Technology FAQ

Comparing the OTS-1000 to Infrared (IR) Thermography

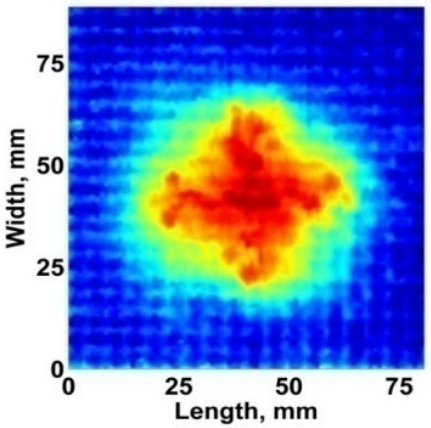
Overview

Optical Transmission Scanning (OTS) is based on transmission measurements using ultraviolet (UV), visible (VIS) or near Infrared (NIR) light sources. OTS techniques originated in lab environments as a cost-efficient alternative to ultrasound testing (UT) for non-destructive testing (NDT) of fiberglass composites. The principles, validation, and comparison with conventional NDT techniques are published in several peer-reviewed publications.

Although OTS can be treated as radiography or through-transmission UT using the light instead of X-ray radiation or sound waves, respectively, it is less intrusive than radiography and less affected by UT air/material interfaces.

For flat composite samples, a two axis flat scanner system is simple and cost effective. Implementing OTS for more complex structures will involve more costly robotics, however the core technology is expected to produce the same high resolution measurements.

OTS is useful over a broad range of composite material and while it has many advantages over legacy technologies, it is limited in two areas by its core principles. The first limitation is that both sides of a sample must be available; one to the optical source and one to the sensor. Secondly, the sample must be semi-transparent to the source (not necessarily in the visible range).



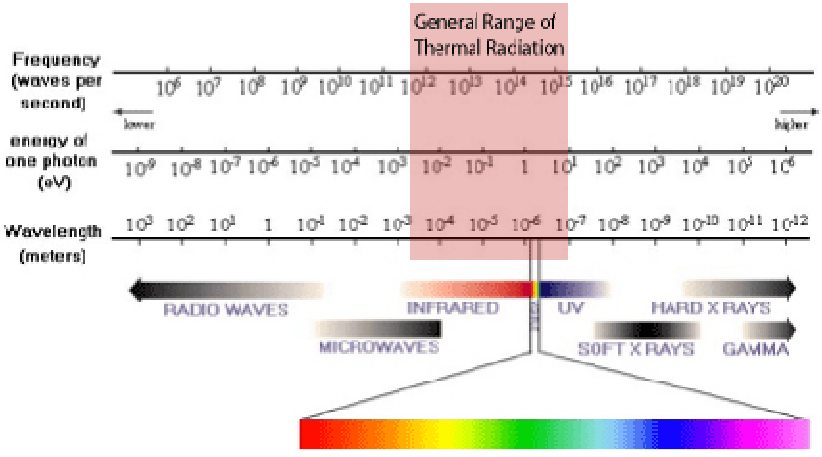
Repeated impact damage to GFRP is shown to be distributed quasi-uniformly in the circumferential direction.

Basics of Infrared Testing

Infrared testing has been an industry standard since 1992 and is the technology of choice for locating temperature hot spots in machinery and electronics. When the emissivity of the sample is known, IR accurately measures surface temperatures, locates "hot spots" inside composites, metals and solid plastics. Diverse applications for IR testing includes monitoring heat caused by excess bearing wear in machinery, observation of heat flows in electrical circuits and even observation of warm bodies inside cool structures. Famously, IR scanners were used to locate the Boston Marathon bomber hiding inside a fiberglass boat.

IR thermography makes use of radiated energy between approximately 400 to 700 nanometers ("sunlight") to about 10 micrometers (invisible infrared). A wide variety of sources and detectors have been developed over the years.

The simplest IR instruments use a single detector, typically a thermistor or bolometer. They can be incorporated in portable instruments and, when calibrated for the emissivity of the source, accurately measure surface temperature in both contact or non-contact modes.



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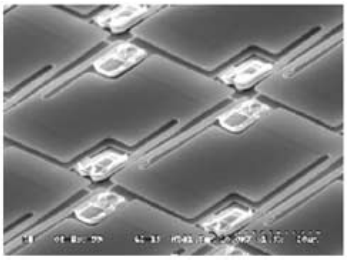
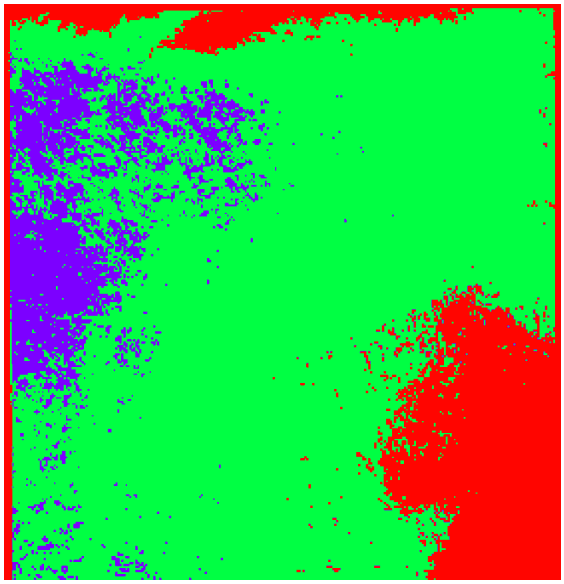
Complex IR systems utilize arrays of sensors to map temperature over an area as opposed to a point, then induce external heating to create heat flow. These thermal scanners allow operators to observe changes of internal thermal conductivity or interruptions to thermal paths. Operators can then infer from differential measurements the presence of flaws or breaks in structures, provided the thickness is not too great.

Differences between OTS and IR Thermography



1. OTS uses lasers to transmit energy through a sample. IR uses an internal or external heat source to generate energy.
2. OTS directly analyzes the molecular structure of a sample. For example, it can differentiate between filler and matrix. IR can only measure the surface radiation and must make assumptions about the interior structure of a sample.
3. The resolution of an IR system depends on the physical layout of the sensor array (image on right); the OTS maps a sample with a laser with much higher resolution.

Summary of OTS Advantages compared to IR thermography



1. **Analysis of Insulating Material:** OTS works better than IR thermography with thermal insulating materials, such as glass fiber reinforced polymer composites. IR can work well with thin metals.
2. **Hard Data:** OTS provides quantitative results unlike IR thermography, which is more qualitative. For example, the image on the right shows the ratio of filler and matrix in a chopped fiber composite structure. The operator sets the specifications for excessive filler or matrix, and the OTS provides a high resolution image of the "good" and "bad" areas. The "blue area" shows composite where the matrix exceeds the spec, the "red area" shows composite with excessive filler (chopped fiber). The "green area" shows where the mix of filler and matrix meet the specification.
3. **Depth of Penetration:** Several centimeters compared to less than 2 mm for IR thermography.
4. **Superior View of Structures:** Because OTS measures optical density as opposed to thermal conductivity, materials with quasi-isotropic material distribution, such as fiber reinforced polymer composites, can be analyzed for any internal defects, not simply for areas with notably different thermal properties.
5. **Cost:** OTS systems are significantly less expensive that state-of-the-art active IR thermography systems.
6. **Sample Degradation:** OTS does not degrade the sample with repeated heating and cooling.

See the OTS-1000 at CAMX 2018
October 16-18
Kay Bailey Hutchinson Convention Center
Dallas, Texas

"We'll be in booth L-85"

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