Non-destructive testing of CFRP using eddy current technique

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Backgrounds - Properties of CFRP -

**CFRP** (Carbon fiber reinforced plastic) has attracted attention as a structural material to replace steel and aluminum.

Excellent mechanical properties
- Light weight
- Specific strength
- Specific Elastic modulus
- Corrosion resistance

**Carbon Fiber** + **Resin**
- Electric conductive
- Dielectric plastic

Anisotropic electromagnetic characteristics
Generally, **UT** (Ultrasonic Testing) is used to detect defects of CFRP.

**Undetectable**
- Flaws in the vicinity of the surface
- Orientation of carbon fiber in CFRP

If detectable in inline, yield rate and production cost is improved.

**ECT** (Eddy current testing)
- Rapid detection capability
  - Flaws in the vicinity of the surface
  - Orientation of carbon fiber in CFRP

In the previous studies of ECT for CFRP
Using a TR probe and high frequency (more than 10MHz)
Detection signal may includes large noise and is unstable.
Objectives

To inspect fiber orientation in CFRP by means of ECT

In this study

To obtain a more stable detection signal

Using mutual induction-differential type probe
Using low frequency (2MHz or less) with less noise
Preparation of CFRP specimens

The CFRP specimens are fabricated by curing epoxy resin of a preform by autoclave process.

Unidirectionally oriented prepreg
(TR380G250S, Mitsubishi Rayon Co., Ltd.)
Thickness : 0.26mm

Autoclave process condition
Curing temperature : 130°C
Compression : 0.5 Mpa, 60 min.
Measurement system of ECT

**FUNCTION SYNTHESIZER**
WF1966 (NF Corporation)

**Lock-In Amplifier**
SR844 (Stanford Research System)

**Exciting signal**
- **Frequency**: 2MHz
- **Voltage**: 0.7V

**Band pass filter by Fast Fourier Transform**

**DAQPad-6020E**
(National Instruments)

**PC**
Results - Unidirectional CFRP -

Unidirectional fiber orientation was identified.

Probe direction

The vertical line indicates the consecutive horizontal fiber orientation (0 deg).

Two-dimensional FFT (Fast Fourier transform) to identify fiber orientation

(Spatial frequency spectrum)
We showed the detectability of carbon fiber orientation of UD laminated CFRP by ECT.

We used mutual induction-differential type probe and low frequency 2MHz to obtain stable signal.

It is possible to obtain the information of carbon fiber orientation in CFRP with stable detection signal by ECT.
The Seminars for CFRP Studies

Founded in October 2014

Consortium of universities, corporations and public research organizations in Tohoku region of Japan, aiming for promotion of the developments with CFRP in Tohoku

http://www.ifc.tohoku.ac.jp/cfrp/

Lecture meeting

Technical investigation
JSPS Core-to-Core Program
International research core on smart layered materials and structures for energy saving

Energy Loss by Friction
Energy Loss and economic loss by contact surfaces amount 2% of gross domestic product

Energy Loss by Turbulence
Boundary layer control of airplane wings may reduce skin friction by 90%, total drag by 40%

Control of interface between flow and structure to make break-through in energy-saving

To establish novel energy-saving technology by smart layered materials and structures based on flow dynamics
International research core on smart layered materials and structures for energy saving

- LTDS Ecole Centrale de Lyon
- SIMAP, LEGI Grenoble INP
- MATEIS, LAMCOS INSA de Lyon
- KTH Royal Institute of Technology
- Institute of Fluid Science Tohoku University
- IZFP Fraunhofer Society
- Nanjing University of Aeronautics and Astronautics
- Xi'an Jiaotong University
- Tsinghua University
- Karlsruhe Institute of Technology
- Saarlandes University

Advanced Materials: Design and evaluation of layered multi-materials
Sensing & Control: Industrial application of smart layered structure, Sensing & control embedded in layered structures
Flow Dynamics: Advanced control of flow-structure interaction