## Nondestructive inspection of CFRP using active thermography

**The electrical conductivity of carbon fibers in composites allows them to be heated by induction. The heating patterns can be observed by an infrared camera and provide information on fiber breakage or ondulations. Together with optically excited thermography, a large class of defects can be detected in a contact-free manner.**

Active thermographic techniques are working contact-free and allow fast image generation and defect detection even on curved component surfaces. Active thermography is based on well-defined heating up of the component for testing purposes. Two types of excitation are well suited for industrial application, namely optical excitation and inductive excitation.

Optically excited thermography by flash lamps or intensity modulated halogen lamps is already a well-established technique to detect inner delaminations in CFRP. Using this type of excitation the heat source is located in a layer at or close to the surface of the component depending on the optical penetration depth of the employed light. The heat propagation further into the component depends on the thermal properties of the material.

### Combining methods

Due to the electrical conductivity of carbon, composites made of carbon fibers can in addition be excited by using an induction coil. The currents induced in the fibers cause resistive losses which lead to release of heat. Furthermore, contact points between crossing fiber bundles are generating heat. The current is following the fiber direction as far as possible and then suddenly changes its direction to form a closed loop. As a consequence, the anisotropic character of most CFRP materials becomes clearly visible in the thermographic images.

Due to the relatively low electrical conductivity of carbon the electromagnetic penetration depth (skin depth) is often much larger than the material thickness. This results in volume heating with the advantage that the component can be heated from any side, given by its accessibility, with similar result. The disadvantage of volume heating is that inner delaminations are less easily detectable compared to optically excited thermography. However, if fibers are broken, e. g. due to an impact, or if ondulations are present, the current flow in the defect area will change significantly. This will produce a clear contrast in the thermographic images.

In total, both variants of active thermography complement one another to detect typical types of defects.

*Thermographic phase image of impact-generated cracks in CFRP*

*Induction coil in front of an infrared camera*

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