INSPECTION OF CFRP USING ACTIVE THERMOGRAPHY – STATE OF THE ART AND CHALLENGES

CHRISTIAN SPIESSBERGER
EDEVIS GMBH
STUTTGART
OUTLINE

• What is Active Thermography?
• Properties of Optically Excited Thermography
• Applications in Manufacturing and Maintenance of CFRP components
Using excitation sources in combination with infrared thermography is called “Active Thermography”
OPTICALLY EXCITED LOCKIN THERMOGRAPHY (OLT)
Landing flap measured at different modulation frequencies

decreasing lockin frequency → increasing thermal diffusion length
OPTICALLY EXCITED LOCK-IN THERMOGRAPHY

PROPERTIES

Advantages
- Depth resolved measurement
- Non-contact
- one-sided access
- Fast
- Robust
- Independent of inhomogeneous heating
- Inspection of complex structures

Limitations
- Limited depth range, approx. up to 5 mm in CFRP
- Lateral resolution strongly deteriorates for larger depths
- Cracks perpendicular to the surface are usually not detectable
- Kissing bonds are usually not detectable
- Disbonds between honeycomb and skin are usually not detectable
OPTICALLY EXCITED LOCK-IN THERMOGRAPHY
TESTING OF LARGE STRUCTURES
DETECTION OF SURFACE-NEAR VOIDS

Tested object:
Stringer-reinforced CFRP panel with hidden voids and porosity
**Detected on:**
Stringer-reinforced CFRP panel with hidden voids and porosity
OPTICALLY EXCITED THERMOGRAPHY

DETECTION OF SURFACE-NEAR VOIDS

Thermography

Manual ultrasound testing
OPTICALLY EXCITED THERMOGRAPHY
IMPACT DETECTION
OPTICALLY EXCITED THERMOGRAPHY
IMPACT DETECTION AT TAIL ROTOR AXLES

CFRP tubes at different impact energies

lock-in thermography phase image

Samples of EADS - Eurocopter
OPTICALLY EXCITED THERMOGRAPHY

TESTING OF ADHESIVE JOINTS

CFRP car body (foot space)
OLT Phase image at 0.01 Hz

- dry fibers – absence of resin
- missing adhesive
- bond line
MONOCOQUES TESTING

VOIDS AND POROSITIES

wheel suspension area

monocoque, side view
Carbon fibre preforms are made of **Stitch bonded fabrics** (multi-axial interlaid complexe of non crimped fabrics (NCF)).

Detection of a gap (missing roving in the –45° direction)

Detection of stitched fuzz ball

OLT Phase signatures at 0.1 Hz
OPTICALLY EXCITED THERMOGRAPHY
FIBER ORIENTATION MEASUREMENTS (FIRST PLY)

Fiber orientation hardly detectable in the visible region of the spectrum

Very good contrast in the infrared
CONCLUSIONS

• Optically excited thermography is applicable to a wide range of applications
• The method is limited in its depth range but very sensitive near the surface
• CFRP components can be tested during manufacturing and maintenance
• Applications range from testing of inserts, characterization of repaired areas, testing of fiber preforms, thickness measurements, detection of voids, detection of dry areas, detection of undulation, testing of fiber preforms, etc.
THANKS FOR LISTENING!

christian.spiessberger@edevis.de