OKABE, Y. LAB.

[Structural health monitoring and adaptive structures]

Department of Mechanical and Biofunctional Systems
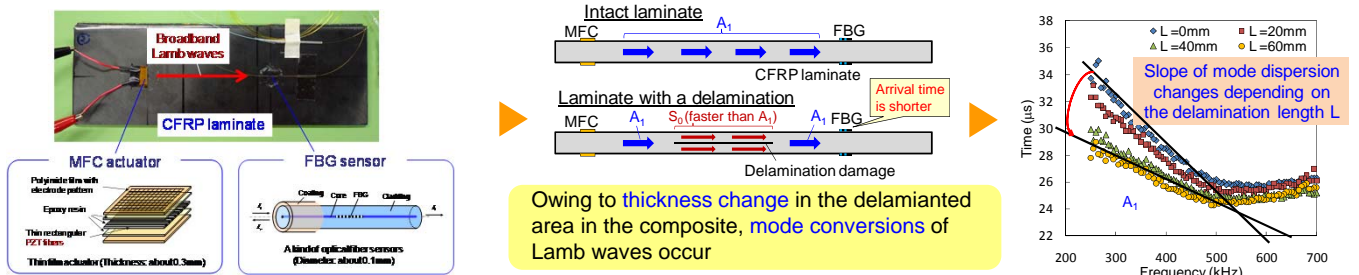
http://www.okabeylab.iis.u-tokyo.ac.jp/

Smart Material Systems

Department of System Innovation
School of Engineering

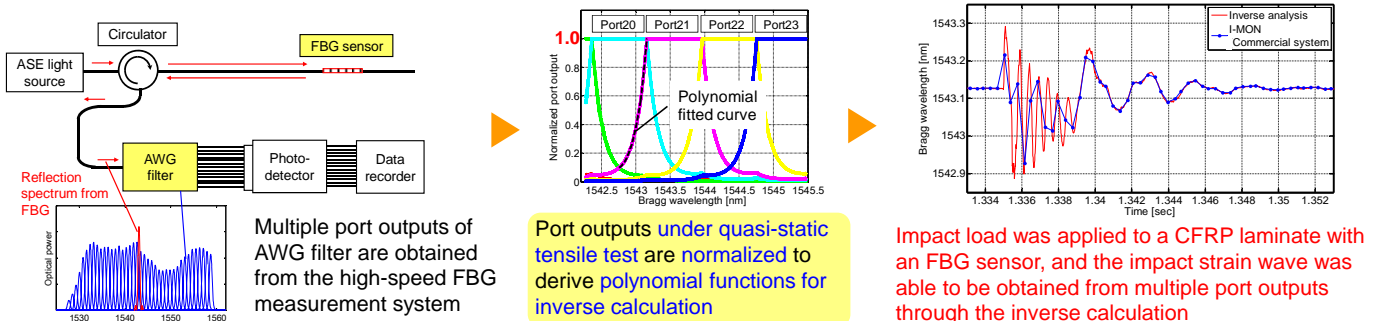## Damage detection system using ultrasonic waves and optical fiber sensors

Built-in broadband ultrasonic propagation system for detection of delamination damage

Intact laminate
MFC A_1 FBG
CFRP laminate

Laminate with a delamination
MFC A_1 S_0 (faster than A_1) A_1 FBG
Arrival time is shorter
Delamination damage

Owing to thickness change in the delamianted area in the composite, mode conversions of Lamb waves occur

Slope of mode dispersion changes depending on the delamination length L

L =0mm   L =20mm   L =40mm   L =60mm

Broadband ultrasonic waves are propagated with the devices integrated with the composite laminate, and the internal delamination damage are evaluated quantitatively based on the mode conversion behavior.

(Toward practical use of the system to aircraft et al., we investigates the correction method of environmental temperature effect.)

Function enhancement of the system for passive detection of impact strain waves

Multiple port outputs of AWG filter are obtained from the high-speed FBG measurement system

Port outputs under quasi-static tensile test are normalized to derive polynomial functions for inverse calculation

Polynomial fitted curve

Inverse analysis / I-MON / Commercial system

Impact load was applied to a CFRP laminate with an FBG sensor, and the impact strain wave was able to be obtained from multiple port outputs through the inverse calculation

Collision of foreign objects that is the main cause of damage occurrence in CFRP composite structures can be detected passively.

Smart adaptive structure systems with integrated shape memory materials

Sandwich structure with self-repair function for impact damage

Shape memory alloy (SMA) honeycomb made of 50μm SMA foils

Owing to shape memory effect of SMA, the mechanical properties of the panel can be recovered along with the shape recovery.

SMA artificial muscle for rehabilitation

Through the geometric investigation of SMA wires, we construct the artificial muscle with high stretch properties and moderate contractive force suitable for rehabilitation of joint in the finger.

Shape-variable lightweight actuator structure

Heating / Cooling

Bending shape can be controlled effectively by uniform application of shear recovery force from Honeycomb to CFRP skins.