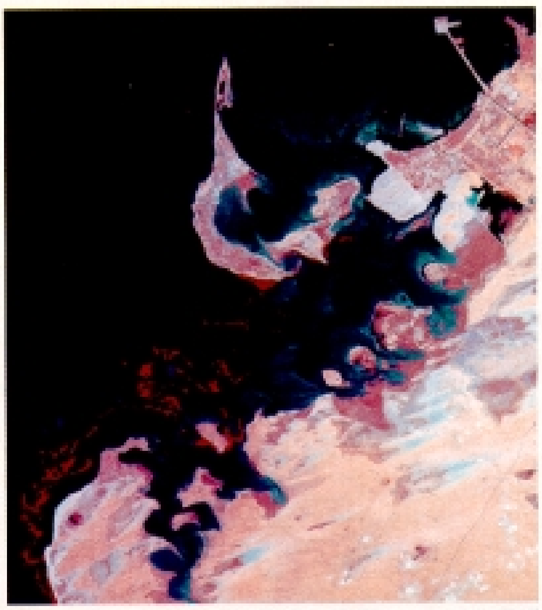
INFRARED detectors made from materials already used in lasers promise to provide the best infrared cameras and night-vision devices yet. These quantum well infrared photodetectors, or QWIPS, are made from alternating layers of semiconductor materials, arranged atom by atom into layers just 10 molecules thick, says Manijeh Razeghi of Northwestern University in Illinois.

These thin layers of Gallium Arsenide and Indium Gallium Arsenide Phosphide (InGaAsP) are called quantum wells because quantum effects come strongly into play at the tiny dimensions involved. Quantum wells are widely used in lasers to generate light from electricity, but Razeghi's devices will reverse that process.

In quantum well devices, electrons can only exist in one of two energy bands—the low-energy "valence" band or the higher-energy "conduction" band. Ina conventional detector, a photon arriving at the surface with sufficient energy knocks an electron into the conduction band. This leaves behind a "hole" which can also act as a positively charged current carrier. If a voltage is applied across the detector, the electron travels through the layers of semiconductor, and the flow of electrons and holes generates an electrical signal.

The new QWIPs, however, are so sensitive that they can detect photons with only enough energy to shift electrons within, rather than between, the two bands. By raising the current carriers to higher energy levels within the same band, photons arriving at the surface enable them to move around under the influence of an applied voltage, and this also generates an electrical signal.



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"We can fabricate these detectors into arrays containing tens of thousands of individual detectors," says Razeghi. "The resolution of cameras based on QWIPS will be far better than today's mercury cadmium telluride (HgCdTe) arrays." She says that the HgCdTe detectors are difficult to make in large arrays because the material is chemically rather unstable.

In contrast, the indium-based compounds are so stable that Jim Hoff, who works with Razeghi, says: "The first array we make will be a square 1024 devices by 1024 devices. The companies making HgCdTe arrays have worked for years to be able to make 480 by 640 arrays." In addition, experience with InGaAsP laser diodes suggests that the detectors should work for thousands of hours.

"This is the first material that is sensitive to both 3 to 5 micrometre radiation, and 8 to 12 micrometre radiation, simultaneously," says Razeghi. "Since the atmosphere is virtually transparent to light at these wavelengths, an infrared camera with such an array should—if mounted on an airplane, or even a satellite—be able to create detailed images from hundreds of metres or even several kilometres away."

Murzy Jhabvala, the chief engineer at the Solid State Device Development Branch of NASA's Goddard Space Flight Center, says that the agency is working with Geophysical Environmental Research, a company in New York that will make an infrared QWIPS camera for mounting in an aircraft. "A plane flying at 1000 metres can detect leaks in oil or gas pipelines, and make images of oil spills," says Jhabvala.

According to Razeghi, the broad spectral range from 3 to 12 micrometres, and the ability to sample two bands simultaneously will allow cameras to collect more information with each scan. "In a single pass, a plane will be able to produce a multicoloured image in the infrared," she says. □