APPLICATION STORY

Active thermography from a Resistance Spot Welding (RSW) specimen with flash-light in pulse-thermography mode, Source: LWF

FLIR THERMAL IMAGING CAMERAS HELP RESEARCHERS MONITOR AND EVALUATE INNOVATIVE JOINING TECHNIQUES

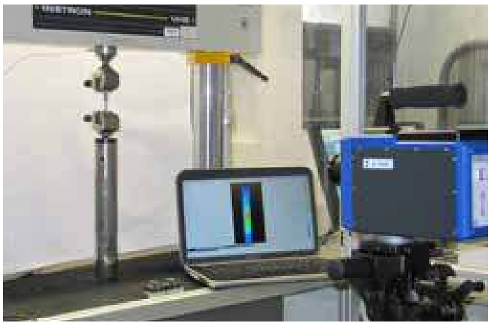
Industries like automobile, aircraft and railway manufacturing are increasingly using new composite materials like carbon. Although these materials hold many benefits for the design and production of these vehicles (high performance and light weight to name a few), they also come with new challenges in terms of manufacturing, inspection and maintenance. At the Laboratory for Materials and Joining Technology (LWF), part of the University of Paderborn in Germany, researchers particularly focus on the development of joining techniques for composite materials. In their search for the most durable and energy-efficient materials, they use the power of thermal imaging cameras from FLIR Systems to test novel joining techniques.

The Laboratory for Materials and Joining Technology (Laboratorium für Werkstoff- und Fügetechnik, LWF) is a nationally and internationally recognized research organization focusing on joining technology and materials engineering. New and optimized joining techniques are necessary for pure material combinations as well as hybrid or composite materials. These techniques include mechanical joining, adhesive bonding, thermal bonding or welding, and hybrid joining (which is a combination of the before-mentioned techniques). A major goal of the LWF is the economic development and manufacturing of energy-efficient and affordable lightweight structures by specific research in materials and joining technology.

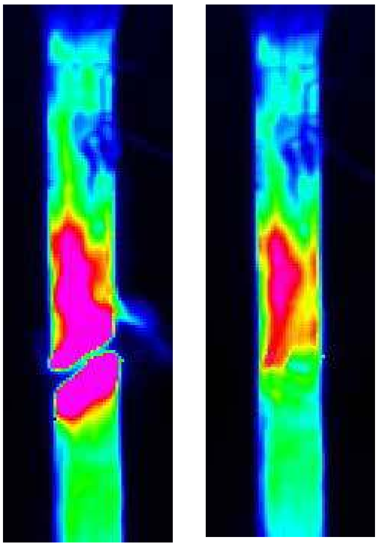
THERMAL IMAGING FOR NON-DESTRUCTIVE TESTING (NDT)

In addition to the development of new joining processes, the LWF also performs experimental and numerical process simulations, stress analysis and life prediction tests with joined hybrid structures under application-related conditions. For these tests, the LWF now relies on cameras from FLIR Systems.

"In our domain of research, you need a technology that allows you to rapidly inspect large areas, without the need to disassemble anything, and that allows you to easily analyze your inspection results," says Eng. Frederik Bröckling, researcher at the LWF. "Thermal imaging provides just that technology."



The LWF uses FLIR cameras to test joined hybrid structures under application-related conditions. Source: LWF



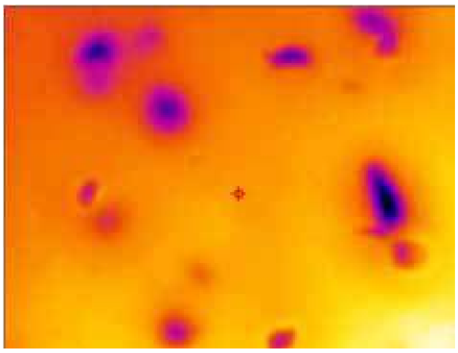
Thermal measurement of a high-speed tensile test on metal specimen (passive thermography), Source: LWF

Thermal measurement of Friction Element Welding (FEW) process (passive thermography), Source: LWF

The LWF benefits from the use of both active and passive thermal imaging techniques. Basically, IR thermography can be divided into two approaches. The passive approach tests materials and structures which are naturally at different (often higher) temperature than ambient while in the case of the active approach, an external stimulus is necessary in order to induce relevant thermal contrasts.

PASSIVE THERMOGRAPHY

At the LWF, passive thermography with a FLIR SC7650 camera is especially used for research and testing of welding processes (thermal joining), since welding naturally includes extreme temperatures. The monitoring of resistance spot welding processes with thermal imaging enables additional information on the inhomogeneity within a joint. A good weld requires the metal to be heated uniformly to melting temperature. By looking at the thermal image of a weld, it is possible to see how the temperature varies across and along the weld. The temperature measured by the camera is a proper indicator for the strength of the weld: a weld is considered acceptable if its average temperature and the standard deviation of the temperature fall within specified limits.



Active thermography from an adhesive specimen with halogen-light in lock-in-thermography mode (with different defects), Source: LWF

ACTIVE THERMOGRAPHY

The LWF also applies the active thermography techniques to research mechanical joining, adhesive bonding and hybrid joining. In this set-up, the LWF relies on a dedicated NDT solution including a FLIR SC7650 camera, designed by German vision sensor specialist Automation Technology. The total solution, called IRNDT, supports a wide variety of NDT techniques based on active thermography, including Lock-In Thermography (with a periodic heat stimulus), Pulse Thermography (with short energy pulses) and Thermal Stress Analysis (inspecting the mechanical stress of components by the thermoelastic effect).

In the set-up provided by Automation Technology, a heat source gives the inspected material a thermal excitation. The flow of thermal energy through the material has a direct influence on the temperature development on the object's surface. This temperature development is recorded over a certain period of time with a FLIR SC7650 camera and subsequently analyzed by the IRNDT software. The software calculates a resulting image by a mathematical analysis and provides the LWF researchers with information about the internal structure of the material as well as or about possible defects within the material.

FLIR SC7650 CAMERA

Research applications rank among the most demanding applications for thermal imaging cameras. The same is true for this project. According to Eng. Frederik Bröckling, the FLIR SC7650 proved to be the best choice, for a variety of reasons.

"The speed and frame rate of the camera were very important for us due to the conductivity of certain materials. For example, if you cast a heat impulse on aluminum, the speed with which aluminum absorbs and gives off heat is so fast, that you need a high-speed camera for accurate recording." Depending on the model and detector, the FLIR SC7000 series can deliver thermal images up to a speed of 62,000 Hz. Windowing allows a subset of the total image to be selectively read out with user-adjustable window size at a much higher frame rate.

The FLIR SC7650 has a number of unique features that are of great value in research environments, such as FLIR's CNUC™ calibration technology.

"We also needed a camera that can be triggered externally and that can be combined with various lenses. Sometimes, we need to be able to monitor closely. Other times, for example with welding applications, we need to keep a certain distance, so that the camera will not suffer from electrical and thermal interference. For these different set-ups, you need different lenses."

FLIR Systems also brings a number of unique features to the table that have proven to be of great value in research environments. FLIR's CNUC™ technology for example is a proprietary calibration process that provides beautiful imagery and accurate measurement stability. CNUC™ calibration also produces accurate measurement stability regardless of camera exposure to ambient temperature variations. The FLIR proprietary Hypercal™ feature ensures the best measurement range with the highest sensitivity. Users can simply set the desired lower and upper temperature limits and the camera will automatically adjust to the appropriate integration (exposure) time.

LWF®

At the Laboratory for Materials and Joining Technology (LWF), part of the University of Paderborn in Germany, researchers particularly focus on the development of joining techniques for composite materials.

For more information about thermal imaging cameras or about this application, please visit:

www.flir.com/research

The images displayed may not be representative of the actual resolution of the camera shown. Images for illustrative purposes only.