

National Aeronautics and Space Administration



# **TECHNOLOGY SOLUTION**

# Sensors

# Guided wave-based system for cure monitoring of composites using piezoelectric discs and fiber Bragg gratings (FBGs)

Use of fiber optic sensors to measure guided waves as a cure monitoring system

The use of carbon fiber reinforced polymer composites for structural components in aircraft, automotive and other applications has grown rapidly and is in extensive use today. A prime example is the Boeing 787 Dreamliner of which the entire fuselage and wings are constructed from CRFP's. Consequently, as a quality control measure, means to monitor the cure rate of the resins as well as means to detect defects has become critically important. Inventors at NASA Langley have developed and demonstrated a system using fiber optic sensors to measure guided waves that propagate in a part as a cure monitoring system. Life-cycle monitoring is now possible because of optical fiber embedded in composite during cure.

# BENEFITS

- Defect detection during cure
- In-situ measurements during all phases (liquid, rubbery, and glassy)
- Embedded sensors
- Performs strain based cure monitoring
- Life-cycle monitoring of aircraft/other critical structures during service
- Can perform low frequency strain (load monitoring) based cure monitoring and high frequency guided wave sensing (damage detection) almost simultaneously during cure



## THE TECHNOLOGY

This system connects the properties of the guided waves to the phase changes of a composite part. The system measures temperature, strain, and guided waves during cure almost simultaneously. During life-cycle monitoring, it is feasible to use embedded fiber optic sensors for both load monitoring because of the ability to measure strain and damage detection because of the ability to record ultrasonic guided waves. The guided wave system is incorporated directly into standard curing equipment and technique. It has also been tested and works with flat panels as well as complex structures. The technology would be valuable to manufacturers of aircraft parts (fuselage, wing and other sections), marine hull sections, high speed rail sections, automotive parts and perhaps even building parts. One major application that exists presently, is the fabrication of fuselage and wing sections for aircraft where carbon fiber composite sections are used such as Boeing's 787 Dreamliner.



Guided wave system for real-time cure monitoring. Image Credit: NASA

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# Agency Licensing Concierge

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### **APPLICATIONS**

The technology has several potential applications:

- General aviation
- Automotive
- Marine
- High speed rail
- Wind turbines

#### PUBLICATIONS

Patent No: 11,590,676

#### technology.nasa.gov

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