Shearography
Composite-NDT

„Make the invisible visible“
Content of Presentation

- Product lines
- Shearography principle
- Materials to be inspected
- Defects to be found typically
- Applications
- Systems
- References
- Summary

Products for Aerospace Applications

3D Scanners:
- Geometry (COMET & T-SCAN):
  - Compare (CAD data)
  - Measure
    - Distance
    - Radius
- Shearography NDT (ISIS)
NEW NDT METHOD

- NEW approach to NDT: Shearography (ST) method
- Enables Non-contact inspection
- Delivers Full-field results
  - 1.4 Million datapoints
- Very Fast method
  - Image was obtained in 10s
- Included into international inspection standards:
  - NAS 410/ EN4179 (ST) training & certification standard
  - ASNT SNT-TC-1A (Visual and optical testing procedure)
  - ASTM E 2581-07 (Standard practice of Shearography for composites & aerospace applications)
Technical Basics – Shearographic Principle

Debond
Deformation
Gradient
of Deformation
Reference Image
Resolution 30 nm
Thermal excitation
Vacuum excitation
Shearography Sensor
Spatial Gradient of Deformation

Fields of Application
Materials To Be Inspected

- CFRP Sandwich Laminates
- Honeycomb
- Aluminium Honeycomb
- Glass fiber - Foam®
- Foamcore Material
- Carbon-Rohacell®
- Sandwich Material
- Glare®
- Carbon - Nomex
- Aluminium Honeycomb

Defects To Be Found Typically

- Debondings
- Delaminations
- Cracks
- Impacts, Dents, BVID's
- Tooldrop impacts
- Failed repair areas
- Wrinkles, Waves
- Inclusions:
  - Air, Water, Foil
  - Foreign Material (FOD)
Applications

C-130 Hercules

- Inspection of CFRP/GRP nose
- Detection of delaminations
- Matching results with 3D-CAD data
C-130 Hercules

- Detection of two laminate debonds
- Merging and matching of results with imported 3D CAD data

C-130 Hercules

- 100% documentation
- Complete stitching of results
Shearography inspection on Tornado hull
- Time saving full-field inspection method necessary in maintenance for detection of dents and impacts

Acoustic liner material
- Detection of laminate-honeycomb core defects
- Full automatic testing by stationary unit
• Barely visible impact damages on a stringer panel
• Inspection of impact
• Damage assessment of surrounding area

Shearographic image

Theoretical approach
Barely visible impact damages

NDT on UAV Wing

- NDT on UAV wing
- Shearography enables fastest inspection procedure
- Defect detection with thermal excitation
NDT on Drone Wing

- Two fields of dry fibres were detected
- Flaws not visible
- Easy localization of defects

Nitrogen Satellite Tank

- Set-up: Optical Shearography NDT System (ISIS1100)
- Tank measurement on cylindrical and dome area
- Detection of artificial inserts
- Radome area stiffer than cylindrical area
Cylindrical area defects

- Cylindrical area inspected
- All 4 defects found
- Defects of inserts in CFRP
- Thermal excitation of 4s

Radome area defects

- Thermal excitation 5s
- All 4 defects found
Shearography on Rohacell material

- NDT of ROHACELL® material
- Thermal excitation
- Testing time less than 15 seconds
- Carbon top skin
- Adhesive layers

- Material is used for:
  - Body panels of Boeing’s Delta II, III & IV rockets
  - Stringer structures in the pressure bulkheads of the Airbus A380/ A340
  - Helicopter applications as main and tail rotor blades and fuselage panels
Composite Vessel Testing

- Composite pressure vessel
- Breathing tank demonstrator
- Type 4, 6, 8 l
- Drop tests according to norm
  EN12245:2002 (D)
- Loaded via internal pressure
- Sensor in pressure chamber

BAM
Federal Institute for Materials Research and Testing

Composite Vessel Testing

- Defects found on all impacted areas
- Pressure variation for detection (0.5 Bar)
- Analysis shows metric of defects
- Results transferable to other tank designs

BAM
Federal Institute for Materials Research and Testing
Performing technical evaluation of shearography to inspect sandwich structures after assembly

ISISmobile 3000 on thick sandwich structures at Airbus in Toulouse

Delamination

Located unbonded honeycomb junction

Delamination
Stringer delaminations – real defects

Stringer delamination – difference of stiffness visible

Delaminations on back side

Field of View (FOV)

Sector 1

Sector 2

Delaminations – real defects

Stringer delamination – difference of stiffness visible

Delaminations
**Aircraft Engine Cover**

- One shot > 4 results
- Thermal loading
- Field of view: A4 paper size

**Aluminium Honeycomb**

Detection of artificially induced defects on backside with ISIS mobile 3100
Wing-Box NDT: Wrinkles

- NDI of wing box panel
- Wrinkles detected by Shearography
- Section analysis shows cut wrinkle details

Wing-Box NDT: Delaminations

- NDI of wing box panel
- Delaminations and linear anomalies detected by Shearography
- Section analysis shows delamination details
Carbon Nomex Fuselage Material

- Fuselage material
- Artificially induced defects
- Defects displayed in right image
- Image below: side view of material

Shearography on helicopter tail rotor blade

- Helicopter tail rotor blade
- Artificially induced drillings (50mm, 20mm, 10mm)
- Delams simulated
- Found defects displayed on the right side
Vacuum excitation (∆ 40 mbar)

1: Delamination Top Layer – Core Impact
2: Impact
3: Delamination Core - Rear Layer

Unscaled result image           Scaled result image

- Scanning of complete spoiler
- Detection of delaminations on composite material
- Comparison between ultrasonic and shearography
Delaminations on Spoiler

- Automatic inclusion of results into report and CAD data
- Comparison of scanning time:
  - Ultrasonic: approx. 1 hour
  - Shearography: approx. 5 minutes

GKN – NDT on Wrinkles

- Wave
- Wrinkle

by courtesy of GKN Aerospace GmbH
- Inspection of wing section cut
- Detection of delaminations due to water inclusions and cracks
Kissing bond NDT

- NDT of a Kissing Bond
- CFRP top-layer foam core material
- First approach with demonstrator material for in-field detection
- Artificially prepared with foil insert before lamination

Kissing Bond is defined as a bonded area with only 10% of mechanical properties.

- Kissing Bond detected
- Thermal excitation (1s)
- Impact detected
- Result within 10s obtained
First approach to NDT – ISIS1100

System for non-contact NDT:
• Portable System
• Flexible
• Easy to use
• On tripod
• Compact Electronic
• Adjustable to various tasks
• Easy upgradable
Modularity of ISIS Systems

Electronic Unit

Sensors

ISIS 3100

ISIS 3010

Hood systems – Two Inspection Sizes

Industrial solutions

- Test large areas quickly
- Scan area & store image
- No calibration
- Reproducible results
- Macro function
- 1 click/measurement

AOI:
A4 Paper Size

Exitation:
Heat & Vacuum

AOI:
A3 Paper Size

Exitation:
Heat
Robot solutions
Stationary units (x,y,z axis rail)

100% Automation

Quantitative Measurement

- From qualitative Testing...
  ...quantitative Evaluation
- Numerical data export as csv
- Enables postprocessing in xls, Mathlab, etc.
Signal to noise ratio (SNR)

- Signal to noise ratio (SNR)
- Numerical values
- Indication of quality to NDT staff
- Direct comparison to UT → dB values

Documentation process chain

100% Process chain

- NDT Task
- Test plan
- NDT Test - Shearography
- Documentation
- One Solution

- Sectors in test plan
- Sectors on test
- Automatic reporting
Successful Cooperation with the Industry

ISISmobile 3000 in operation at Airbus Hamburg

...for constant improvement of our products

ISISmobile 3000 in operation at Airbus Toulouse

References
Summary

- Non-Contact analysis
- Fast inspection
- Full-Field results
- Ideal for composite materials
- Numeric data export
- SNR
- Production & maintenance

Turbine Blade NDT in MRO
Automated disk measurements

**Areas of use:**
- Blade designers
- Blade manufacturers
- Turbine manufacturers
- Turbine & Blade MRO

**Results:**
- 3D point cloud
- STL generation
- Result to CAD fit
  - Detection of abrasion
- Feature measurement
  - Length
  - Centre point
  - Angles
  - Radius
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Automated Cell – Modular Concept

New approach:
- Mobile modular measuring cell with L3D 5M Digitizing Sensor

Thank you for your attention!
Do you have any questions?

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