New NDI Technologies & Tools for CFRP Inspection in Service

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Content

1. Introduction
2. State of the Art for In-Service CFRP Inspection
3. New NDI Technologies and Applications for CFRP Inspection
   - Ultrasonic Camera
   - Paint Thickness Measurement with Microwaves
   - Thermal Damage Detection with Infrared Spectroscopy
   - Dent Size Determination
   - Scratch analysis
4. Inspection Support Tool „Online Maintenance assistance“ (OMA)
5. CFRP Reference Standards
6. CFRP Specific Training
7. Conclusion
1. Introduction
Who and what is Testia?

Testia is a newly founded, small and very reactive company providing all kinds of services for Nondestructive Testing (NDT):

• Training (EN4179/NAS410)
• Training on the job
• Engineering Services
• Inspection
• Special NDT Equipment
• Reference Standards
• Consultancy
Testia Locations

- TESTIA LTD UK
- TESTIA France (NDT EXPERT) France
- TESTIA GmbH Germany
- TESTIA Mexico
- TESTIA Russia
- ENSIA-EXPERT Spain
- TESTIA South Africa
- TESTIA Singapore
2. State of the Art for In-Service CFRP Inspection
Taptest

Manual Tap Test
Simple tool
Fits into each pocket
Cheap & everywhere available.
Proven Probability of Detection (POD)

Mitsui Woodpecker
Simple to use,
Traffic Light Indication, cheap

Both are approved standard processes in Aerospace

Source: Airbus
Ultrasonic Variances

Manual, Single-Channel
Standard Handheld Device

Ultrasonic Array Systems

Source Airbus
Selection of UTPA Applications

- Phased Array Roller Probe for manual and automated Inspection
- Automated Inspection of Ω-Stringer

Source: Airbus
Thermography

GECKO
New
Low Budget IRT System

Source: Airbus
3. New or adapted NDI Technologies and Applications for CFRP Inspection
3.1. Ultrasonic Camera - DolphiCam
General Information

Ultrasound video camera for inspection of CFRP
- High resolution images
- 16,000 transducer elements
- CFRP up to 16 mm thickness
- 2D and 3D images
- A-, B-, and C-scan (Amplitude & Time of Flight)
- Cover large areas with manual stitching
- Compact, ergonomic and easy to transport
- Easily operated by non-experts
- Runs on Windows Tablets and Laptops

Main applications in Aerospace
- Impact damages, debonding and delamination detection
- Detection of delaminations around drilled holes
CFRP-Delaminations

- Detection after „Impact“.
- Damages directly measured

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Debondings

- Ω- or T-Stringer CFRP-Structures
- „Manual Stitching“ for larger areas
Drilled Hole Inspection

• Detection of delaminations in CFRP-Structures around holes
• „Flaking“ after drilling
• Detected by DVI (visual inspection)

DolphiCam
„Measurement in one shot“
3.2. Paint Thickness Measurement with Microwaves

FSC1
FSC2
FSC1/2 – Measuring Principle

- An antenna radiates and detects an electromagnetic field
- CFRP (with or without ECF) acts as one side wall of the resonator
- The cavity resonant frequency depends on the thickness of the dielectric layer(s)
- A reflection meter measures the resonant frequency
- The module sweeps a frequency band and measures the reflection coefficient
- A processor calculates the thickness of the dielectric layer
FSC1/2 – Paint Thickness on CFRP

- The measurement system consists of a handheld probe (sensor Ø ≈ 2 cm) and a control module.
- Measurements possible on electrically conductive substrates (e.g. CFRP, CFRP with ECF, metal) – no GFRP.
- FSC1: 0 to 400 µm
- FSC2: 0 to 1000 µm
- Measuring time < 1 sec
- The measurement data can be exported via USB.

FSC1 – Qualified by Airbus
FSC2 – Qualification in progress
3.3. Thermal Damage Detection with Infrared Spectroscopy
Heat Damage in Composite

- Aircraft and other structures will increasingly be constructed from composite material

- Composites are susceptible to heat and oxidative damage → Chemical damage of the epoxy resin

- Exoscan provides new type of non-destructive testing to detect heat damage

- Exoscan specified in Boeing 787 NDT Manual
**ExoScan**

**FTIR 4100**
- Handheld (~3 kg and 17*12*22 cm³)
- Local measurement (IR spot size: 1,5 mm²)
- Interchangeable sample interface

**FTIR 4200 Flexscan**
- Handheld (~2 kg)
- Local measurement (IR spot size: 1,5 mm²)
- Separated electronic and optical systems
- Dedicated sample interface

Measurements
- Contact with structure required
- About 30 sec for one measurement
- PC or PDA controlled

Source: Agilent
Heat Damage
3.4. Dent Check
MoireView

3D mapping and measurement tool for:
- Dents
- Impacts
- Rivet pull-in
- Blending
- ...

Key features:
- Wireless
- Autonomous
- Lightweight
- Low cost
Easy Dent Sizing

Size of dented area

Depth of dent

3-D
3.5. Scratch Analysis
Measurement Principle

- **Laser triangulation**
- **Profile processing**
- **Image processing**
- **Image snapshot**
- **Laser diode**
- **Scratch**
- **Camera**

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Ergonomic / Easy to use system

- Ergonomic: only 4 control buttons
- Measurement range:
  - \( 0.02 \text{ mm} < \text{Depth} < 1 \text{ mm} \)
    - For \( 0.02 \text{ mm} < \text{Depth} < 0.05 \text{ mm} \), accuracy = \( \pm 0.005 \text{ mm} \)
    - For \( 0.05 \text{ mm} < \text{Depth} < 1 \text{ mm} \), accuracy = \( \pm 10\% \)
  - \( 0.03 \text{ mm} < \text{Width} < 2 \text{ mm} \)
- Weight: 1.7 kg
- External USB port for data saving and reporting
- Autonomy: 6 h

For a wider measurement range or for gap & flush applications, the dedicated tool is:
4. Online Maintenance Assistance (OMA)
OMA Concept

Screen signals

Remote control

Intranet / Public network

Video

Audio

Video

Audio

Operator

Airport Service Hangar

Expert

Airline Service Center

Smart UE1
OMA

- Video based assistance in real time
- Remote control of NDT Equipment
- Usable ad hoc without complex installations (browser based)
- More effective support as using eMail
- Cost saving by:
  - Reduction of travel time
  - Less downtime of aircrafts
- Usable on all IT platforms
- High quality service by having always the best experts available
- Specific developed for NDT

Basic Tool to enable Remote NDI
5. CFRP Reference Standards
CFRP Reference Standards (RS)

- Appropriate RS are essential for a proper inspection
- Have to be adapted to inspection task
- Development, Manufacturing and Sale by Testia
- Certified acc. to Production or In-Service needs
- Worldwide delivery

High Quality of RS = High Quality of Inspection
6. Training
CFRP Training - General

• Need for specific CFRP trainings identified by OEM, Airlines, MRO, etc.
  – Phased Array training course is available already in Europe
    (5 days training – incl. examination)

• International groups work on general content of trainings, e.g.
  – ATA ITG CACRC on the way to define syllabus
  – German Society of NDT install task force to define Level training

• Additional awareness trainings for composite could cover:
  – New equipment, like UT Cameras
  – New paint thickness measurement devices
  – Thermography
  – Scratch measurement and other CFRP specific procedures
  – Specific NTM, SRM and other OEM standards
  – etc.
CFRP Training: CFRP Equipment

- Trainings on applications of specific equipment in cooperation with equipment manufacturer and aircraft OEM
- Trainings can be done In-Situ or by webinars

Gecko (Thermography)

Elasticity Laminate Checker (ELCH)

ExoScan

DolphiCam

FSC1/2
7. Conclusion
Conclusion

NDT inspection of CFRP requires

• New technologies
  – Microwave
  – Infrared Spectroscopy
  – Scratch Inspection

• Adaptation of existing technologies
  – Ultrasonic
  – Dent Inspection

• Use of advanced support tools
  – OMA

• Availability of High Quality Reference Standards

• New Trainings on Processes and Equipment

......and all of this is what Testia offers you!
NDT – A technique which gets under your skin

Thank you for your attention!
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