3D EDDY CURRENT TESTING – A method for fiber angle analysis of carbon fiber preforms

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German Aerospace Center (DLR)
Overview of the DLR

- 8000 employees
- 32 institutes or facilities
- 16 sites
DLR - Institute of Composite Structures and Adaptive Systems: 6 Departments

- Composite Technology
- Adaptronics
- Composite Process Technology
- Composite Design
- Structural Mechanics
- Multifunctional Materials
ZLP Site Stade
Team EVo – Netshape RTM parts in high volumes

**Goals:**
- Automated production of complex RTM parts
- 100,000 Parts/year
- Net-shape production

**Research focus:**
- Design and test of new draping technologies
- Injection concepts and simulation
- High precision trimming (< 0.1 mm)
- Integrated QA (Prefoming and RTM)

**Key facts:**
- Production line: 40 x 8m
- Max. part size: 2 x 2.5m
- RTM press: 500 tons
EVo - Research Production Line

**Ply-Preparation**
- Textile-Storage
- Cutter
- Ply-Storage
- Portal-Vacuum-Gripper

**Netshape-Preforming**
- Draping-Robot
- Consolidation-Press
- Handling-Robot
- Finetrimming-Robot

**RTM-Line**
- Movable Core-Mold
- 500t-Press
- 2 Component-Injection-Unit
- Curing-Oven
Basics - Eddy Currents

Schematic illustration of the generation of eddy currents

Illustration of the electric and capacitive coupling between the fibers
Basics – Eddy current pictures

Toho Tenax UD: \((0/45/90/-45)_s\) 
Hexcel G1157 UD: \((45/-45/0/90)\)

- Illustration of the conductivity of the material
- Up to 8 layers in depth demonstrated
- Detection of defects, like missing rovings, gaps, fuzz balls, insertions, undulations and the fiber angle
Basics - Fiber angle analysis

Image

2D-FFT
Fiber angle analysis software

- Loading of the eddy current data
- Selection of the measurement area
- 2D FFT of the picture
- Result of the fiber angle analysis
- Overlay of the analysis with the original picture
Mounting at the Robot

Drawing of the linear robot

Robot on the way to a measurement
Mounting at the Robot

Mounting of the eddy current sensor

Drawing of an absolute sensor

Electronic box  Robot flange
Preamplifier
Springy bearing
Sensor

Measuring coil  Exciting coil  Specimen
3D-Measurement

Offline programming of the robot path  

3D Eddy current data
3D-Measurement

Interactive selection of the analysis area

Analyzable picture
Conclusion

• Detection of different kind of defects up to 8 layers in depth

• Fiber angle analysis based on FFT

• Measurement of 3D objects guided by a robot
Outlook

• Calculation of the accuracy of the measurement system

• Test of a newly designed 3D printed sensor

• Analysis of the whole frame, including the radii
THANK YOU FOR YOUR ATTENTION!