Low-Frequency Noise in Mid-Wavelength Infrared Type-II Superlattice Focal Plane Arrays

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BIOGRAPHY

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TECHNICAL ABSTRACT

The type-II InAs/GaSb superlattice material platform has demonstrated itself as a promising alternative to HgCdTe technology for detection and imaging in the mid-wavelength infrared (MWIR) regime [1, 2]. This is due to the incredible growth in the understanding of the material properties and improvement of the device processing which have led to design and fabrication of better devices [3, 4]. The successful demonstration of 320×256 MWIR focal plane arrays (FPAs) [3] together with the band-structure engineering capabilities of this material system make this technology a good candidate for the development of high operating temperature MWIR infrared imaging systems.

However, MWIR FPAs suffer from low-frequency noise (LFN), like any other infrared imaging technology. In order to making better infrared imaging systems, we need to investigate the origin of the LFN and reduce it. It is also essential to study this kind of noise within the context of different parameters such as integration time and operating temperature.

We present the LFN measurement results of a MWIR type-II superlattice FPA [3]. We first perform a study on the relationship between the integration time and the LFN power spectral density (PSD). A first order approximation of the relation between integration time and PSD of the LFN can be shown as the following:

$$P^*(\omega) = \tau^2 P(\omega) \quad (1)$$

where $P(\omega)$ and $P^*(\omega)$ are the PSD of the detector LFN, as a function of frequency, for infinitely large integration time and an integration time of τ sec, respectively. This equation is valid when the product of the integration time and the LFN corner frequency is large enough. It means that the approximation is not valid for high frequency noise. Equation (1) can be used to calculate of the LFN power ratio, ΔP, (in dB) at two different integration times of τ_i and τ_j as the follows:

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$$\Delta P = 20\log\left(\frac{\tau_i}{\tau_j}\right). \tag{2}$$

We also studied on effect of the operating temperature on the LFN spectrum of the FPA. The results [Fig. 1] show that the LFN power spectral density and the corner frequency are changed by increasing the operating temperature, for a fixed bias voltage. However, the slope of the LFN spectrum remains *1/f* over the operating temperature range up to 150 K. The LFN corner frequency stays less than 1 Hz.

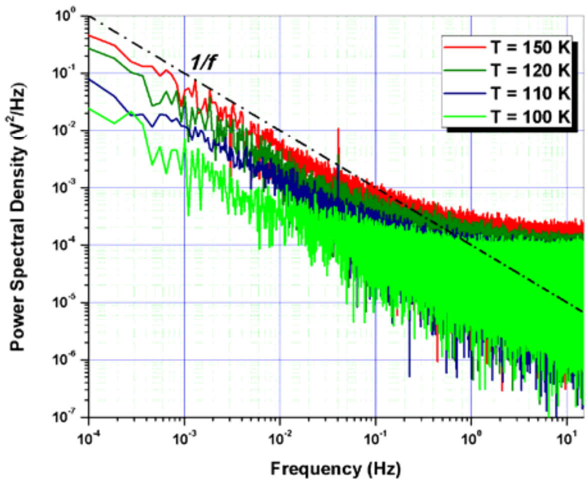

Fig. 1 Comparison of LFN PSD of a MWIR type-II superlattice FPA at operating temperatures up to 150 K (applied bias of 48 mV and an integration time of 5.98 ms).

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