Optical Coherence Tomography for Inspection of Aeronautic Composite Parts

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Aeronautical context
  Carbon fibre reinforced plastics
  Manufacturing process
  Waviness & Flash of resin
  Escalation method

Optical Coherence Tomography
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OCT results
  Methodology
  Correlation results

Conclusion
Aeronautical context

Aircraft, helicopters, launchers: more and more composite structures.

Besides, we have at least to maintain safety level.

NDT is mandatory for these materials as the current manufacturing processes cannot assure flawless structures.
Aeronautical context

Target: Evaluation of the resin distribution on the CFRP surface.

- Indicator of health assessment of the CFRP part.

Lack of resin $\rightarrow$ problem of resin diffusion $\rightarrow$ porosity

Resin overthickness $\rightarrow$ presence of wavinessness (light/severe)
Aeronautical context

Waviness and flash of resin.

The sample is constituted of a stack of carbon plies. The resin is located on the surface along a row.

Stiffened panels manufacturing.
Aeronautical context

Need for a NDT method.

Today, a drilling is performed with the risk of damaging the first ply of carbon

Looking for a NDT method that avoids destruction, more reliable and quantify results.

OCT: A scanning is possible along the part (not punctual measurement)
Optical Coherence Tomography

Principle 1 (Time domain)

Reference arm

Signal arm

Source

Depth
Optical Coherence Tomography

Principle 2 (Fourier Domain)

Spectral Domain OCT

Swept Source OCT
Optical Coherence Tomography for Inspection of Aeronautic Composite Parts

Optical Coherence Tomography

Main applications / Medical

Dermatology

Ophtalmology

Life Science

Toward better treatment of clogged arteries
Balloons for angioplasty

Optical coherence tomography cross-sections of balloon inside an artery phantom (a) before inflation and (b) during inflation. Markers are spaced by 1mm in optical thickness. Intima, media, and adventitia: Three layers of the artery.

OCT Results

Waviness in corners
OCT Results

Waviness in stiffeners radii
## OCT Results

**Correlation between micro-cut section and OCT**

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<th>Part $\text{n}$</th>
<th>Micrography (mm)</th>
<th>OCT (mm)</th>
<th>Ecart (mm)</th>
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<td>0.71</td>
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</table>

**Ecart moyen** 0.041
OCT Results

Interesting tool for laser ultrasonics application

Volumic absorption and thermal expansion within the epoxy resin

In absence of epoxy resin, risk of damaging the carbon fibre
OCT Results

Defect surface characterization

Meshgrid in surface master

Meshgrid in epoxy resin

Prints
Conclusion

The method is validated.

Measurements performed on several specimens

Industrialisation is in progress

- Adapt the tool to the geometries
- Automate recurring tasks
- Improve software
MERCI DE VOTRE ATTENTION !!!

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