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QWIP Status at THALES

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Since 2002, the THALES Group has been manufacturing sensitive arrays using QWIP technology based on GaAs and related III–V compounds, at the Alcatel-Thales-III-V Lab (formerly part of THALES Research and Technology Laboratory).

In the past researchers claimed many advantages of QWIPs. Uniformity was one of these and has been the key parameter for the production to start. Another widely claimed advantage for QWIPs was the so-called band-gap engineering and versatility of the III–V processing allowing the custom design of quantum structures to fulfil the requirements of specific applications such as very long wavelength (VLWIR) or multi-spectral detection. In this presentation, we give the status of our LWIR QWIP production line, and also the current status of QWIPs for MWIR (<5 μm) and VLWIR (>15 μm) arrays.

As the QWIP technology cannot cover the full electromagnetic spectrum, we develop other semiconductor compounds for SWIR and UV applications. We present here the status of our 320 × 256 SWIR module with InGaAs photodiodes.

1. Introduction

For 5 years, the THALES Group has been manufacturing sensitive arrays using QWIP technology at the III-V Lab. In late 2005, the III-V Lab moved in new facilities including a 250 m^2 clean room of class 1000/100 fully dedicated to QWIP arrays production. The QWIP production started mainly with quantum structures dedicated to LWIR imagery [1,2].

Serial production of CATHERINE-XP and CATHERINE-MP has now started for the various programs for which both cameras have been selected. THALES has based its current strategy on very compact TI in order to address the largest range of platforms and applications, and is working in cooperation with Sofradir and TRT/III-Vlab on the evolution of the product to take advantage of the new capabilities offered by QWIP technology. In addition, future products based on dual band, multi-band and polarimetric imagery are under development. An overview of these developments is presented.

As far as 2-D arrays are concerned, uniformity of the transducer becomes the critical parameter. Hence from now on we validate our new quantum structures with focal plane arrays (FPAs) measurements or considerations. We present in the following QWIP FPA performance in MWIR and VLWIR spectra.

As the QWIP technology cannot cover the full electromagnetic spectrum, we develop other III–V semiconductor compounds for SWIR and UV applications. We present here the status of our FPA and modules realization in SWIR with InGaAs photodiodes.

2. LWIR QWIP FPA production status

After development and low-rate initial production (LRIP) phase in 2005, the first production stage of the QWIP-based CATHERINE-XP thermal imager [1] by Thales Optronique SA (TOSA) started in 2006. The 384 × 288, 25 μm pitch, long-wave infrared (LWIR) QWIP active layers are produced by Alcatel-Thales-III-V Lab. The hybridisation step and the VEGA-LW-RM4 integrated Dewar device cooler assembly (IDDCA) fabrication are done by Sofradir [2]. The required IDDCA performance (f/2.7; T_{BKG} = 293 K; instantaneous dynamic range > +50 °C; Tint < 7 ms; NETD < 50 mK) must be reached at operating temperatures higher than 75 K. In the following we will address two topics: FPA operability and measured performance of the thermal imager.

The FPA operability has been studied on a set of 403 FPAs. Before integration into IDDCA, QWIP FPAs are sorted in a liquid nitrogen Dewar at 79 K (f/2.2; T_{BKG} = 293 K). The results are reported in Fig. 1. Dead pixels are defined as exhibiting performance levels (output voltage, 20–35 °C response, NETD) at ±30% away from the mean value. This is a very restricting criterion, taking into account unconnected/saturated pixels as well as non-uniformities. The achieved mean operability level exceeds 99.5%, hence the acceptance level is currently set at 99.5% for mass production.

After an initial optimisation phase, the measured IDDCA performance reached an excellent agreement with the calculated value,

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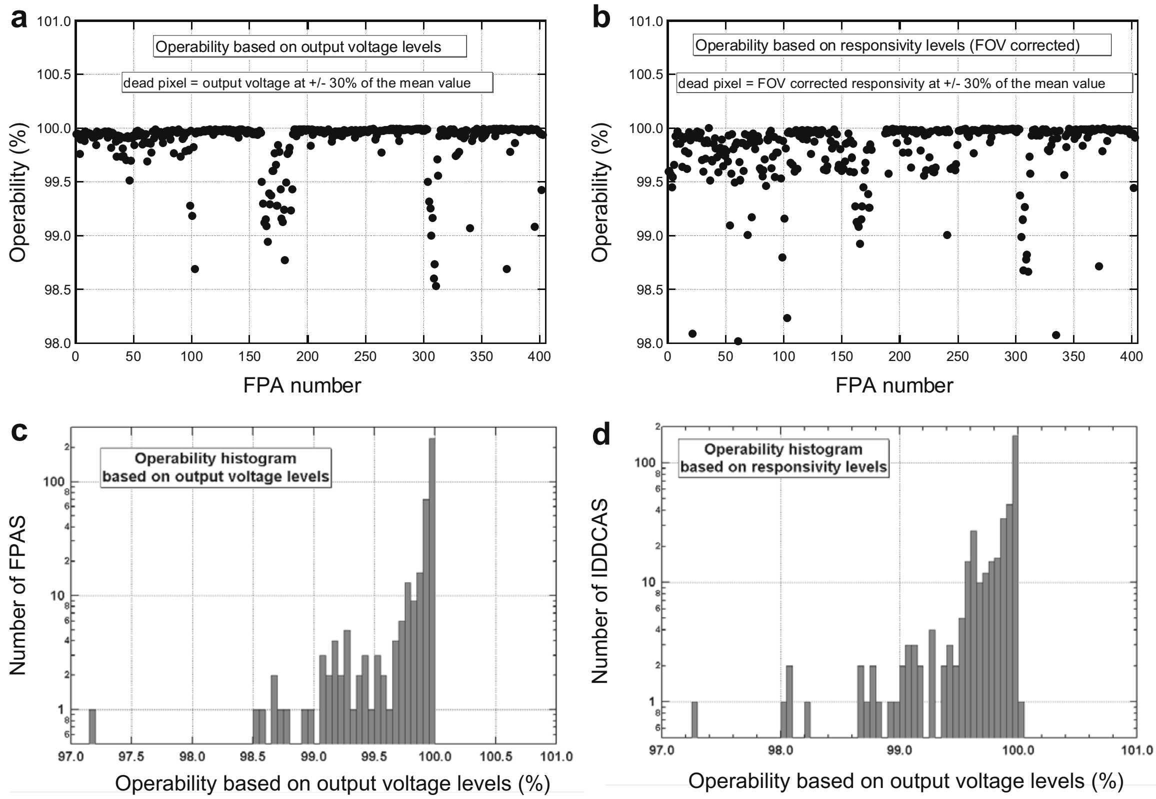

Fig. 1. Operability and operability histograms deduced from: (a and c) output voltage levels and (b and d) field of view corrected 20–35 °C response.

as reported in Fig. 2. The comparison is performed on a set of 400 IDDCAs. NETD calculations are performed considering a FPA temperature of 75 K. They are based on electro-optical characterisations worked out on test cells at the pixel level and take into account the mean scene temperature, instantaneous dynamic range and field of view [3].

The next step will be to guarantee the required performance level at fixed integration time, leading to simplified IDDCA operation. Moreover, the excellent temporal stability of the QWIP technology allows in-factory non-uniformity correction (NUC), stable over the entire lifetime of the imager. Only one offset correction is needed at cool-down: this greatly simplifies the imager architecture, and avoids any interruption during observation for recalibration of NUC tables.

Last but not least, the required performance level is now achieved at 79 K (f/2.7; T_{INT} = 5.5 ms; instantaneous dynamic ran-

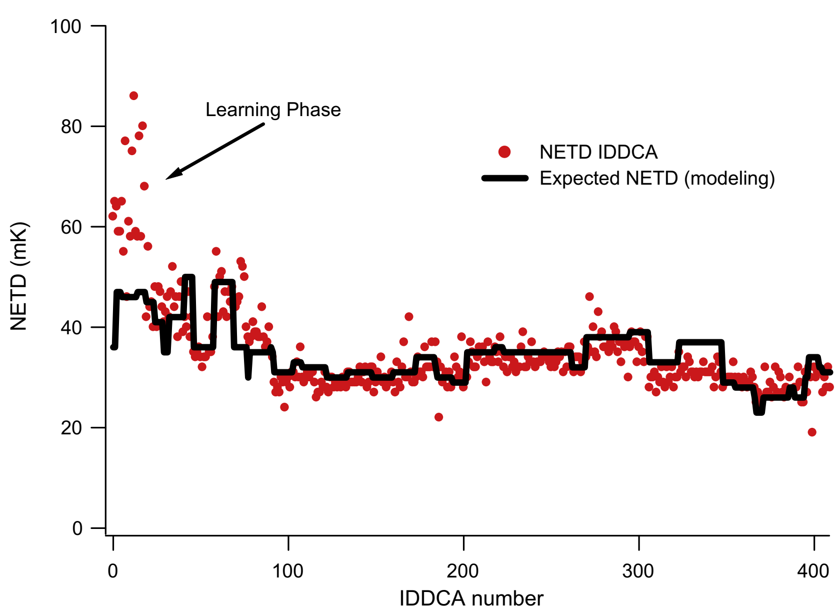

Fig. 2. Comparison between the NETD of the IDDCA and the calculated value (FPA temperature = 75 K).