



Introduction to Laser Bond Inspection

Potential Inspection Method of the Cold Spray Bond Strength

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LSP Technologies

Agenda



- The Laser Bond Inspection Process
- Laser Bond Inspection Data & Examples
- Laser Bond Inspection Equipment





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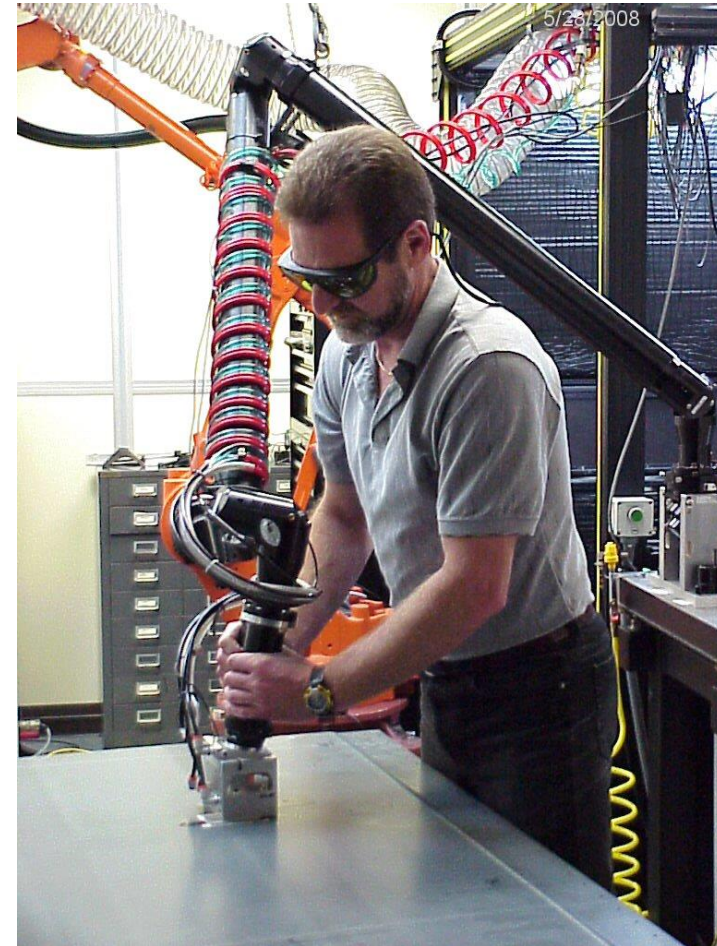
Laser Bond Inspection Process

The Laser Bond Inspection Process



A pulsed laser method to assess the strength of an adhesive bond in:

- bonded composite structure
- bonded metal to composite structure
- bonded metal structure

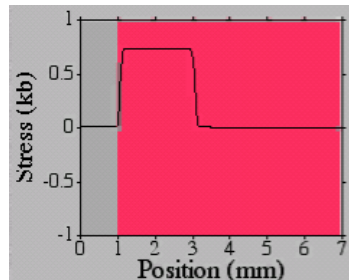
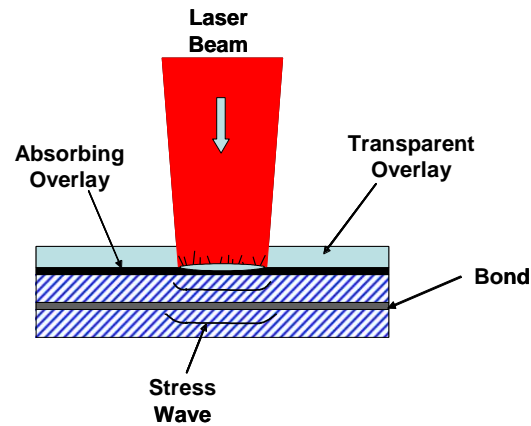


Created to find kissing bonds, matured to assess bond strength

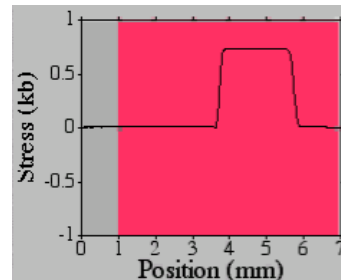
The Laser Bond Inspection Process



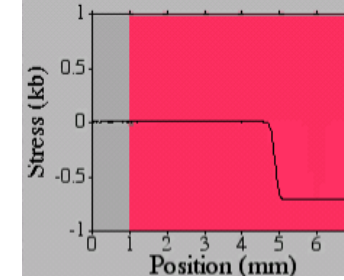
- High-energy pulsed laser
- Laser-generated stress waves
- Overlays enhance stress waves
- Generates compressive stress waves



1. Laser produces stress wave



2. Propagates as compression



3. Reflects as a Tensile wave

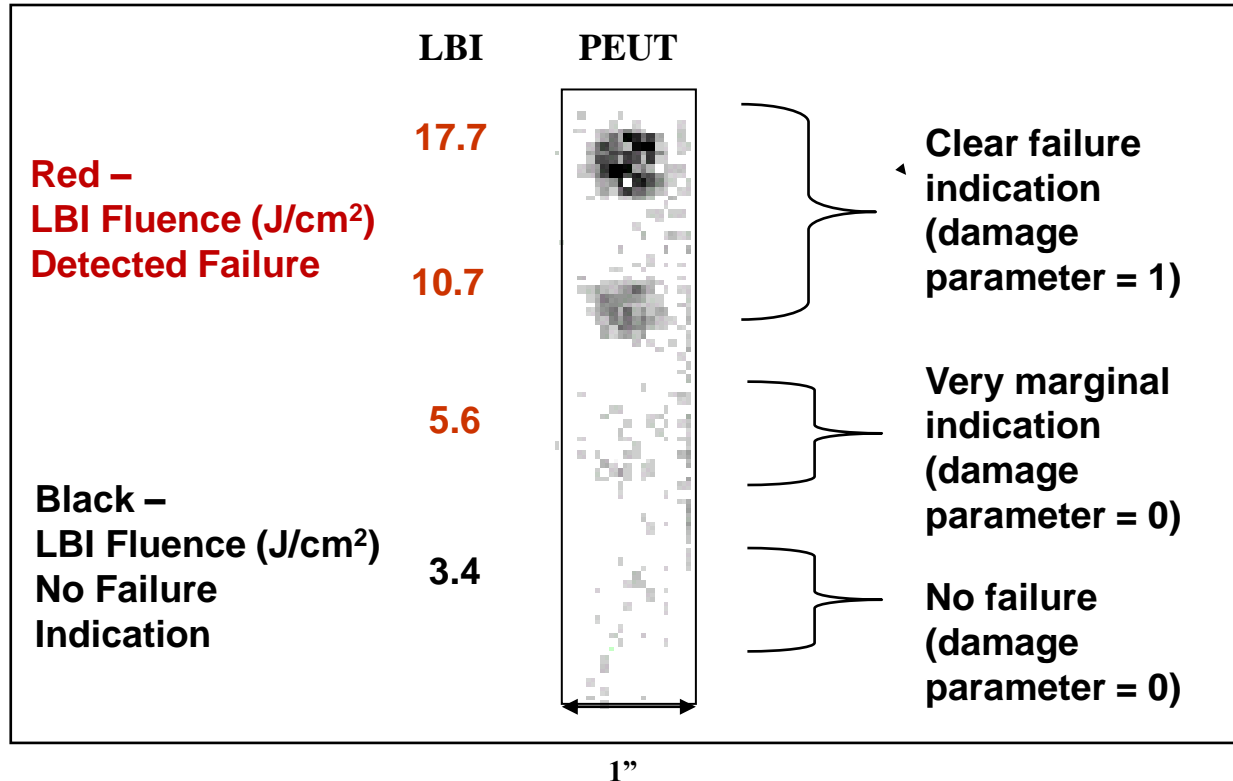
Energy: 5-50 J **Pulse Width:** 100-300 ns **Beam Diameter:** 10 mm **Wavelength:** 1054 nm

Harnessing stress waves through precise laser control

The Laser Bond Inspection Process



Post LBI Ultrasonic Examination (UTI)



To determine bond strength,

- a damage parameter is assigned based UTI result

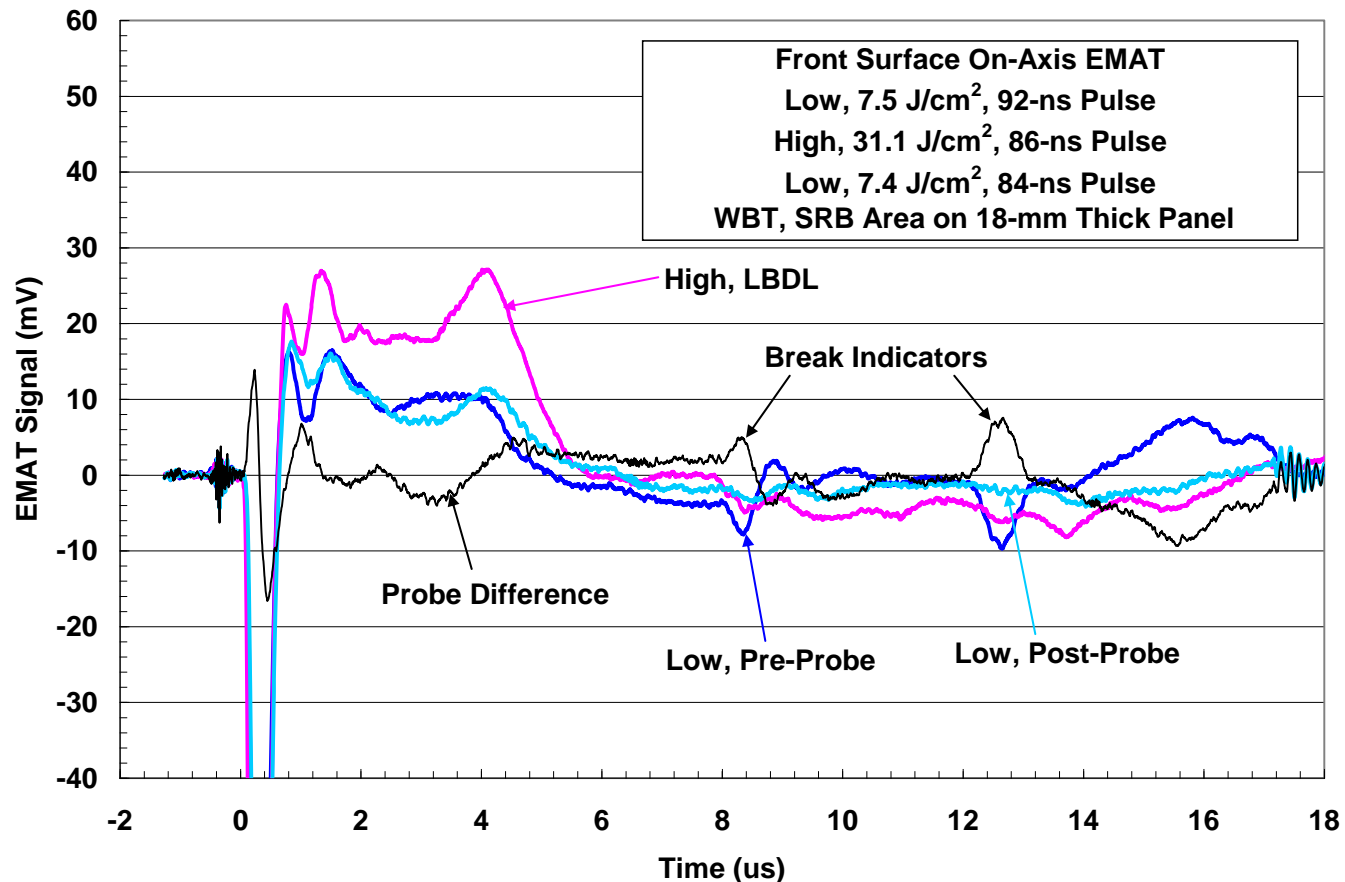
• Damage Parameters Value

- 0 when no detectable bond damage can be detected
- 1 when delamination of bond can be detected

The Laser Bond Inspection Process



Real-Time EMAT Evaluation



1. Apply **low energy** laser pulse to surface of part – not enough energy to damage the bond – record EMAT signal
2. Apply **high energy** laser pulse to surface of part – enough energy to fail a weak bond – record EMAT signal
3. Apply **low energy** laser pulse to surface of part – not enough energy to damage the bond – record EMAT signal

Compare the two low signals, if identical then bond is strong, if different, bond is weak

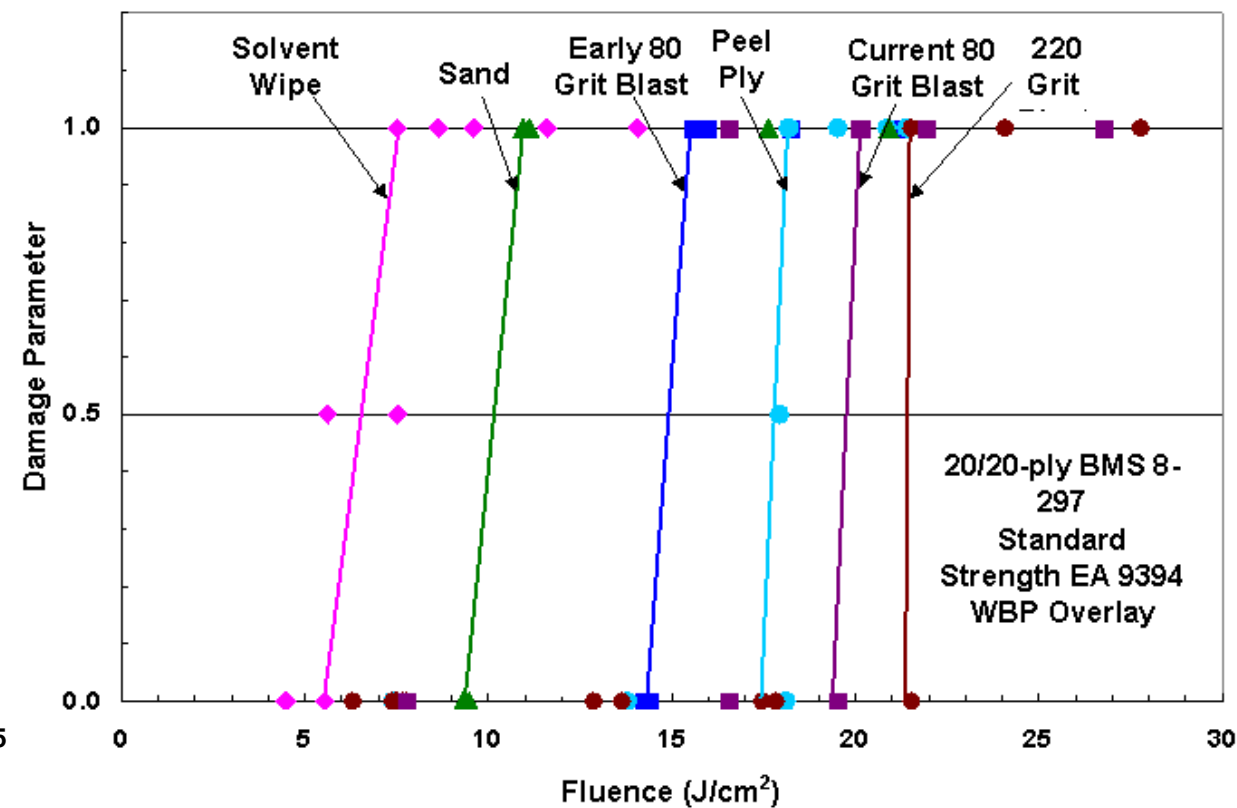
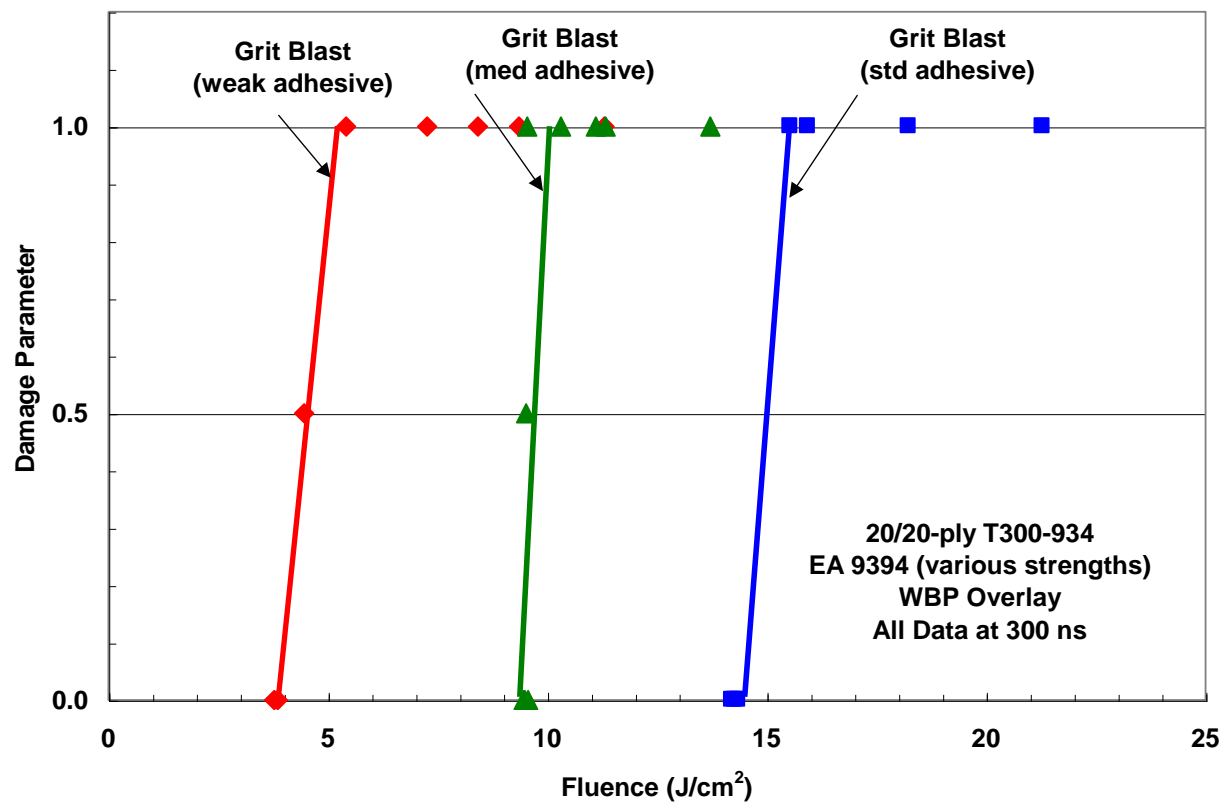


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Laser Bond Inspection Data & Examples



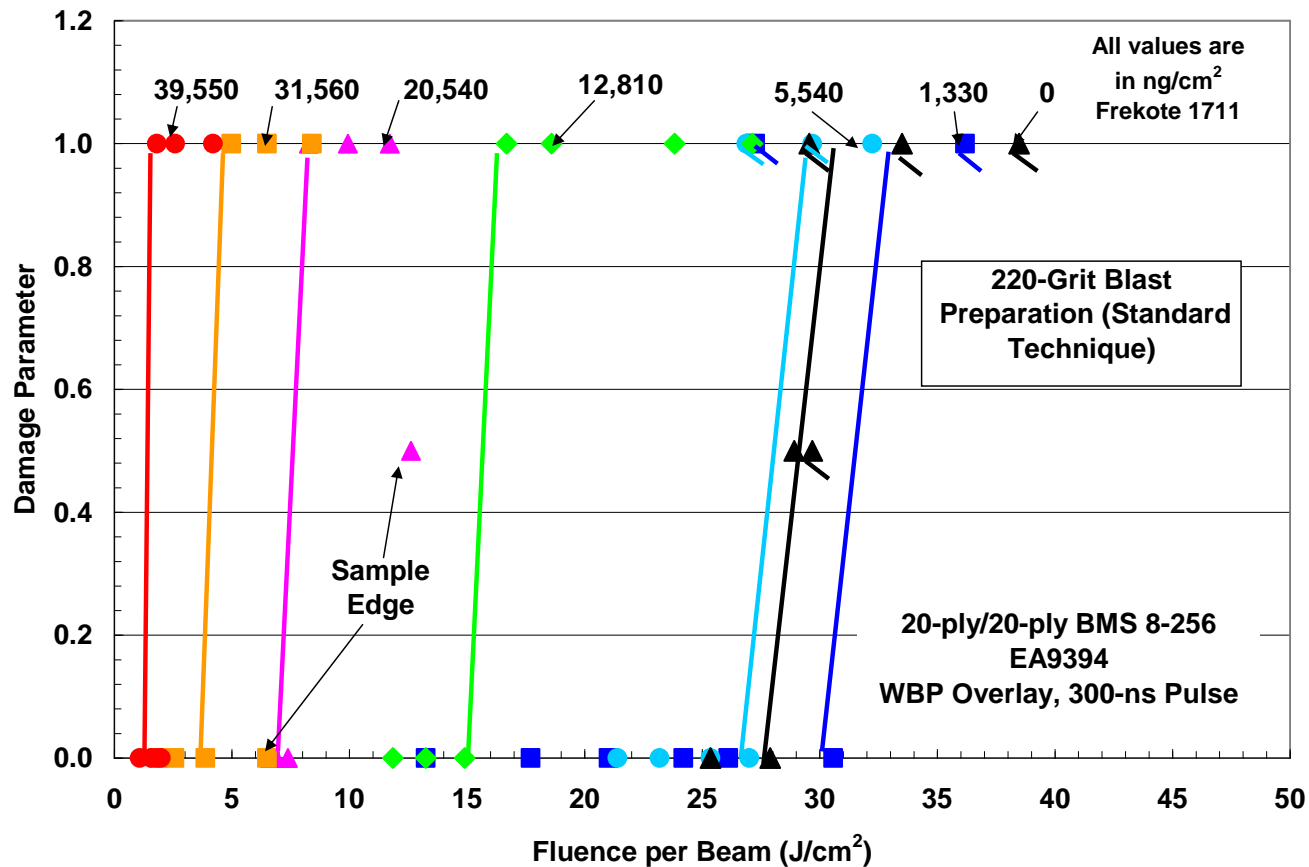
Surface Preparation



Various strengths for standard grit blast and surface preparations



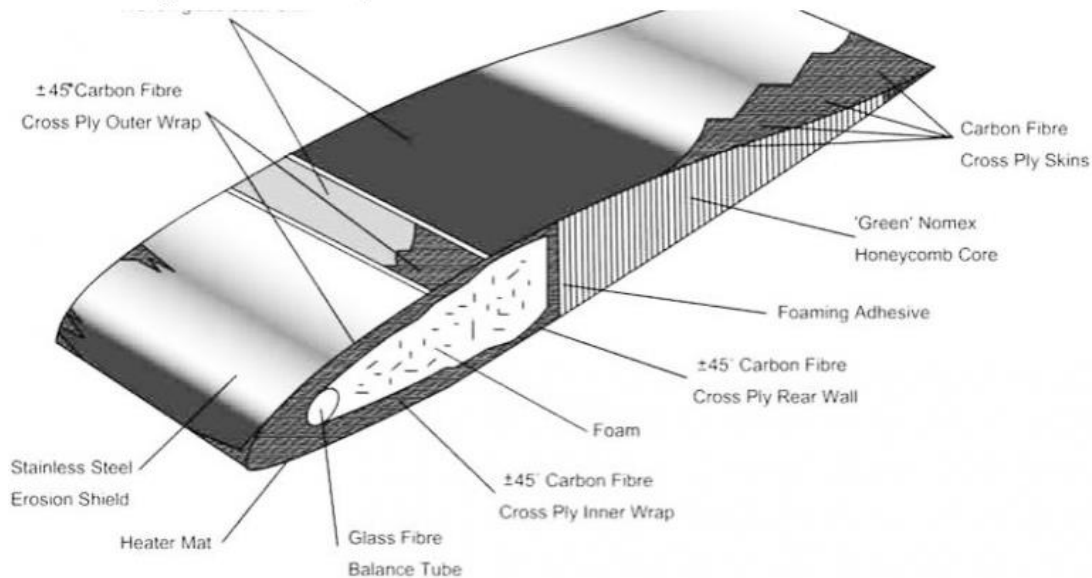
Surface Contamination – Mold Release Agent



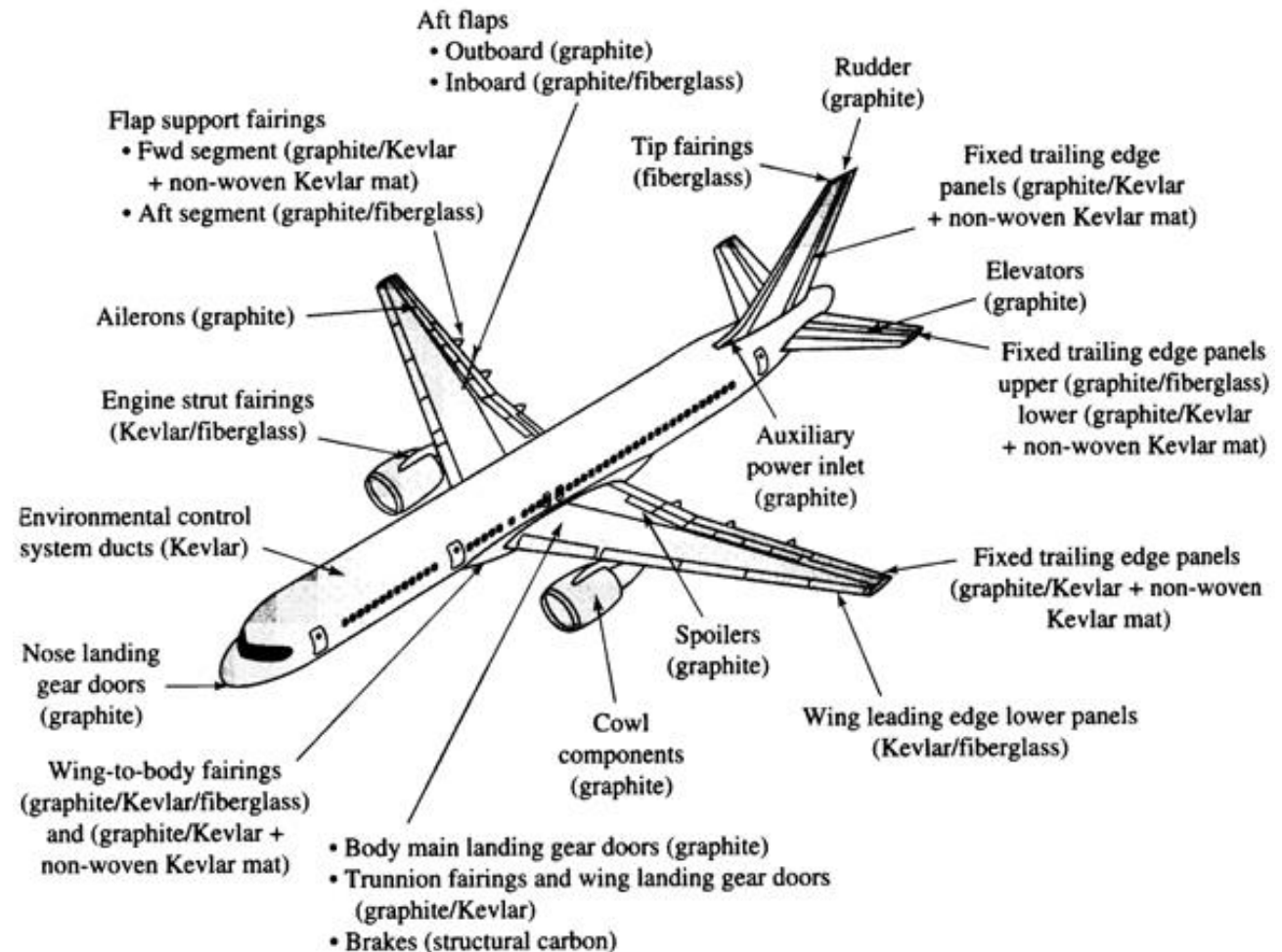
Laser Bond Inspection Examples



Aviation Structures



Helicopter Blade



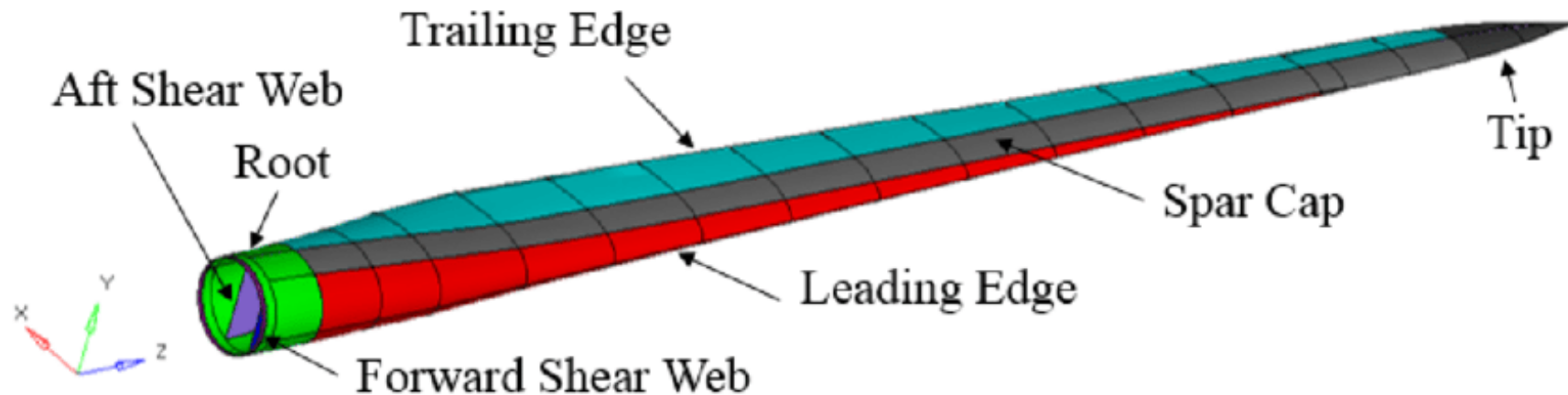
“LBI is the only known method for evaluating bond strength” – The Boeing Co



Automotive



Wind Power





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Laser Bond Inspection Equipment

Laser Bond Inspection Equipment



PROCESSING
HEAD

PROCESS
WATER
CONDITIONING

CART

ARTICULATED ARM

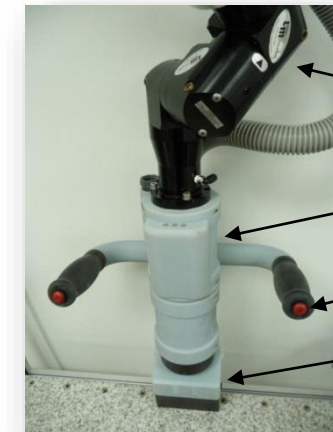
LASER ENCLOSURE

POWER DISTRIBUTION
CABINETS

INTERBUS CABINET

PROCESS
CONTROLS

OVERALL DIMENSIONS:
WIDTH = 64 INCHES
LENGTH = 157 INCHES
HEIGHT (ENCLOSURE) = 78 INCHES

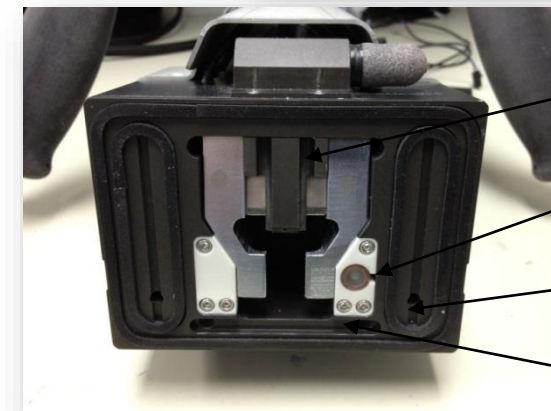


ARTICULATED
ARM

INSPECTION
HEAD

CONTROL
BUTTON

INSPECTION
HEAD BASE



EMAT MAGNET

EMAT COIL

VACUUM HOLD
DOWN

OVERLAY WATER
EVACUATION