Thermal imaging systems for Mobility and IoT – TF3

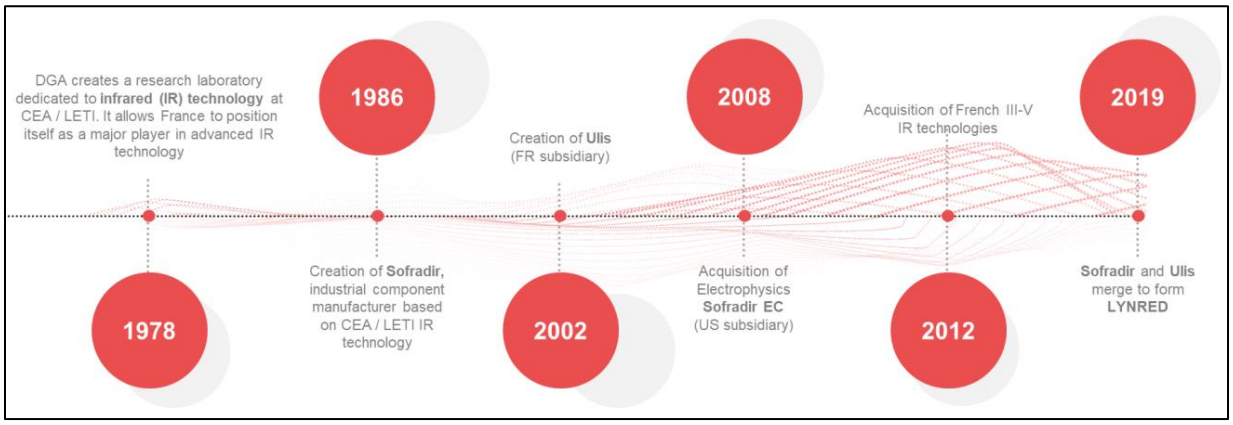
High performance and very large IR sensors for Astronomy and Space applications – TF5

High Operating Temperature IR sensors – TF5

Company presentation

LYNRED is an Integrated Device Manufacturer (IDM). End of 2020, with its subsidiaries LYNRED USA and LYNRED Asia-Pacific USA, it totaled about 1050 employees. LYNRED specializes in designing and manufacturing high quality infrared technology products.
LYNRED was founded in 2019 from the merger of SOFRADIR (created in 1986) and ULIS (created in 2002). However, the roots of the company's history go back more than 35 years to the development of the first Mercury Cadmium Telluride (MCT) infrared detector in what would later become Europe's Imaging Valley: Grenoble, France.
Since 1986, the very beginning of the company, about 1 million detectors have been shipped. The company is jointly owned by Safran and Thales which both own 50% of LYNRED.

Figure 1: Timeline of the major events in LYNRED history.



The company has a vast portfolio of infrared detectors that covers the entire electromagnetic spectrum from near (NIR) to very far (VLWIR) infrared. LYNRED covers these IR wavelength bands with 2 main families of infrared sensors:

- Sensors made using a MEMS-above-IC technology for which the whole semiconductor process takes place on Si wafers.
- Sensors requiring hybridization between a Read-Out Integrated Circuit (ROIC) made from CMOS Si wafers and a detection circuit made from II-VI ternary alloys ($Hg_{1-x}Cd_xTe$ compound semiconductor, also called MCT) or III-V materials (InGaAs and others).

LYNRED's business model is to provide its customers infrared detectors that they can integrate in their products. The main applications and markets served by LYNRED products are:

SPACE

AEROSPACE

LYNRED is among the main European manufacturers for space-grade infrared detectors. 90 different LYNRED products are used on spacecraft to date.

40 LYNRED products are currently orbiting the earth or exploring the solar system.

SECURITY & SURVEILLANCE

SECURITY / SURVEILLANCE

LYNRED has the widest range of infrared detectors on the market for stationary and mobile surveillance, observation, and detection at all distances and in all weather.

INDUSTRY

INDUSTRY

LYNRED provides sensors for thermography, machine vision, gas detection, and firefighting systems, for building inspection, risk prevention, in-line quality inspection, environmental safety, and manufacturing process.

LEISURE & OUTDOOR

LEISURE & OUTDOOR

Compact, robust, and affordable infrared detectors for nature observation during the day and at night, in all weather.

DEFENSE

DEFENSE

LYNRED supplies high-end infrared detectors battlefield-proven for army, navy, and air force applications worldwide.

SMART BUILDINGS
ThermEye™ Building detectors are easy to integrate into smart building systems for presence detection, people counting, and activity classification to enhance workspace management, energy efficiency, safety, and security.

AUTOMOBILE
Reliable obstacle detection and in cabin monitoring day and night in all weather conditions for enhanced safety today and autonomous vehicles tomorrow.

In 2020 LYNRED revenue was 237 000 000. Each year LYNRED invests about 15% of its revenue in R&D.

Objective

LYNRED presents 3 complementary sensor developments in terms of knowledge and sectors, fully aligned with the IPCEI objectives. One is in Technology Field 3 (smart sensors) and two in Technology Field 5 (compound semiconductors):

- In TF3, the main project objective is to propose innovative thermal systems for emerging markets and applications where the thermal sensing will bring a clear added value in terms of performances, robustness and reliability. The main targeted markets are the Transport & Smart Mobility market, especially Automotive, and the IoT market, especially Smart Building.
- In TF5, Lynred aims to develop very large dimension and very high performance IR imagers for astronomy (extremely large telescope) and space applications (earth observation). It requires II-VI semiconductors of the HgCdTe family,
- InTF5, the second objective aims to develop high operating temperature (HOT) MWIR imagers based on III-V semiconductors. These sensors are designed to be integrated in drones for on-demand localized and more precise monitoring and for portable systems.

Challenges

Thermal imaging systems for Mobility and IoT – TF3
Next generation of IR focal plane technologies must address pixel pitch reduction in order to produce large format imagers at minimum cost. For imaging applications, for example automotive ADAS systems, there is also a need to maintain high sensitivity together with a thermal time constant ($Thau_{th}$) compatible with video rate. Hence typical specifications for NETD and $Thau_{th}$ are respectively <50mK and <10ms, whatever the pixel pitch.

High performance and very large IR sensors for Astronomy and Space applications – TF5
Today, high performance HgCdTe infrared FPA can be manufactured by Lynred but not with dimensions compatible with the astronomy market needs which Lynred plans to address with $2k^2$ FPAs with 15µm pitch (2048x2048 pixels).

High Operating Temperature IR sensors – TF5
For HOT sensors the challenge is to identify the semiconductor materials, the device architecure and develop the processes that will allow to manufacture performant and reliable MWIR sensors operating at high temperature (>150K).

Solution approaches

Thermal imaging systems for Mobility and IoT – TF3
The solution to address the identified challenges and reach the project objective described in the previous sections lie in the development of multiple key technologies:

- IR sensor technologies related to the focal plane array,
- Vacuum packaging technologies,
- IR optics technologies,
- Electronic and signal processing technologies,
- Integration module technologies.

These key technologies have to be developed in a holistic approach. They are dependent from each others and can impact on technical choices to be taken.

High performance and very large IR sensors for Astronomy and Space applications – TF5
Lynred will develop the following technologies to address the identified challenges:

- 4'' CdZnTe substrates and HgCdTe epilayers. They are required to process multiple detection circuits per substrate
- 4'' HgCdTe/CdZnTe wafer processing line
- 8'' Si wafers processing line
- Acceptance electro-optic test set-up and protocol

High Operating Temperature IR sensors – TF5
Lynred will develop the following technologies to address the identified challenges:

- Modeling tools able to design the epitaxial structure used to absorb and collect IR photons, identify the key parameters and ensure a first-pass success for the design of the 15 µm pitch and 7.5 µm pitch ROICs
- growth of material to generate the iGn epitaxial structures defined by modeling (1st brick). iGn technology requires Molecular Beam Epitaxy (MBE)
- detection circuit technology for 15 µm pitch and 7.5 µm pitch in order to isolate each pixel and to be able to make the electrical connection with the ROIC.
- Chemistries for material etching
- Numeric, high-frame rate and small pixel size (7.5 µm) compatible ROIC, to trigger high-end applications. This will be a double challenge as testing hardware and software will also have to be fully developed in parallel

Perspectives

Thermal imaging systems for Mobility and IoT – TF3
15 years ago, demanding applications such as defense market required night vision capabilities to support soldiers on the field. Developed in the 90s, thermal imaging device based on Microbolometer MEMs technology started to be introduced into handheld Night Vision goggles. Over the last 15 years, efforts done in research and development to mainly lower cost and size while increasing production

capabilities helped to extend the use of thermal imaging devices and associated system in other markets like:

- Commercial: energy audit, building inspection,
- Security and surveillance,
- Firefighting to detect and to rescue people through smokes,
- Leisure for recreation and hunting.

Lynred aims at extending microbolometer sensor usage to

- IoT
- Smart transportation
- Smart Building

Smart Phone Integrator.

High performance and very large IR sensors for Astronomy and Space applications – TF5

Short-term forecasts for large R&D infrastructure programs are usually difficult to evaluate. Such programs are indeed often impacted by important delays due to technical difficulties, political factors linked to the international nature of the programs or budget shortage. Astronomy facilities are prone to this type of uncertainties.

There is one certainty though. It is that on the long-term programs will more and more need very large sensors: ESA and CNES programs, Giant Magellan Telescope (GMT), Thirty Meter Telescope (TMT)...

High Operating Temperature IR sensors – TF5

Multispectral, hyperspectral and drone markets for gas detection, security, agriculture, and environment monitoring are emerging. Market studies and forecasts predict a bright future to these application fields. However, they are still at a developing phase and the accuracy of the predictions is difficult to evaluate. Some of these developments for example depend heavily on environmental policies which in turn depend on political factors. For example, the timing of and the way regulations are put in place to control green house gas emission may significantly change the need for HOT sensors aboard drones for gas detection and industrial site monitoring.

Project information

- Technology field(s): TF3 and TF5
- Project coordinator: Lynred
- Project duration: 5 years
- National funding reference: Nano 2022
- Location(s): Grenoble and Palaiseau (France)
- Public Authority Contact: DGE