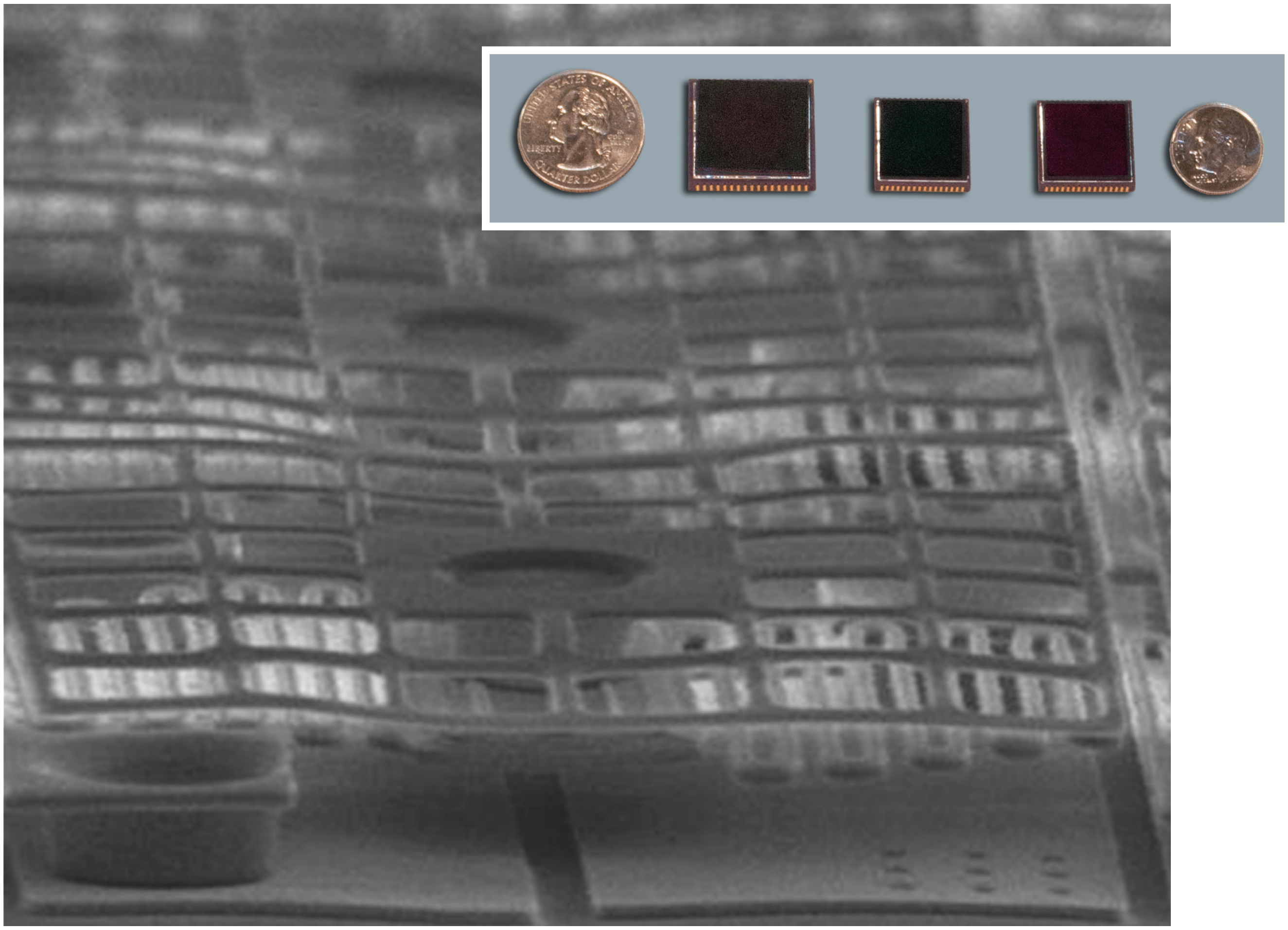
ADVANCED-ABSORBER MICROBOLOMETER SUPERSTRUCTURE

LEONARDO DRS' PATENTED SENSOR TECHNOLOGY REVEALED

Leonardo DRS, Electro-Optical & Infrared Systems



LEONARDO DRS

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Since the inception of infrared sensor integration and the first Forward Looking Infrared equipment in the 1960s, thermal technology development has matured at unprecedented rates, garnering wide-spanning adoption from the defense and aerospace industries initially - progressing to commercial applications in present day. The key drivers of market adoption for thermal imaging products lies in four basic requirements;

(1) ***S***ize
(2) ***W***eight
(3) ***P***ower consumption
(4) ***C***ost

This is also referred to as ***SW***a***P***-***C***. The most significant development in the production of infrared sensors and their ability to affect improvements to SWaP-C requirements stems from the introduction of uncooled focal plane array (FPA) designs. Uncooled sensor technology, by the nature of its material makeup and manufacturing processes, is a far more affordable option for infrared sensor development. In contrast to infrared imaging material such as Mercury Cadmium Telluride (HgCdTe) and Indium Antimonide (InSb) which require a cryogenic cooling device to maintain core temperatures and minimize background noise, uncooled infrared packages can be manufactured in much smaller form factor, meeting requirements for smaller size, lower weight and power input, for more flexible integration.

Beyond specialized military applications such as thermal weapon sights and night vision enhancers, the progress of uncooled infrared sensor development has paved the way for a host of applications spanning multiple industries, to include commercial and civilian. Still, the growth in these markets is tied to the manufacturer's ability to provide even smaller, lighter and more cost effective uncooled devices without compromising image quality and effectiveness.

As businesses evaluate the incorporation of these specialized sensors into their systems, a high degree of confidence must be established, ensuring that the sensor selected is a viable solution that will address current and future performance goals. When establishing a consideration set for evaluating uncooled thermal camera applications, many businesses have come to realize that not all detector offerings deliver the same performance – and not all providers have a viable roadmap to support future demands. Leonardo DRS is committed to delivering state-of-the-art uncooled thermal technology for a broad range of applications and has the pedigree to support such a demand. DRS' efforts to meet and exceed requirements for improved size, weight and power have not derailed the company from its legacy of providing best-in-class, high performance infrared products. Therein lies the delicate balance between SWaP-C advancement and maintaining the integrity of the sensor's imaging capability. Through years of persistent development efforts against rigorous quality standards, DRS' patented Advanced-Absorber Microbolometer Superstructure offers equilibrium to this balancing act.

Back to Basics – Asking the Pivotal Question

To address the performance demands of its uncooled thermal offering with greater sensitivity and reliability, the Leonardo DRS' team led by Principal Staff Scientist, Dr. George Skidmore, PhD, focused their attentions to evaluating the common microbolometer construct, the micro-machined device inside the uncooled FPA. Microbolometers measure the fluctuations in temperature and transduces radiant-heat energy from the scene onto a thermal image. Critical to the microbolometer's performance is the absorbent nature of material used and its ability to effectively generate electrical resistance. ***Could this vital component be enhanced for heightened performance?*** This question provided the ground work for years of laboratory research and the eventual success of the Advanced-Absorber Superstructure.

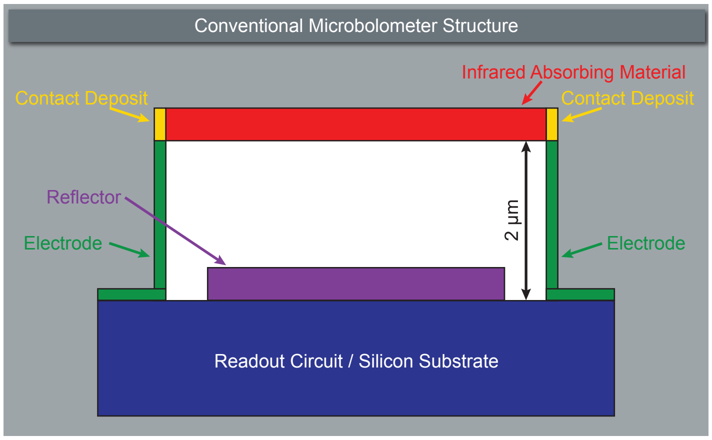
To fully appreciate the incredible innovation behind this structure, a baseline understanding of standard microbolometers is required.

Conventional Microbolometer Structures

Microbolometers are made up of a pixel array, where each pixel contains several material deposits. Common microbolometer are comprised of:

1. Silicon substrate and readout integrated circuit (ROIC)
2. Electrical contact deposits
3. Reflector
4. Infrared absorbing material

Infrared Absorbing Material: There are a variety of infrared absorbing materials used within the industry. Vanadium Oxide (VOx) and Amorphous Silicon (a-Si) are among the most prevalent in uncooled sensor production. Leonardo DRS is one of the world's premier providers of VOx based detectors, pioneering thin films development. Thus, the Advanced-Absorber Superstructure contains a VOx infrared absorbent material.



Single vs. Double-Layer Structures: Beyond the infrared absorbing material used, microbolometers can be further categorized by their basic layering structure. There are two types of microbolometers commonly utilized in uncooled infrared sensor builds; single and double-layer.

Single-Layer: A single-layer microbolometer is comprised of a transducer element, which is the heart of the measurement that registers the change in temperature, and a leg structure. In order for the device to effectively measure the temperature change, it must be isolated thermally from the Readout Integrated Circuit (ROIC). To do so, the leg structure, a thin connecting element, creates a raised void. A critical shortfall of the single layer design is that some of the space needs to be devoted to the leg structure and the balance of available radiation falls on the leg, which isn't consumed or converted. The only way to be accurately measured is if it falls on the transducer structure.

Double-Layer: A double-layer microbolometer consists of a space-filling metal/dielectric sandwich layer designed to fill the available area and capture a maximum amount of incoming radiant heat energy. The end result is a structure over the pixel that resembles an umbrella. A critical advantage to the double layer umbrella structure is that the second layer can fill space over the top and ensures approximately 95% of radiation from the 8-14 micron spectrum is absorbed. The double-layer structure would provide the fundamental architecture of DRS' Advanced-Absorber Superstructure.

Thermal Isolation: A key component of any microbolometer structure is the intentional gap between the infrared absorbing material and the silicon substrate/ROIC. This structure is in place to account for the energy that is passed through the infrared absorbent layer. The reflecting material then redirects some of the lost energy back to the absorber. This gap is created with components that act like legs suspending the absorber above the ROIC. It is in this component of the microbolometer structure that DRS would affect significant improvements with its Advanced-Absorber Superstructure.

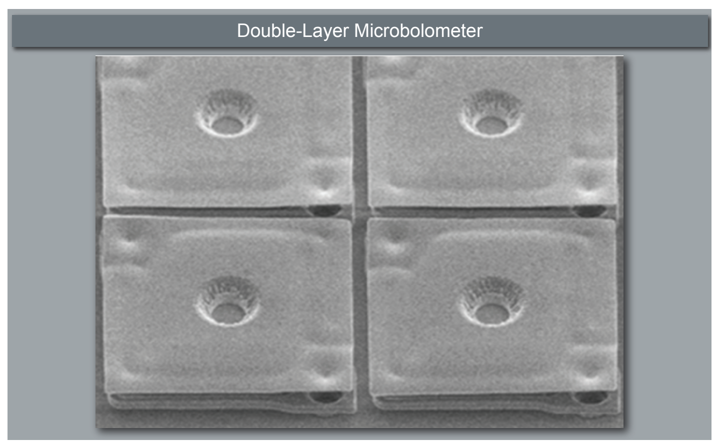
A Simple Concept for a Competitive Edge

Armed with the initiative to investigate existing microbolometer structures in the hopes of uncovering new methods or structures that may yield greater sensitivity, the DRS discovery team developed a simple hypothesis for experiment.

A double-layer microbolometer structure could potentially be further optimized to reduce the amount of radiant energy lost through reflections and transmissions, increasing absorption.

The resulting discovery would push forward a concept that, until then, would have been viewed as a counter-intuitive bolometer design.

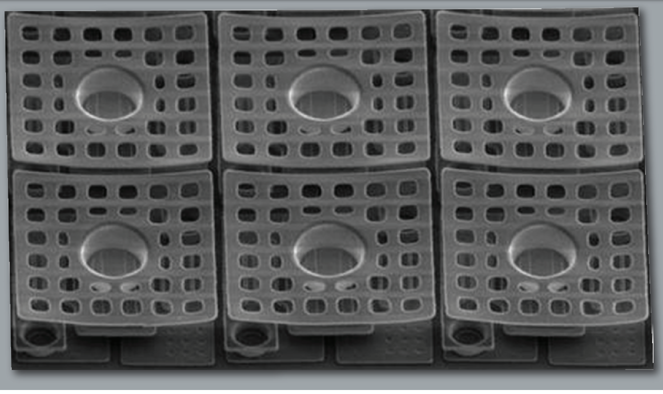
Recall the comparison of the double-layer design to an umbrella over the pixel. Put simply, the patented Advanced-Absorber Superstructure sought to alter the double-layer device by puncturing holes in the space-filling umbrella layer. This layer is responsible for radiant heat absorption. The reason this would have been viewed as "counter-intuitive" is that the umbrella layer of a standard double-layer microbolometer is thought to have been designed with an optimized (or maximized) surface area to capture more of the radiation, and puncturing this layer would decrease its measurable surface area and mass.



So, why would a punctured umbrella layer positively affect sensitivity and performance? The design improves performance through increased absorption and faster temperature rise. The fact is, even though the umbrella absorber layer has less solid surface mass, it is better able to capture incoming radiant energy. Because the thermal mass of the umbrella has been reduced by the holes, the radiant energy heats the umbrella faster, for better responsivity.

The holes of its umbrella layer are a sub-micron size, which are smaller than the incoming long-wave radiant energy, affording the Advanced-Absorber Superstructure the ability to better capture this energy. A traditional solid umbrella structure is prone to higher reflection rates typically

DRS' Patented Advanced-Absorber Microbolometer Superstructure



measured at 20% reflectance, whereas the Advanced-Absorber Superstructure with precision recesses reduces reflection by a factor of four, producing an average of 5% reflectance.

Manufacturing a Competitive Advantage

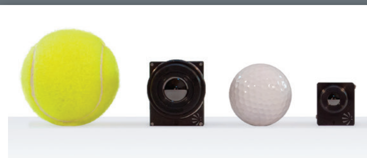
Manufacturers of infrared sensors will continue to push the envelope for new advantages in SWaP-C requirements. Adjustments to these market drivers will only add to the flexibility of infrared imaging and lead to greater induction in new products and systems. While these advancements are vital to the growth of infrared imaging, SWaP-C improvements often come at the expense of image quality, reliability and performance. DRS' patented Advanced-Absorber Microbolometer Superstructure is the catalyst of integrity in thermal image quality. The design allows for greater sensitivity and its unique packaging provides DRS with proprietary advantages for further product development, be it smaller pixel pitch, varying resolutions, custom calibrations, or smaller packaging.

In review, the Advanced-Absorber Superstructure separates DRS from the pack with greater responsivity, better contrast with lower noise and improved resistance – all resulting in superior image quality and reliability.

- Expedient Response Requested – The device's ability to convert the incoming radiation into an electrical signal is enhanced as the umbrella layer maximizes fill factor and delivers faster heat transfer.
- Maximized Contrast with Minimized Noise – The sub-micron holes in umbrella maximize absorption and the temperature rise of the traducer. The transducer layer is then uniquely optimized for minimum thermal conductivity to the substrate. The net effect is better image contrast without disturbances to the signal.
- Path of Least Resistance - The Advanced-Absorber Superstructure offers lower resistance to room temperature variances. Decreasing resistance leads to lower power requirements. Devices with higher resistance also adversely output greater noise levels. The Advanced-Absorber Superstructure is optimized with lower resistance to help mitigate noise and decrease power input.

About Leonardo DRS Electro-Optical & Infrared Systems

Loeonardo DRS is a leading supplier of integrated products, services and support to defense and commercial partners along with prime contractors worldwide. The company is a wholly owned subsidiary of Leonardo S.p.A, which employs approximately 47,000 people worldwide. Leonardo DRS Electro-Optical & Infrared Systems line of advanced sensors and solutions is developed and manufactured in Dallas, Tex. and Melbourne, Fla.



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- Integrated shutter for flat field correction
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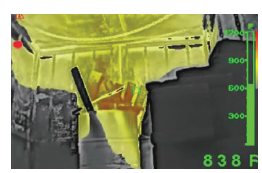

To get more information on Leonardo DRS and our family of thermal camera cores and detectors, call 855.230.2372 to speak to a DRS representative today or visit www.drsinfrared.com.

Leonardo DRS | Electro-Optical & Infrared Systems
13532 N. Central Expwy, Dallas, TX 75243, Tel. 855-230-2372
sales@drsinfrared.com | www.drsinfrared.com