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Non-destructive testing of CFRP using eddy current technique

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Contents

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**

BMW, i3

Carbon Fiber + **Resin**

Electric conductive　　Dielectric plastic

Anisotropic electromagnetic characteristics

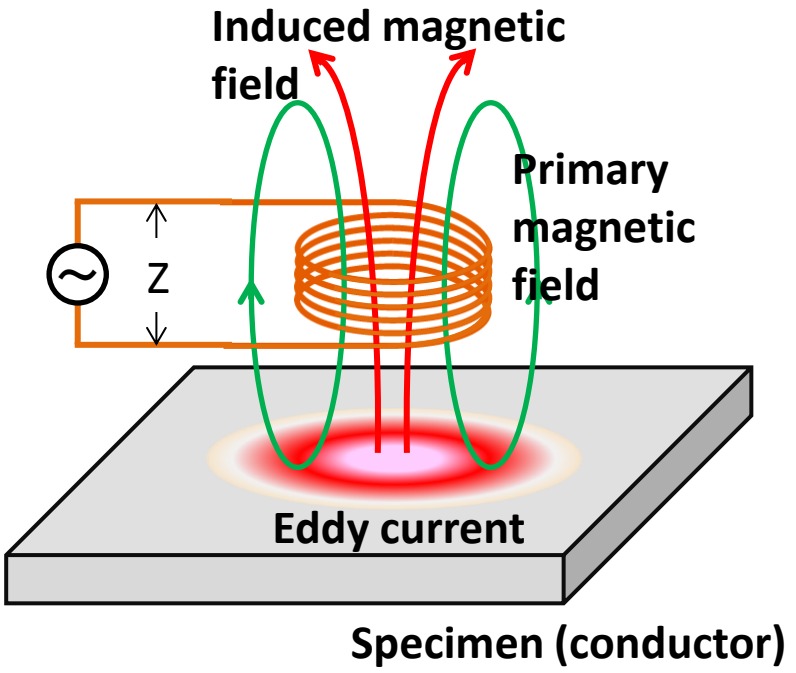
Backgrounds - Non-destructive testing -

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

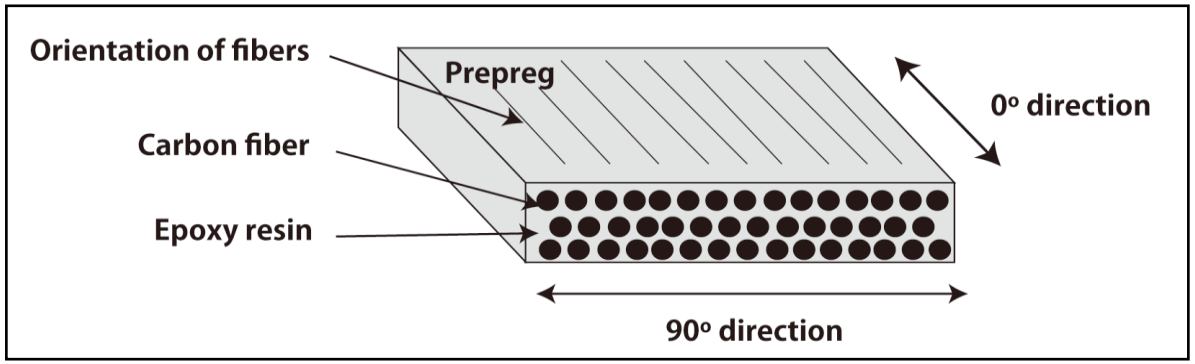
In this study

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

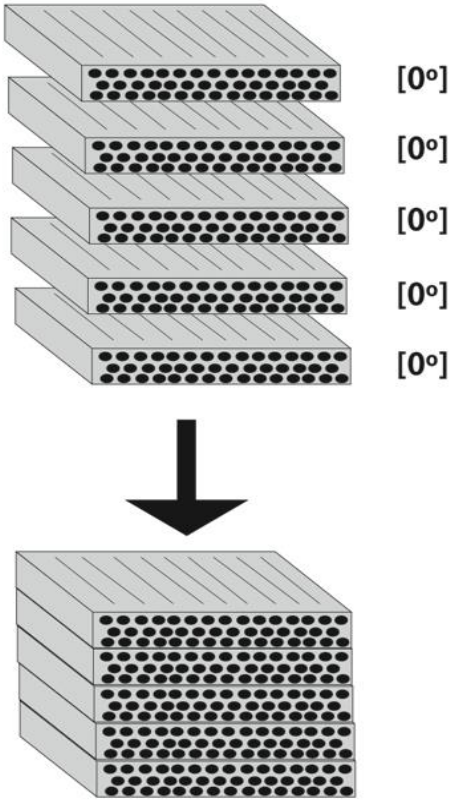
The CFRP specimens are fabricated by curing epoxy resin of a preform by autoclave process.



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

Autoclave process condition
Curing temperature : 130℃
Compression : 0.5 Mpa, 60 min.

Lamination layer



Preform

Measurement system of ECT

FUNCTION SYNTHESIZER
WF1966 (NF Corporation)

Lock-In Amplifier
SR844 (Stanford Research System)

REF signal

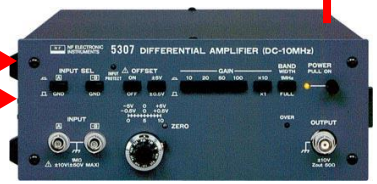
Exciting signal

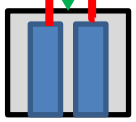
Frequency	2MHz
Voltage	0.7V

DAQPad-6020E
(National Instruments)

PC

pickup signal





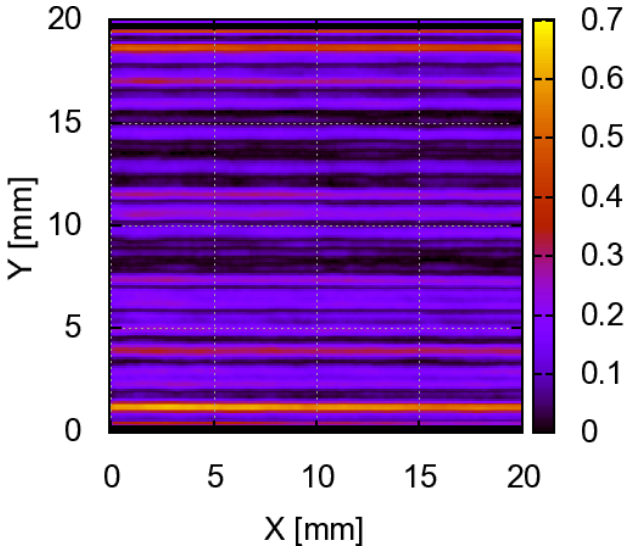
ECT probe

Differential Amplifier
5307 (NF Corporation)

Band pass filter by Fast Fourier Transform

Results - Unidirectional CFRP -

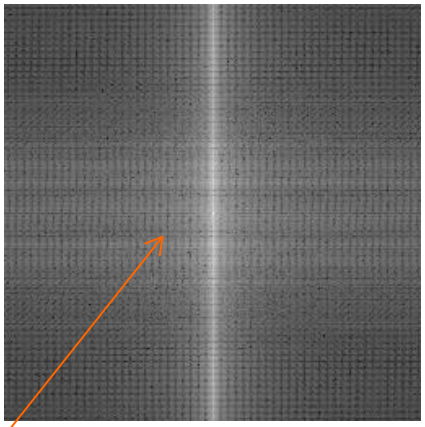
C-scan image



Two-dimensional FFT
(Fast Fourier transform)

to identify fiber orientation

FFT image



(Spatial frequency spectrum)

Probe direction

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

Unidirection fiber orientation was identified.

Summary

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

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

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

Lecture meeting

Technical investigation

JSPS Core-to-Core Program

International research core on smart layered materials and structures for energy saving

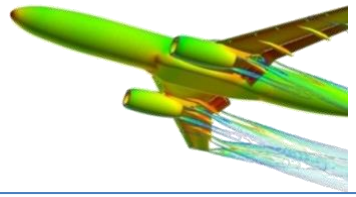
http://www.ifs.tohoku.ac.jp/c2c/

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