Image Cover Sheet

CLASSIFICATION	SYSTEM NUMBER 510351
UNCLASSIFIED	

TITLE

NDE FOR THICK SECTION, LAYERED COMPOSITE STRUCTURES

System Number:

Patron Number:

Requester:

Notes: Paper #8 contained in Parent Sysnum #510343

DSIS Use only:

Deliver to: DK

#510351 (8)

NDE for Thick Section, Layered Composite Structures

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Naval Surface Warfare Center, Carderock Division, Annapolis Detachment

ABSTRACT

OBJECTIVE

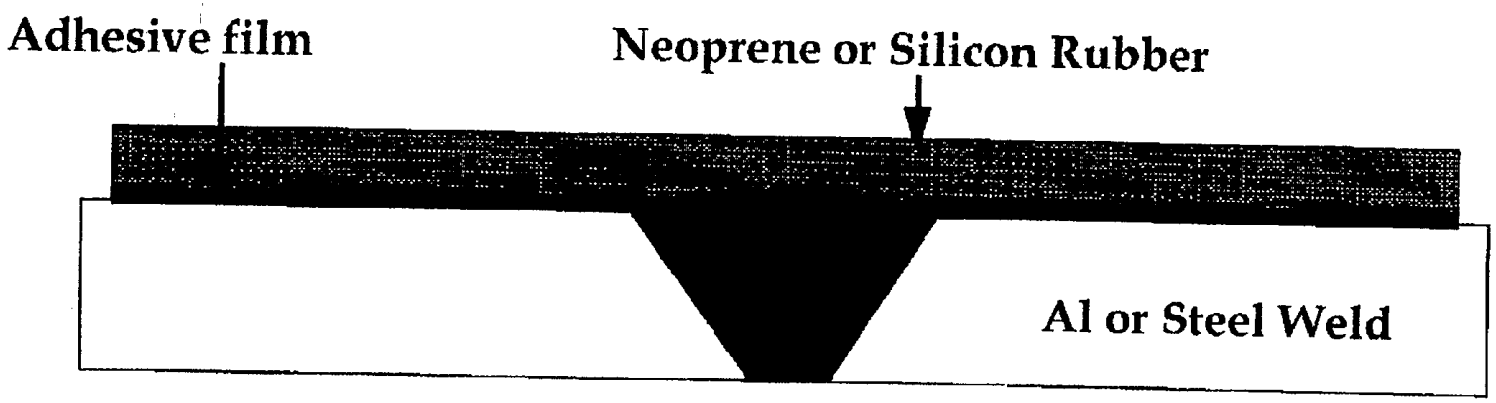
EVALUATE/DEVELOPMENT TECHNIQUES TO INSPECT LAYERED AND SANDWICH STRUCTURES

- MANUFACTURING AND IN-SERVICE INSPECTIONS
- MIL-STD-271 AND ADVANCED TECHNIQUES

NDE of Thick Section, Layered Materials

- INSPECTION THROUGH LAYERED MATERIALS
- URETHANE-COATED METALLIC COMPONENTS
- THICK, SANDWICH COMPOSITES

Inspection Through Layered Materials



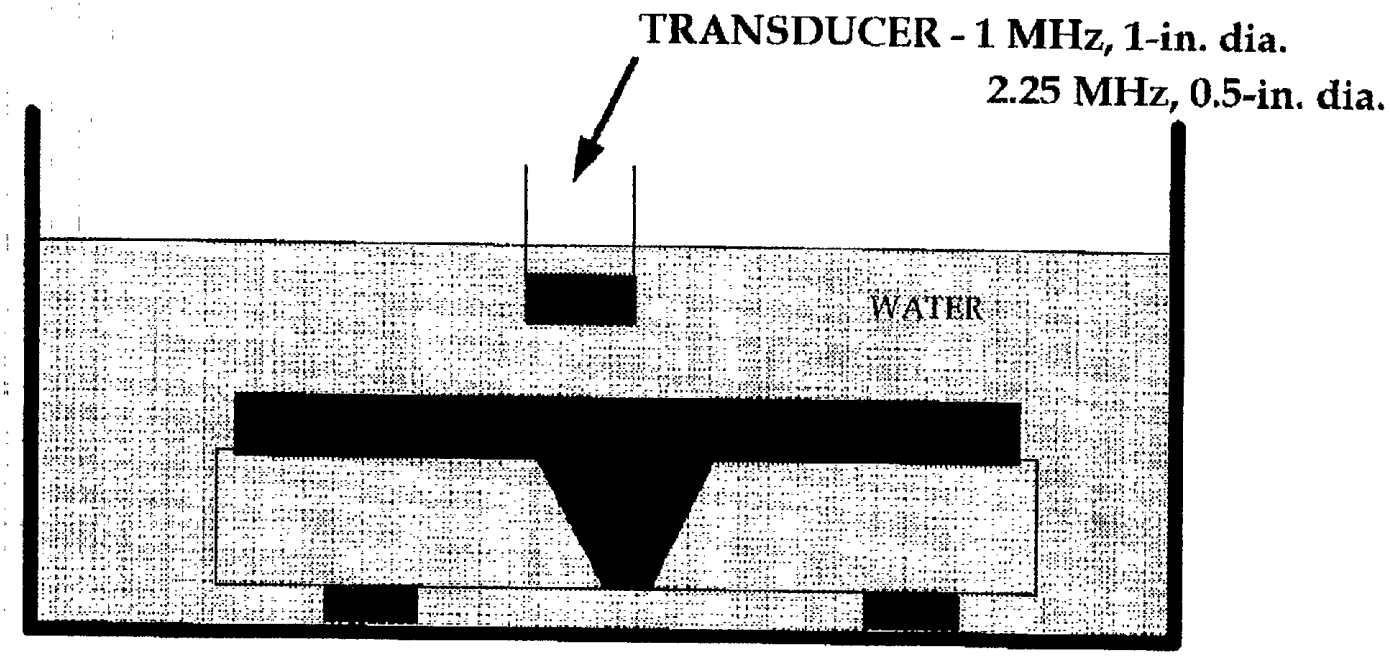
- **PREVENTS VT OF WELDS**
- **DEGRADES X-RAY RT IMAGE**
  - **PENETRAMETER NOT VISIBLE**
- **DEGRADES UT SIGNAL**
  - **NO RETURN SIGNAL @ 2.25MHz**

EXPERIMENTAL MATRIX

- *Al 5456 Weldments*
  - No defects
  - Lack of fusion
  - Clustered Porosity
  - Scattered Porosity
- *3 Types of Layered Materials*
  - 2 Neoprene rubber foam based
  - 1 Silicon rubber foam based

Inspection Through Layered Materials

C-SCAN SETUP



Inspection Through Layered Materials

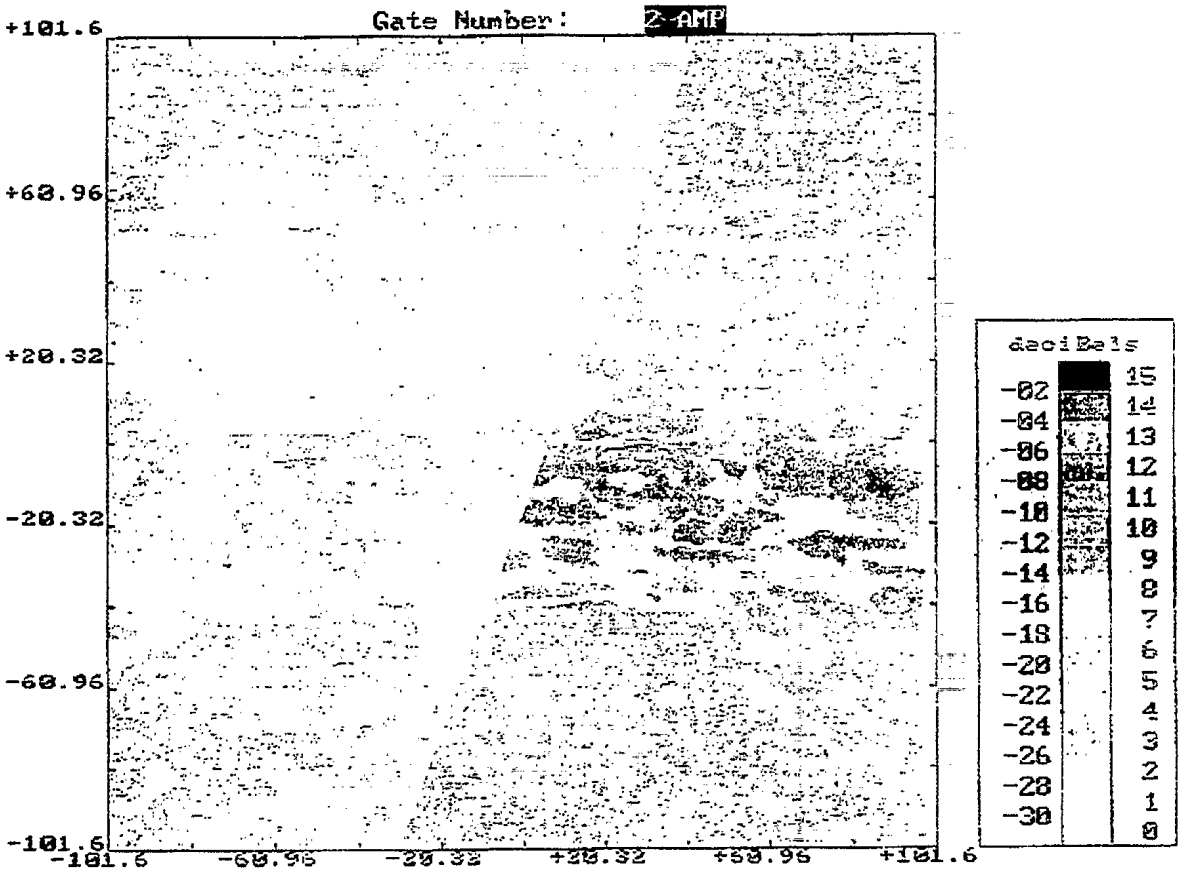
Ultrasonic Velocity (Longitudinal)

Aluminum	0.25
Neoprene 1	0.046
Neoprene 2	0.017
Silicon	0.022

Operator:	CAL	Transducer Type:	2.25MHz,.5",flat
Transducer S/N:	v306	Transducer Mfr:	panametrics
Nominal Cntr Freq:	2.25	Attenuation:	20
Energy:	2	Damping:	4
Gain:	40	HP Filter:	.3
Comment1:	a/d brd - 500mv	Comment2:	
Comment3:		Comment4:	

Par File: RD7.CSP Data Dir: C:\DATA Data File:

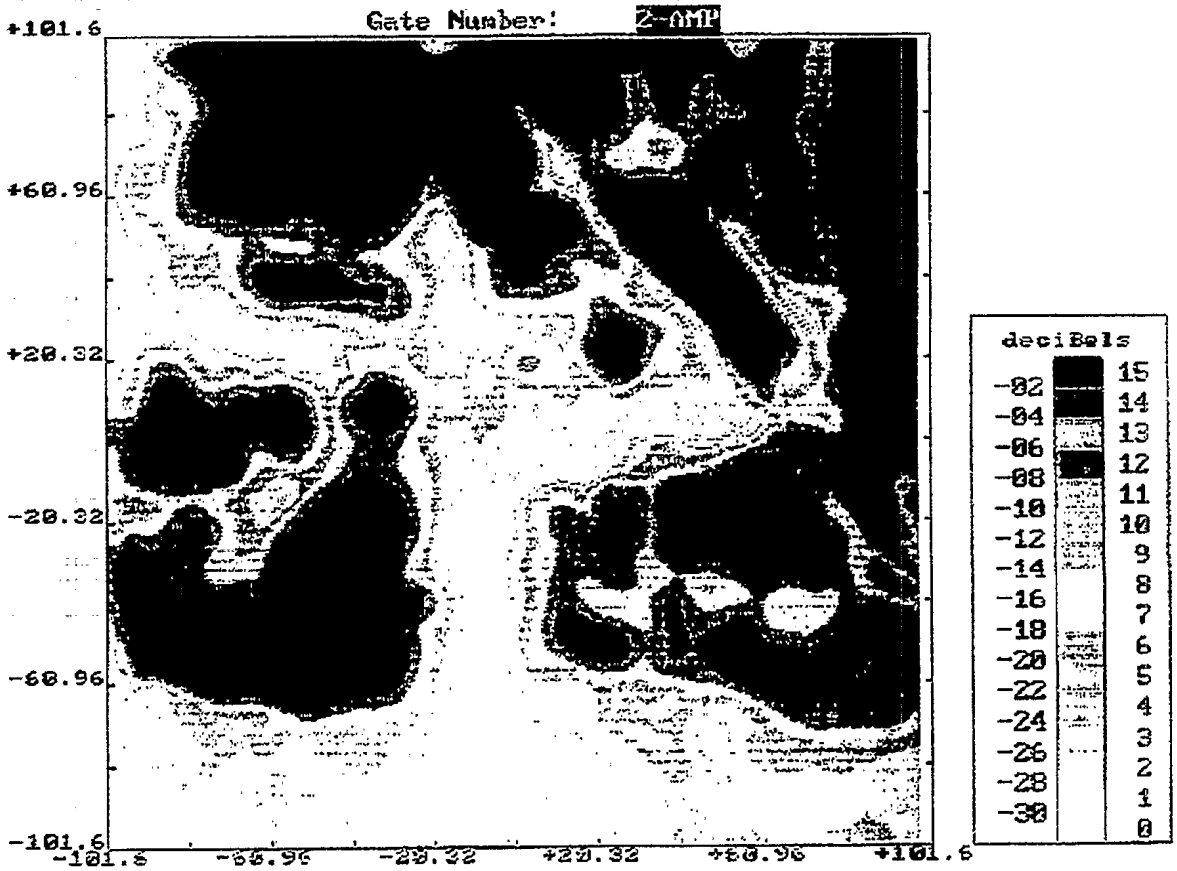
Gate Number: 2-AMP



PART I.D. Number:	RD2	PART TYPE:	ST PLT W/TYP 3R CT(
Operator:	CAL	Transducer Type:	1MHz, 1"DIA FLAT
Transducer S/N:	A302R	Transducer Mfr:	panametrics
Nominal Cntr Freq:	1	Attenuation:	20
Energy:	3	Damping:	2.75
Gain:	40	HP Filter:	.1
Comment1:	a/d brd - 500mv	Comment2:	
Comment3:		Comment4:	

Par File: RD13.CSP Data Dir: C:\DATA Data File:

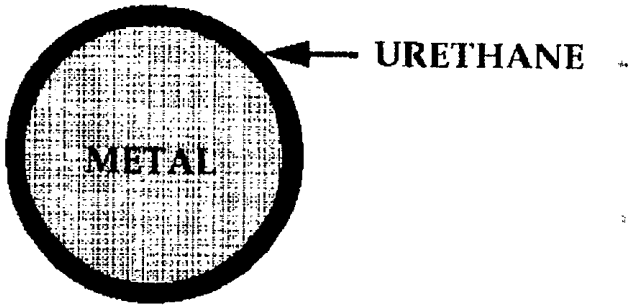
Gate Number: 2-AMP



NDE of Urethane-Coated Metals

MORE AFFORDABLE MANUFACTURING THROUGH REDUCED MACHINING COSTS

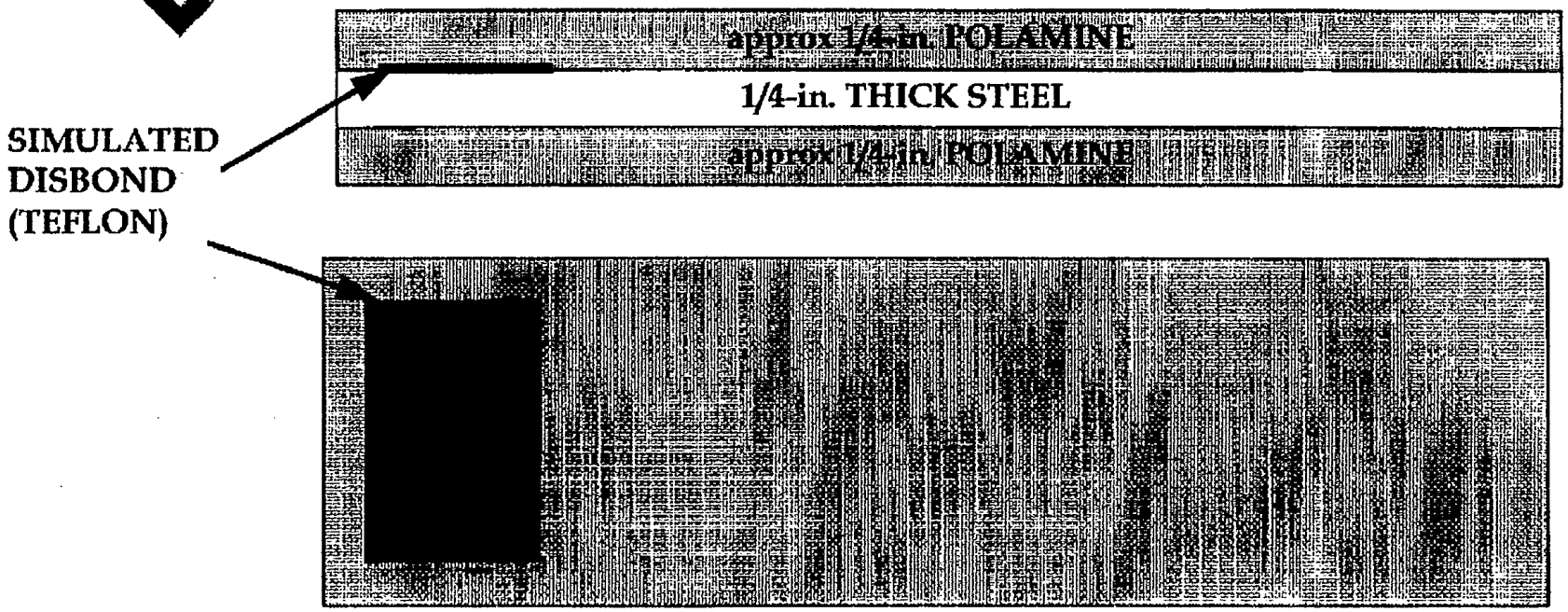
MACHINED PART



CAST PART COATED W/ URETHANE

NDE TECHNIQUES NEEDED TO MEASURE COATING THICKNESS AND BOND INTEGRITY

NDE of Urethane-Coated Metals



NDE Techniques

Ultrasonics - thickness, disbond

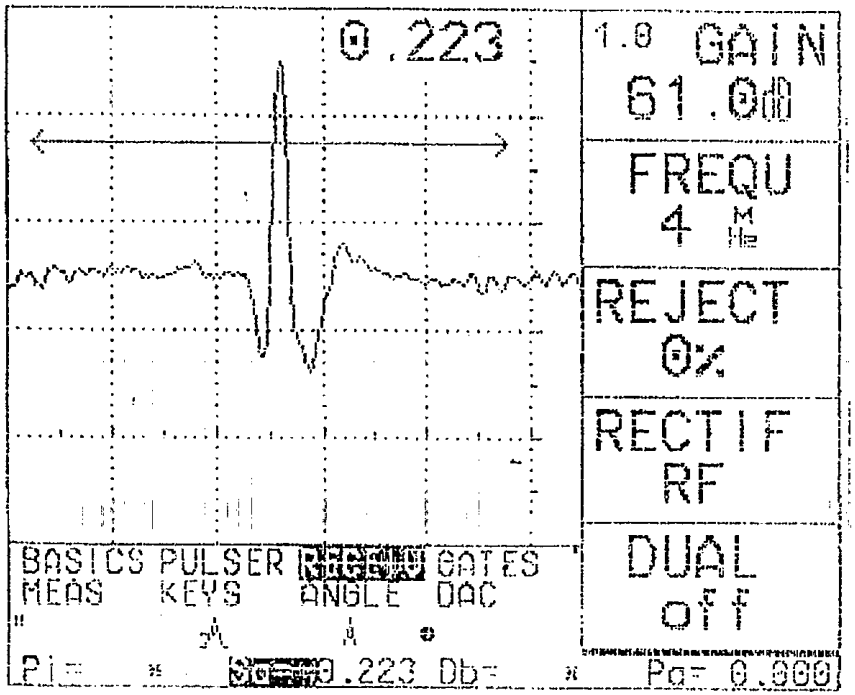
Shearography - disbond

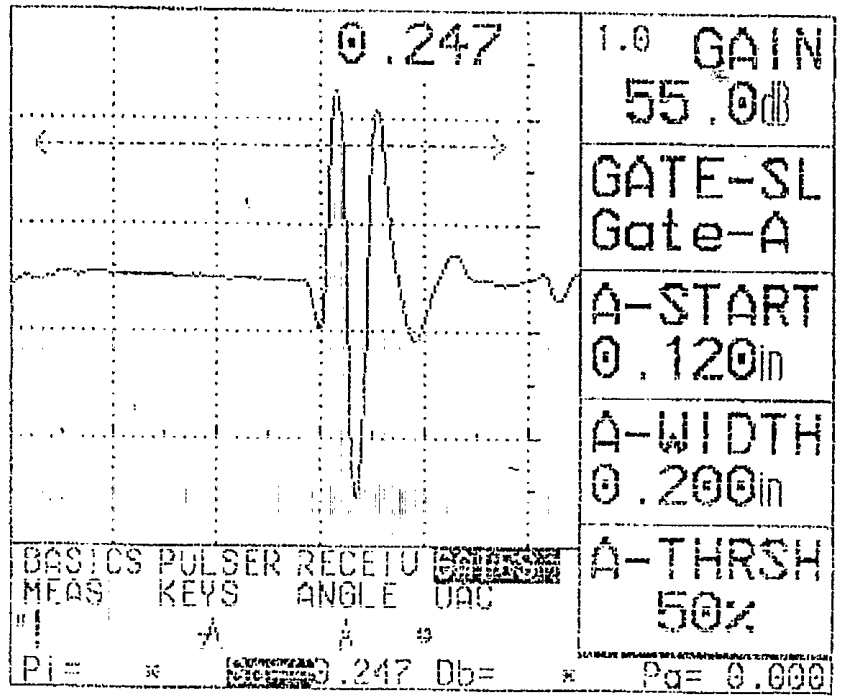
Thermography - disbond

NDE of Urethane-Coated Metals

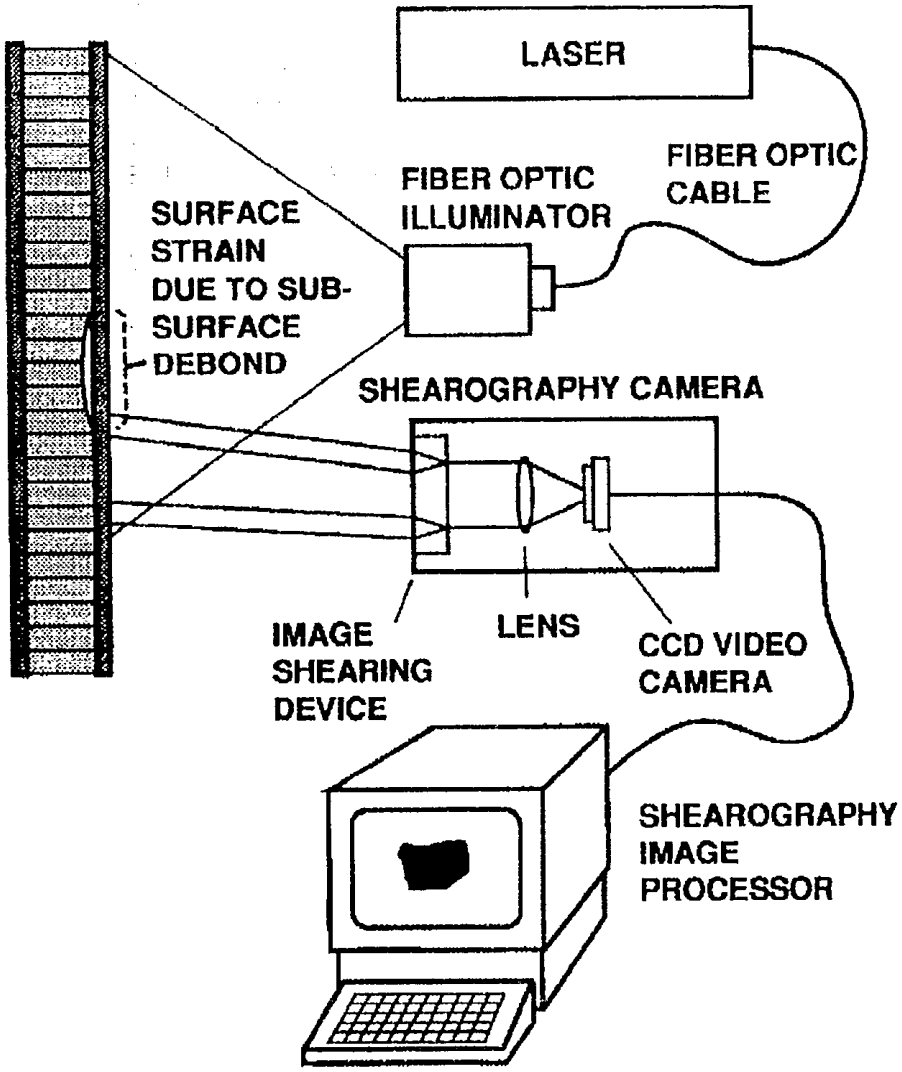
UT RESULTS

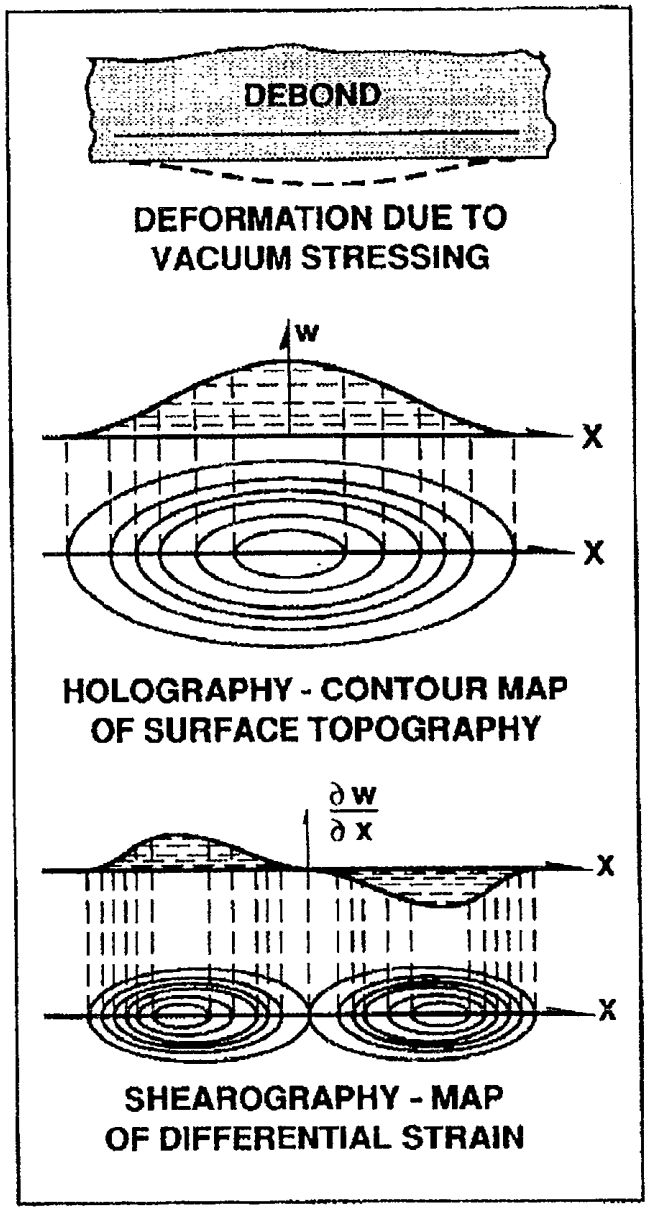
COATING THICKNESS:
(81 MEASUREMENTS)
MEAN = 0.26 in
STDEV = 0.01 in





THEORY OF SHEAROGRAPHY



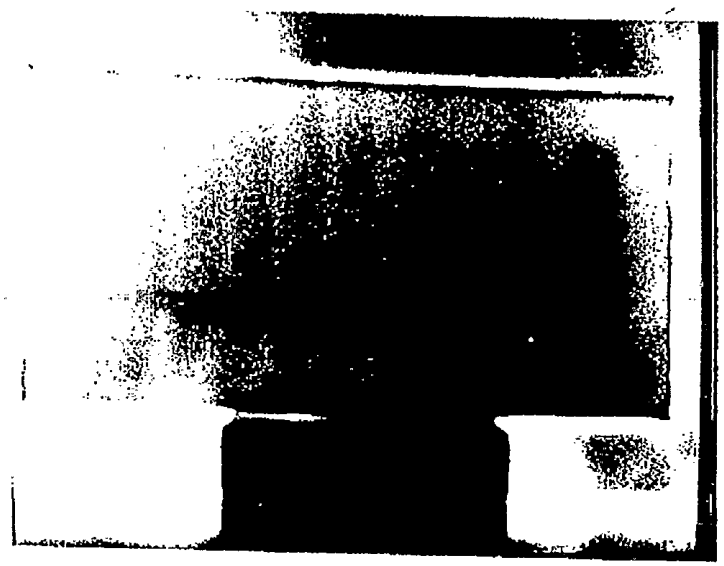


- Full field video strain gauge
- Uses phase relationship between two light waves
- Sensitive to 1/2λ changes in surface of object ⇒ ~1/4 μm

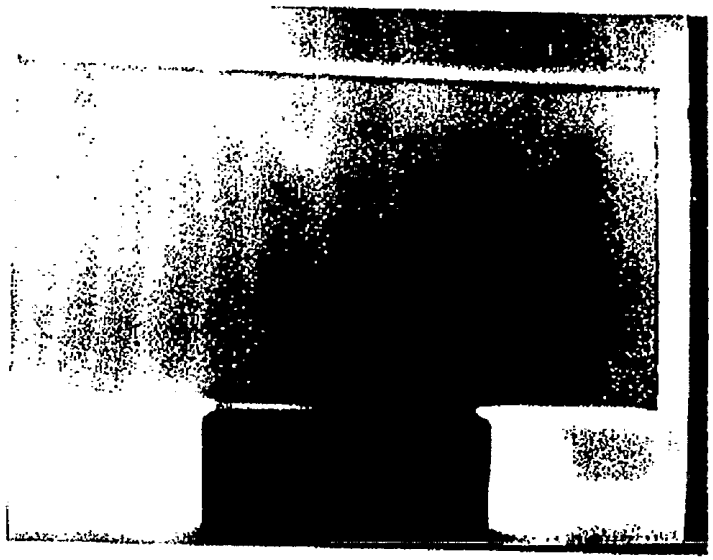
SHEAROGRAPHY RESULTS

NDE of Urethane-Coated Metals

THERMOGRAPHY RESULTS

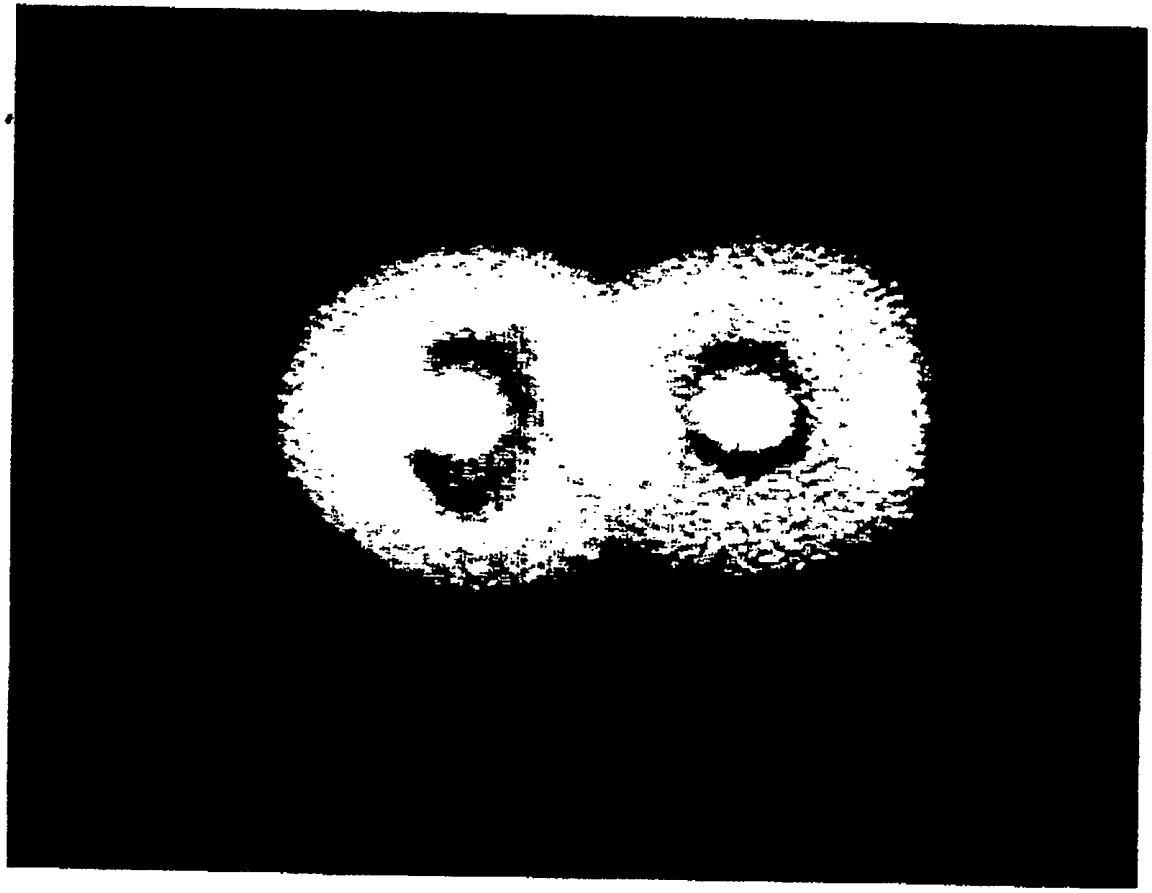


NO DEVELOPER
8-FRAME AVERAGING
NO CONTRAST ENHANCEMENT



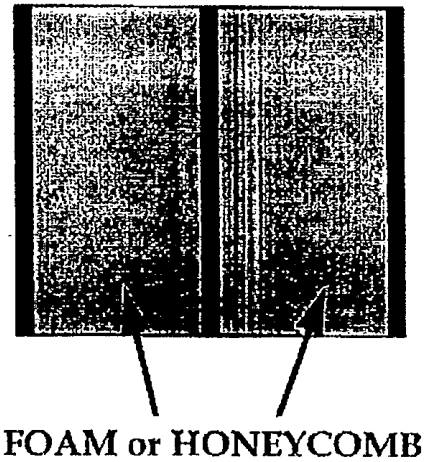
PENETRANT DEVELOPER
NO IMAGE AVERAGING
NO CONTRAST ENHANCEMENT

SHEAROGRAPHY RESULTS - IMPACT DAMA



NDE of Thick, Sandwich Composites

COMBINING THIN COMPOSITE LAMINATES
WITH VARIOUS CORE MATERIALS



WEIGHT SAVINGS

SIGNATURE REDUCTIONS

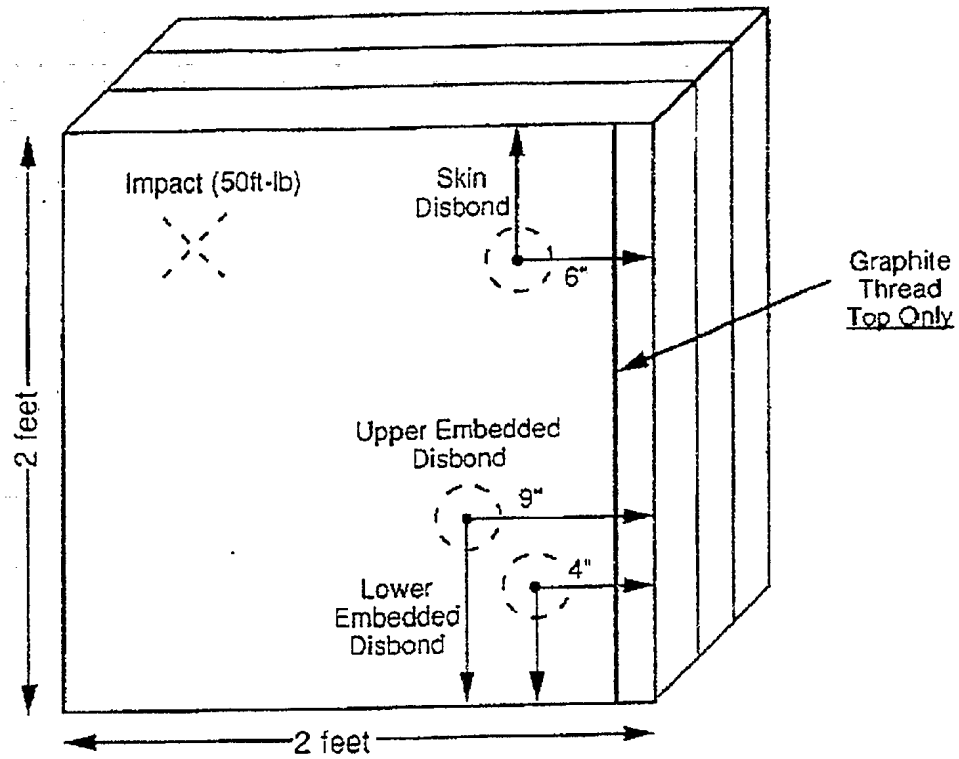
NDE TECHNIQUES NEEDED TO DETECT DEFECTS IN LAMINATES AND AT BOND LINES

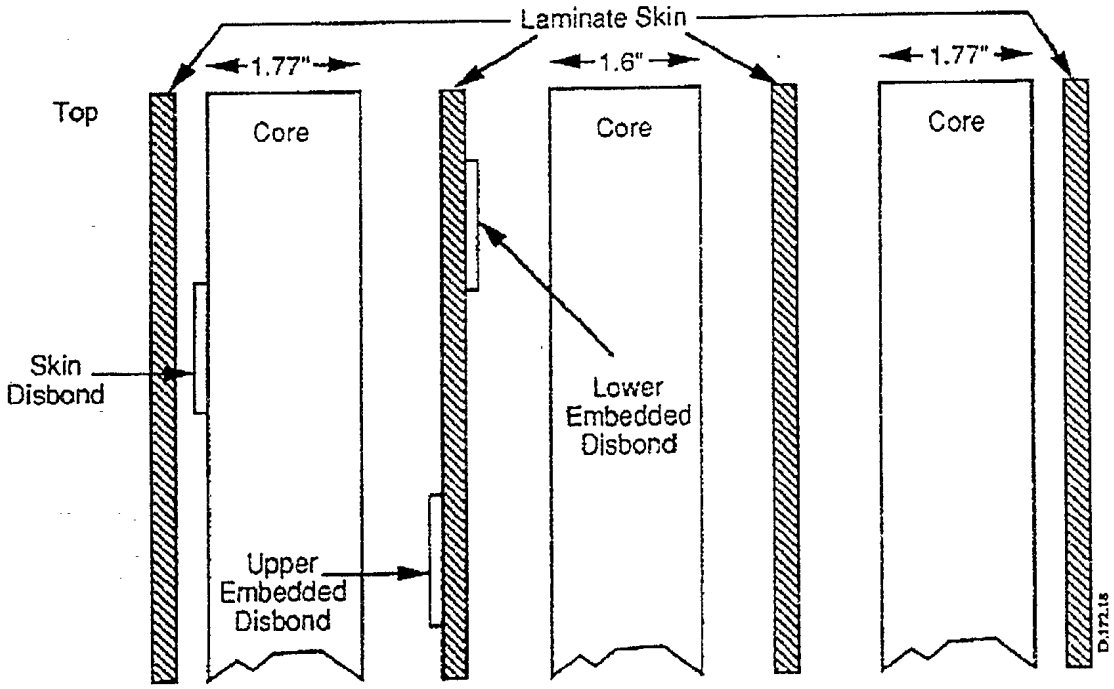
SHEAROGRAPHY NDE, QUARTER SCALE MAST

AFTER 2nd AIR BLAST TEST

FIELD TESTING - LASER TECHNOLOGY, INC.

NDE INDICATIONS - SKIN/CORE DISBONDS





Exploded View (not to scale)

MICROWAVE NDE SETUP

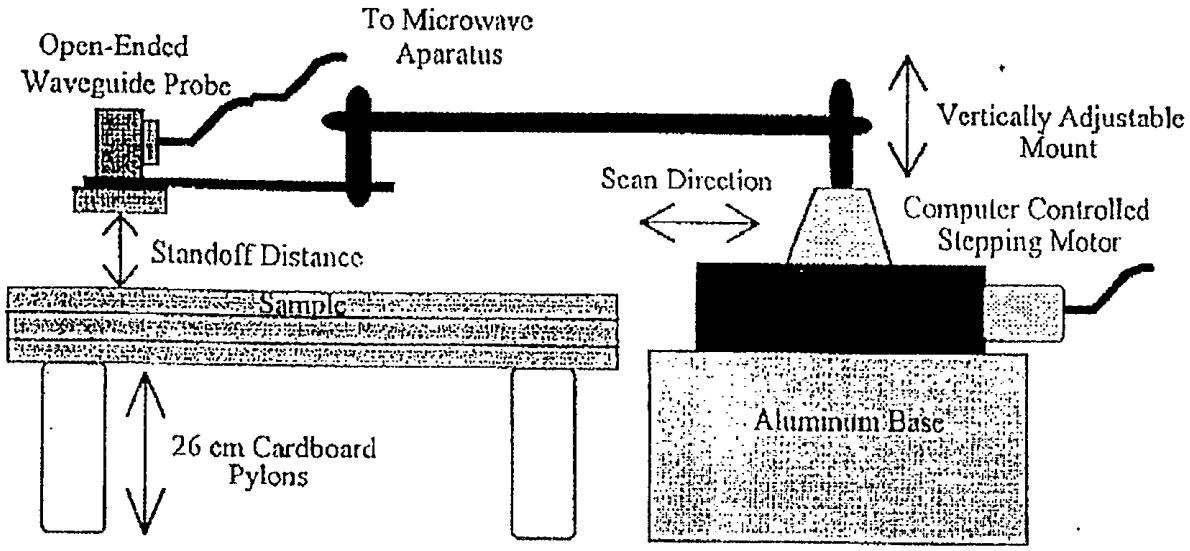
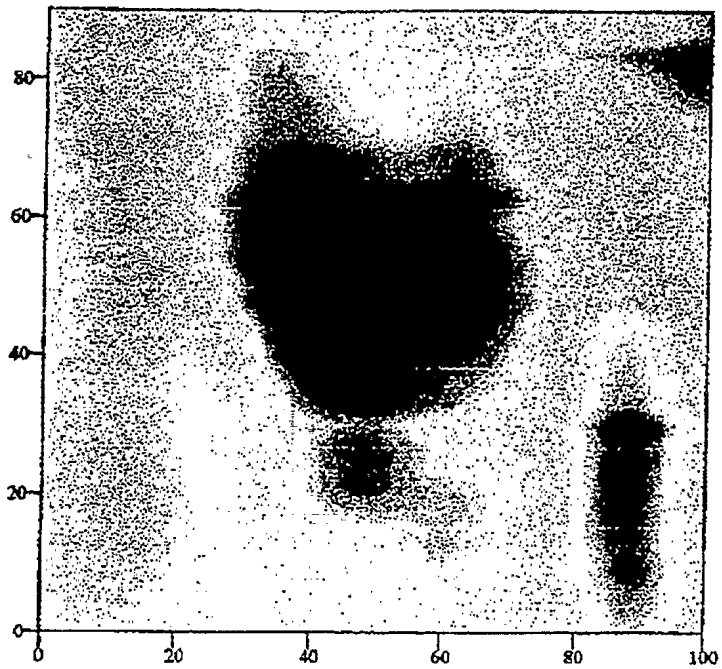
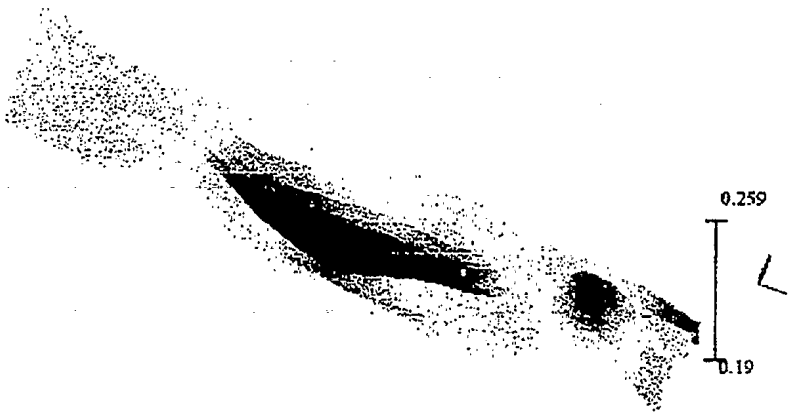


Figure 2: Scanner using a stepping motor.



Img11

Image 11a: The contour plot of the scan of the upper embedded delamination (Defect 3) for the honeycomb sample at 9.1 GHz at an 17 mm standoff distance.



Img11

Image 11a: The contour plot of the scan of the upper embedded delamination (Defect 3) for the honeycomb sample at 9.1 GHz at an 17 mm standoff distance.

MICROWAVE RESULTS

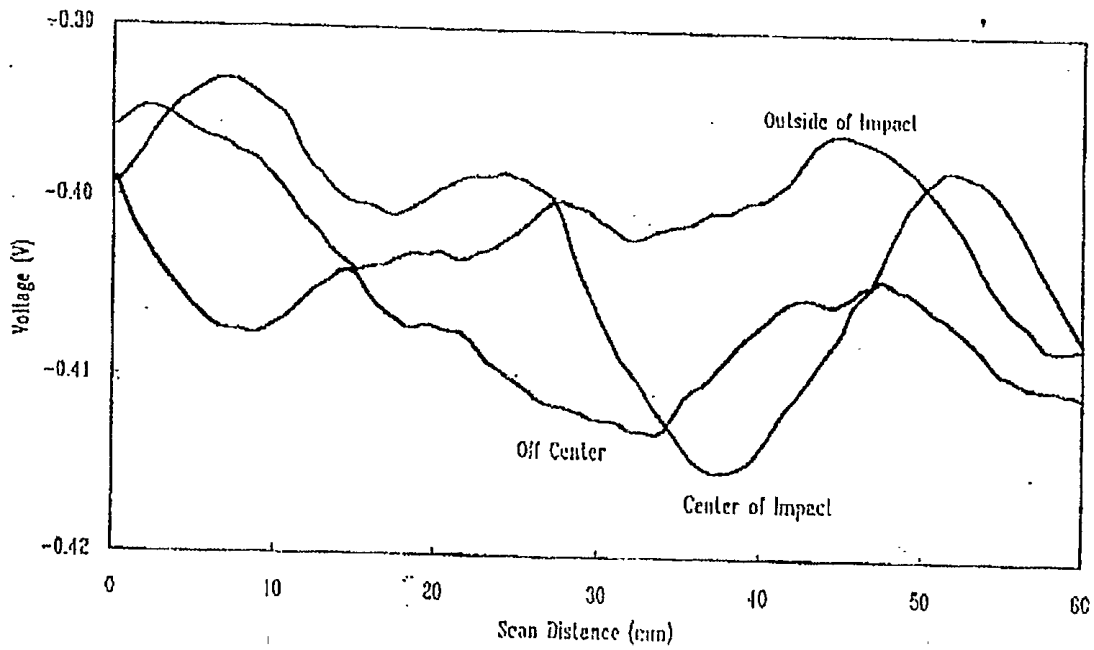


Figure 23: Three line scans of the impact damage of the honeycomb sample from the opposite side at 6 GHz.

NDE of Thick Section, Layered Materials

- INSPECTION THROUGH LAYERED MATERIALS
- URETHANE-COATED METALLIC COMPONENTS
- THICK, SANDWICH COMPOSITES