Quantum-dot IR photodetectors get 'hotter'

MANIJEH RAZEGHI

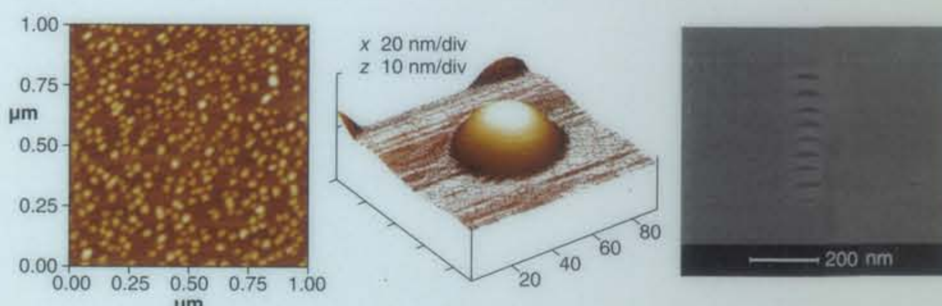

FIGURE 1. An atomic-force micrograph shows InAs quantum dots (left) and a zoom-in view of a single dot (middle) grown by self-assembly with MOCVD. A scanning-electron micrograph of the cross section of the QDIP active region shows that the quantum dots are vertically aligned due to the strain (right).

Most current infrared focal-plane arrays (FPAs) are based on quantum-well infrared (IR) photodetectors (QWIPs) or mercury cadmium telluride (MCT) intrinsic photodetectors, and both types of detectors suffer from significant disadvantages.

Quantum-well IR photodetectors do not absorb much light at normal incidence because the optical transition for light striking normal to the surface is forbidden. Gratings can be used to get around this problem, but the additional fabrication steps increase cost. Furthermore, QWIPs are unsuitable for high-temperature operation because of their high dark current. So they are usually operated at low temperature and require cooling, which adds significant cost, bulk, and power consumption to the imaging system.

In the case of MCT-based detectors, instability of the MCT makes it difficult to achieve high-uniformity detector arrays—so focal-plane arrays based on MCT suffer from high cost and poor yield.

Improvements in operating temperature and quantum efficiency of quantum-dot infrared photodetectors promise improved imaging techniques that may lead to high-performance imagers operating at or close to room temperature.

Recent improvements to the operating temperature and quantum efficiency of quantum-dot infrared photodetectors (QDIPs) may lead to new imaging techniques that can be applied to medical and biological imaging, environmental and chemical monitoring, night vision, and infrared imaging from space. By using nanotechnology to form quantum dots, our research group is a step closer to developing high-performance imagers that can operate at or close to room temperatures.

Quantum dots, also known as "artificial atoms," have been widely investigated as a means of improving a variety of electronic and optoelectronic devices. Their small size, usually around 10 nm, gives quantum dots a unique physical property of three-dimensional confinement that can enable higher operating temperatures

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