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Performance of 12-μm- to 15-μm-Pitch MWIR and LWIR HgCdTe FPAs at Elevated Temperatures

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Infrared (IR) focal-plane arrays (FPAs) with higher operating temperatures and smaller pitches enable reduced size, weight, and power in infrared systems. We have characterized a large number of medium- and long-wavelength IR (MWIR and LWIR) FPAs as a function of temperature and cutoff wavelength to determine the impact of these parameters on their performance. The 77-K cutoff wavelength range for the MWIR arrays was 5.0 μm to 5.6 μm, and 8.6 μm to 11.3 μm for the LWIR. The dark currents in DRS's high-density vertically integrated photodiode (HDVIP)® FPAs (based on a front-side-illuminated, via-interconnected, cylindrical-geometry N+/N/P architecture) are dominated by Auger-7 recombination from 120 K to 200 K for the MWIR and 70 K to 100 K for the LWIR. In these temperature ranges the FPA operability is generally limited not by dark current defects but by noise defects. Pixels with high 1/*f* noise should produce a tail in the root-mean-square (rms) noise distribution. We have found that the skewness of the rms noise distribution is the simplest measure of an array's 1/*f* noise, and that the rms noise skewness typically shows little variation over these temperature ranges. The temperature dependence of the defect counts in normal arrays (wet etched prior to CdTe interdiffusion) increases as n_i, while nonstandard arrays (ion milled or plasma etched prior to CdTe interdiffusion) can have high 1/*f* noise and defect counts that vary as n_i^2. Our models indicate that, if the dominant dark current is due to diffusion, then the 1/*f* noise varies as n_i^2, whereas if depletion current dominates, then the 1/*f* noise varies as n_i. Systemic 1/*f* noise is not an issue for DRS's standard MWIR FPAs at 110 K to 160 K, or for standard LWIR FPAs at 77 K to 100 K.

Key words: Infrared, FPA, MWIR, LWIR, 1/*f* noise, dark current

Reducing an array's pixel pitch reduces the size and weight of the focal-plane array (FPA) and its associated Dewar, cooler, and optics. Higher operating temperatures reduce cooldown time and cooler power, enabling reduced cooler size and weight. High-operating-temperature, small-pitch (≤15 μm) infrared detectors are therefore highly desirable. We have characterized a large number of medium- and long-wavelength IR (MWIR and LWIR) FPAs as a function of temperature and cutoff wavelength to determine the impact of these parameters on FPA performance. The 77-K cutoff wavelength range for the MWIR arrays was 5.0 μm to 5.6 μm, and 8.6 μm to 11.3 μm for the LWIR. DRS's high-density vertically integrated photodiode (HDVIP)® FPAs are based on a front-side-illuminated, via-interconnected, cylindrical-geometry N+/N/P architecture.

The dark current density versus inverse temperature is shown for LWIR arrays in Fig. 1, and for MWIR arrays in Fig. 2. The expected temperature dependence for Auger-7 recombination in HgCdTe is included in Fig. 1. All arrays show similar Auger-7-dominated behavior. No dark current contribution, either diffusion or depletion related, is observed from the N-side of the HDVIP® diode at temperatures

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