



## SPOTLIGHT ON

# **Advanced Imaging Technology**



Digital focal plane array.

MIT Lincoln Laboratory has long been a leader in advanced imaging for defense and scientific applications. Our imaging capabilities are broadly classified into three categories: charge-coupled devices (CCDs), avalanche photodiodes (APDs), and digital focal plane array (DFPA) technology.

- World's lowest readout noise, highest quantum efficiency CCD imagers
- Geiger-mode (GM) APDs with single-photon sensitivity and noiseless digital readout
- DFPAs containing a complete analog-to-digital converter in every pixel, enabling image processing on the focal plane

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#### **Charge-Coupled Devices**

Our CCDs are used in ground, air, and spaced-based applications of interest to the government and scientific research community. These CCDs span a range of wavelengths including visible, near infrared, ultraviolet, and soft X-ray. Among imagers employing our CCDs are the two 1.4-billionpixel Panoramic Survey Telescope and Rapid Response System's (Pan-STARRS) focal plane arrays, the largest focal planes fabricated to date, and the Space Surveillance Telescope's curved focal planes that provide a uniform and wide field of view.



Optical micrograph of back-illuminated CCD wafer.

### Geiger-Mode Avalanche Photodiodes

For passive imaging, the noiseless readout of our GM-APDs enables photon counting, providing both the requisite sensitivity for low-light applications and photon count rates for high-speed imaging. APDs are also employed in active ladar systems to time-stamp photon arrival times, enabling 3D imaging in compact airborne systems. We also fabricate APD arrays on compound semiconductor materials, expanding these capabilities further into the infrared.

### **Digital Focal Plane Array**

Our DFPAs enable sensors with in-pixel computation and inter-pixel data communication to allow image processing at the focal plane prior to transmitting data to a display or computer. DFPAs have been built into a number of systems for use in infrared imaging applications. Fielded systems have helped protect soldiers at forward operating bases, while prototype systems have demonstrated wide-area motion imagery from an airplane and assisted pilots when landing helicopters in degraded-vision environments.



Processed APD wafer.

### **Going Forward**

- Utilize new architectures and fabrication techniques to combine the exquisite uniformity and sensitivity of CCDs with the low voltages and high speeds of CMOS imagers
- Take advantage of on–focal plane processing capability to improve information extraction and enable a new generation of autonomous imaging sensors

### **TECHNICAL CONTACT**

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