Two-dimensional focal plane detector arrays for LWIR/VLWIR space and airborne sounding missions

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Abstract for Review Process (455 words)

An increasing need for high-precision atmospheric data has arisen in the past years not only for the analysis of climate change and its effect on the earth's ecosystem, but also for weather forecast and atmospheric monitoring purposes. Especially data on the upper troposphere / lower stratosphere (UTLS) region are essential since this region's composition has a significant impact on the radiative balance that triggers climate changes.

Spatially and spectrally resolved atmospheric emission data are advantageously gathered through limb or nadir sounding using an imaging Fourier transform (FT) interferometer with a two-dimensional (2D) detector array in one interferometer arm. For this purpose, the LWIR/VLWIR spectral range with its multitude of spectral bands of key trace gases like O_3, CO_2, N_2O, etc. is of particular interest. European satellite-based and airborne programs making use of this remote sensing technique in the LWIR/VLWIR are, e.g., MTG IRS, PREMIER, and GLORIA.

Cryogenically cooled 2D $Hg_{1-x}Cd_xTe$ (MCT) photodiode detector arrays with their high quantum efficiency, fast response times, and comparatively low power consumption are preferential candidates and best suited for use with FT spectrometers when both high radiometric as well as high imaging performance in the infrared are required. In order to demonstrate the feasibility of large, high-performance MCT-photodiode focal plane arrays for Fourier transform sounding (FTS) applications in the LWIR/VLWIR spectral range, AIM has designed and manufactured focal plane arrays (FPAs) within the MTG phase A predevelopment. Both concepts for the photosensitive detection layer as well as for the read-out integrated circuit (ROIC) have been addressed:

The (112x112) pixel photodiode array in n-on-p technology on LPE-grown MCT has a 40µm pixel pitch and a spectral response cut-off wavelength >14µm at 55K operating temperature. In order to achieve low dark currents, the pv-material is extrinsically p-doped. For increased operability, the 2D array is organized in super-pixels each comprising (2x2) pixels that can be individually selected or de-selected. The application of an anti-debiasing technique promotes the detector response homogeneity in the LWIR/VLWIR high photon flux regime even for large arrays. A broad-band anti-reflection coating permits detector use in the 8-15µm infrared spectral range.

The ROIC has a buffered direct injection input stage for high linearity. It operates in the integrate-while-read mode at a full frame rate of typically 4k frames/sec. For redundancy, the ROIC is composed of two independently operating halves with two analog video outputs each. To accommodate the varying photon flux levels in and outside the zero delay point of

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the interferometer in an optimal way, the signal gain can be switched, and the maximum full well capacity is as high as 143 Megaelectrons.

In this paper, AIM presents its latest results on LWIR/VLWIR FPAs for infrared sounding.

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Abstract for Publication (90 words)

In this paper, AIM presents its latest results on MCT LWIR/VLWIR FPAs for Fourier transform infrared sounding applications in the 8-15µm spectral range. The performance of a (112x112) pixel photodiode test array with a 40µm pixel pitch incorporating extrinsic p-doping, an anti-debiasing technique, pixel select/de-select, and a (2x2) super-pixel architecture is discussed. The customized ROIC supporting IWR operation has a BDI input stage and a FWC of 143 Megaelectrons. It consists of two independently operating halves with two analog video outputs each. The full frame rate is typically 4k frames/sec.

keywords: HgCdTe, MCT, LWIR, VLWIR, FTS, infrared sounder