

Image Cover Sheet

CLASSIFICATION

UNCLASSIFIED

SYSTEM NUMBER

510351



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

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities.

2. It then outlines the various methods used to collect and analyze data, including surveys, interviews, and focus groups.

3. The next section describes the results of the study, highlighting the key findings and their implications for practice.

4. Finally, the document concludes with a discussion of the limitations of the study and suggestions for future research.

5. The overall goal of this document is to provide a comprehensive overview of the research process and findings.

6. It is intended for use by researchers, practitioners, and students interested in the field of study.

7. The document is organized into several sections, each addressing a specific aspect of the research.

8. The first section provides a detailed description of the research objectives and the research design.

9. The second section describes the data collection methods and the analysis techniques used.

10. The third section presents the results of the study, including the main findings and their implications.

11. The fourth section discusses the limitations of the study and suggests areas for future research.

12. The final section provides a summary of the research and its contributions to the field.

13. The document is written in a clear and concise style, using simple language and avoiding technical jargon.

14. It is intended to be a useful resource for anyone interested in the research process and findings.

15. The document is available for free download and use, and is subject to the Creative Commons Attribution-NonCommercial-ShareAlike license.

NDE for Thick Section, Layered Composite Structures

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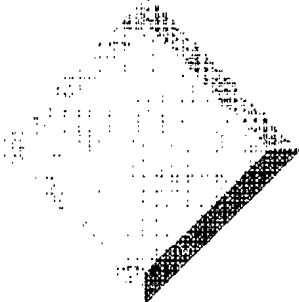
ABSTRACT



OBJECTIVE

**EVALUATE/DEVELOPMENT TECHNIQUES
TO INSPECT LAYERED AND SANDWICH
STRUCTURES**

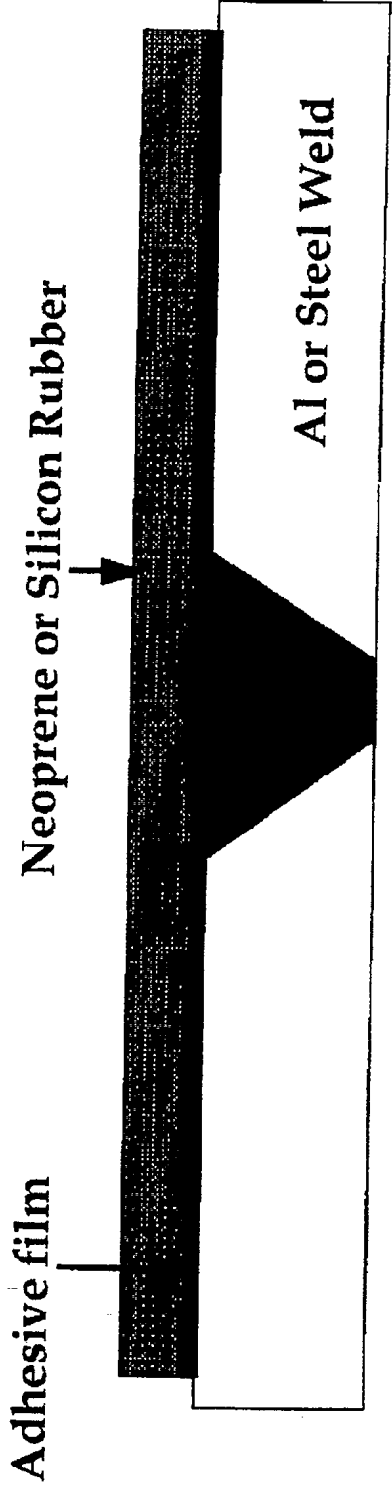
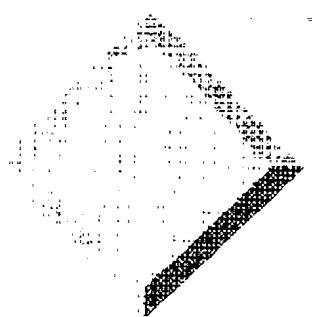
- **MANUFACTURING AND IN-SERVICE
INSPECTIONS**
- **MIL-STD-271 AND ADVANCED
TECHNIQUES**



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
 - PENETRAMEETER NOT VISIBLE
- DEGRADES UT SIGNAL
 - NO RETURN SIGNAL @ 2.25MHZ

Inspection Through Layered Materials

EXPERIMENTAL MATRIX

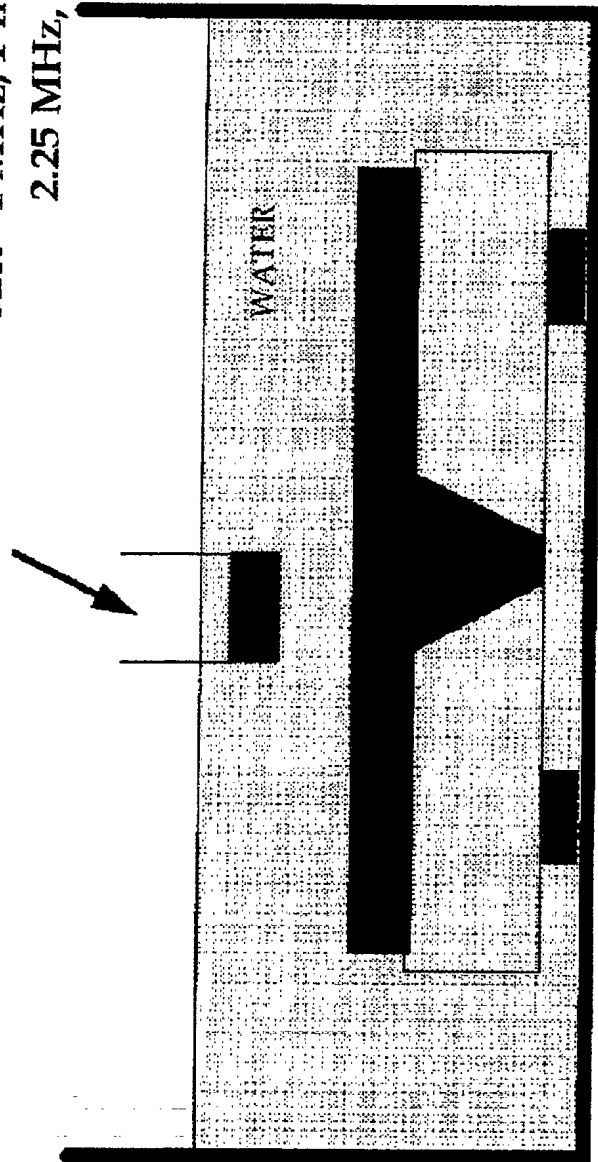
- *Al 5456 Weldments*
 - No defects
 - Lack of fusion
 - Clustered Porosity
 - Scattered Porosity

- *3 Types of Layered Materials*
 - 2 Neoprene rubber foam based
 - 1 Silicon rubber foam based

Inspection Through Layered Materials

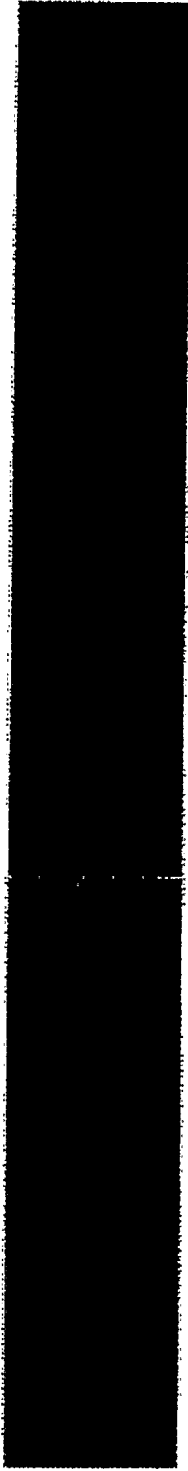
C-SCAN SETUP

TRANSDUCER - 1 MHz, 1-in. dia.
2.25 MHz, 0.5-in. dia.



Inspection Through Layered Materials

Ultrasonic Velocity (Longitudinal)



Aluminum

0.25

Neoprene 1

0.046

Neoprene 2

0.017

Silicon

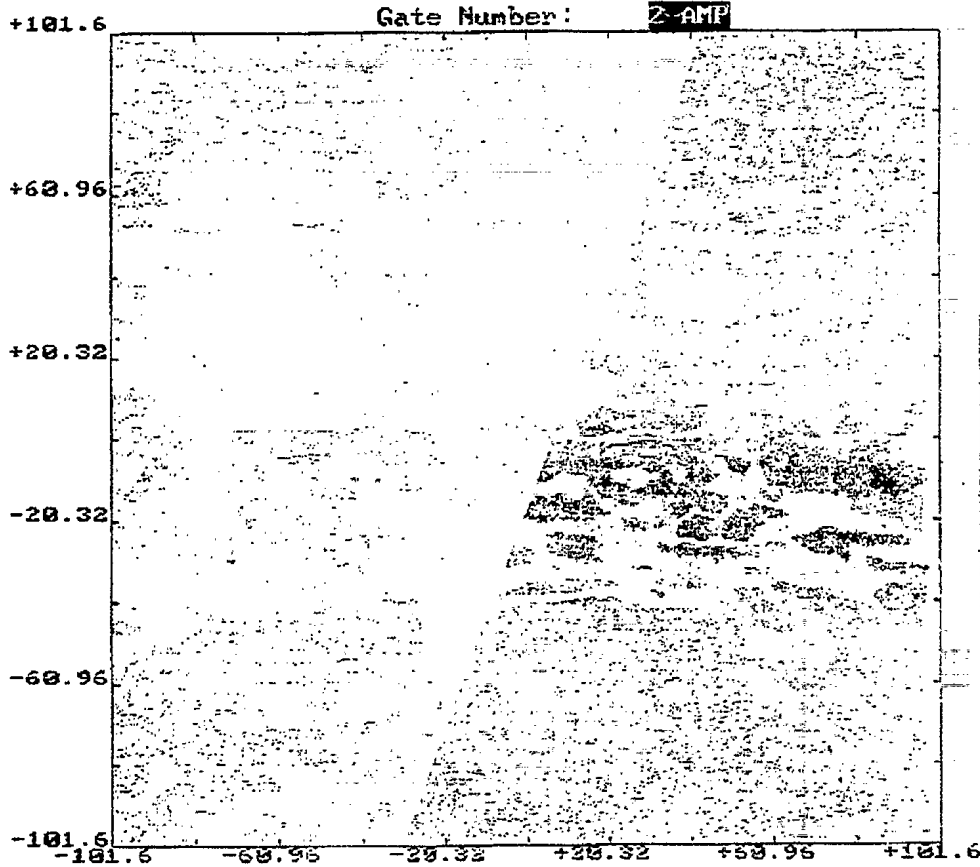
0.022

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:



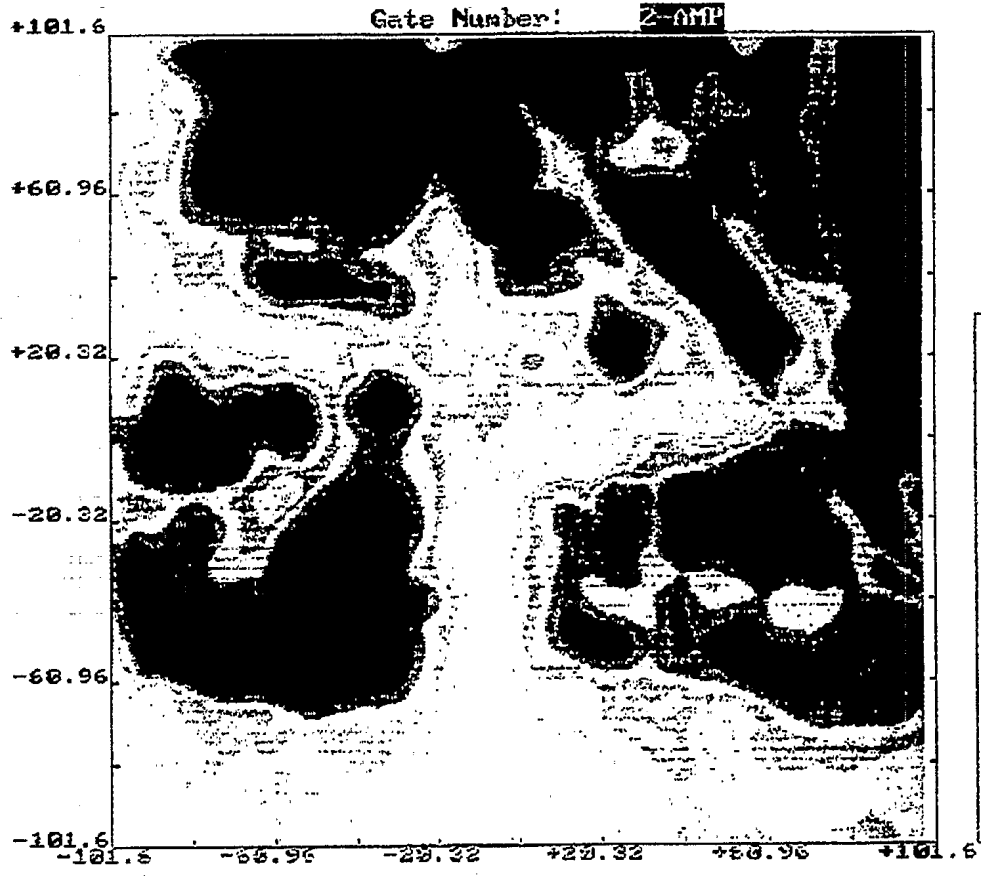
decibels	
-02	15
-04	14
-06	13
-08	12
-10	11
-12	10
-14	9
-16	8
-18	7
-20	6
-22	5
-24	4
-26	3
-28	2
-30	1

PART I.D. Number: RD2
 Operator: CAL
 Transducer S/N: A302R
 Nominal Cntr Freq: 1
 Energy: 3
 Gain: 40
 Comment1: a/d brd - 500mv
 Comment3:

- 162 -

PART TYPE: ST PLT W/TYP 3R CTC
 Transducer Type: 1MHZ, 1"DIA FLAT
 Transducer Mfr: panametrics
 Attenuation: 20
 Damping: 2.75
 HP Filter: .1
 Comment2:
 Comment4:

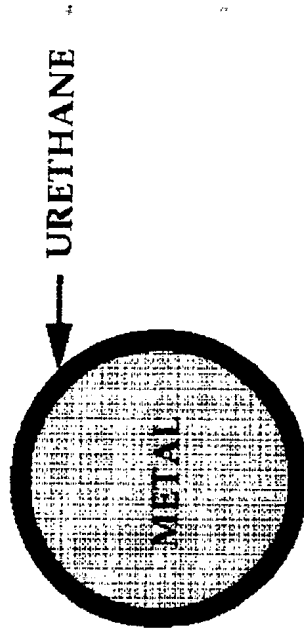
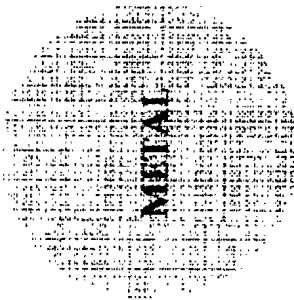
Par File: **RD13.CSF** Data Dir: **C:\NDATA** Data File:



decibels	
-02	15
-04	14
-06	13
-08	12
-10	11
-12	10
-14	9
-16	8
-18	7
-20	6
-22	5
-24	4
-26	3
-28	2
-30	1
	0

NDE of Urethane-Coated Metals

**MORE AFFORDABLE MANUFACTURING
THROUGH REDUCED MACHINING COSTS**



MACHINED PART

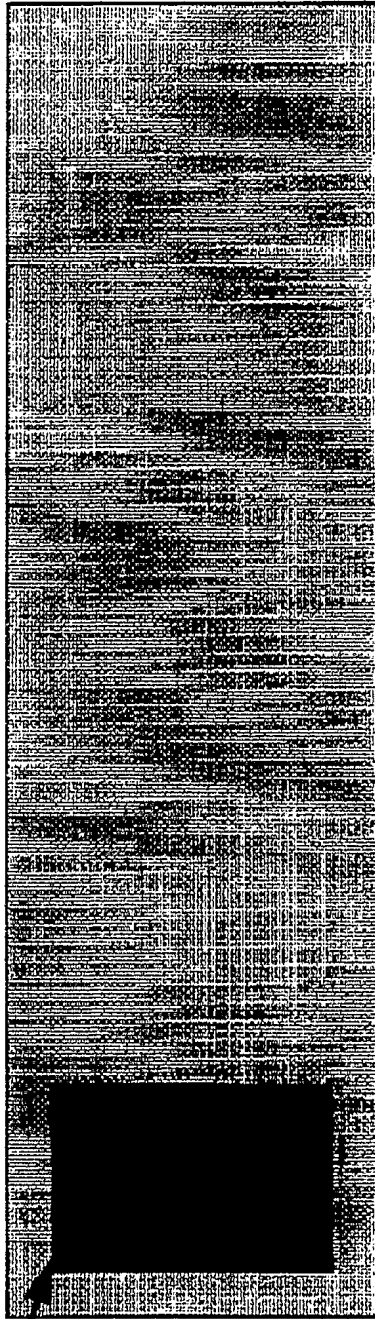
**CAST PART COATED W/
URETHANE**

**NDE TECHNIQUES NEEDED TO MEASURE
COATING THICKNESS AND BOND INTEGRITY**

NDE of Urethane-Coated Metals



SIMULATED
DISBOND
(TEFLON)



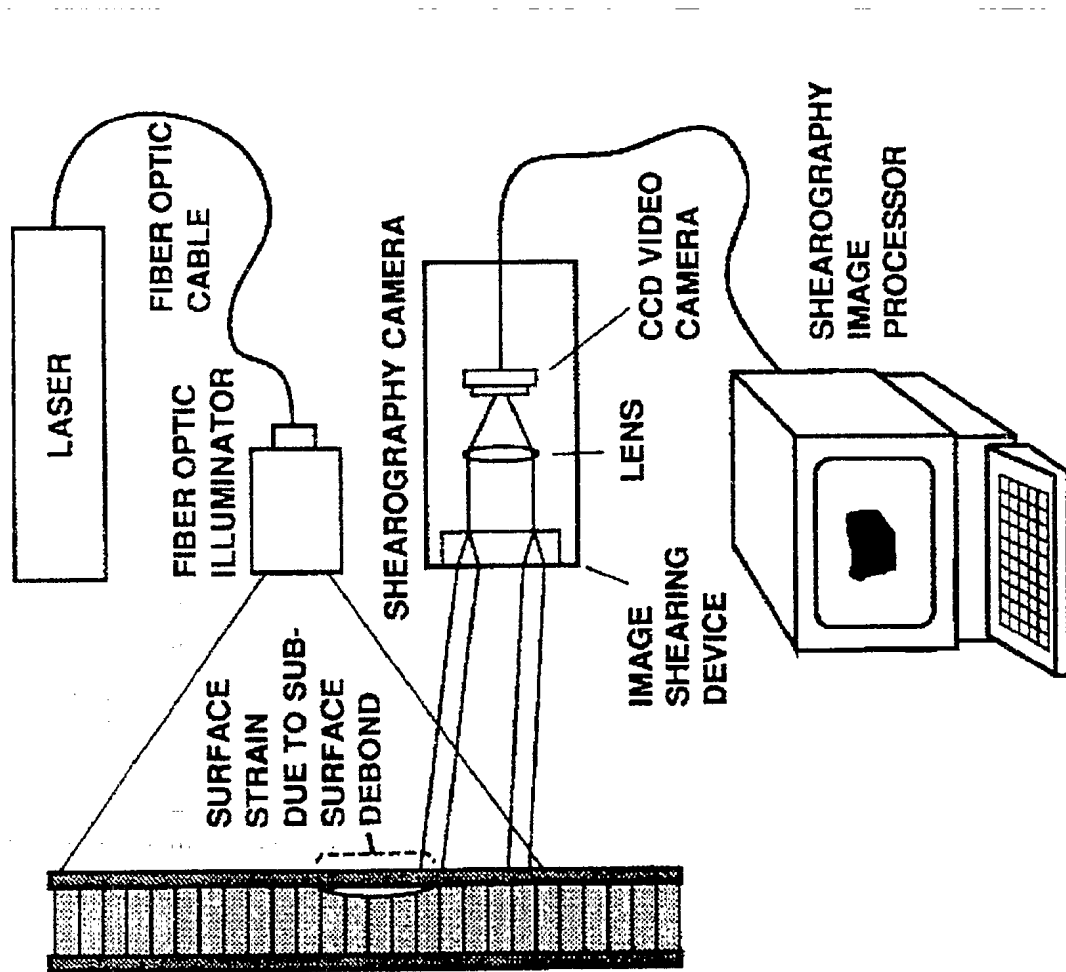
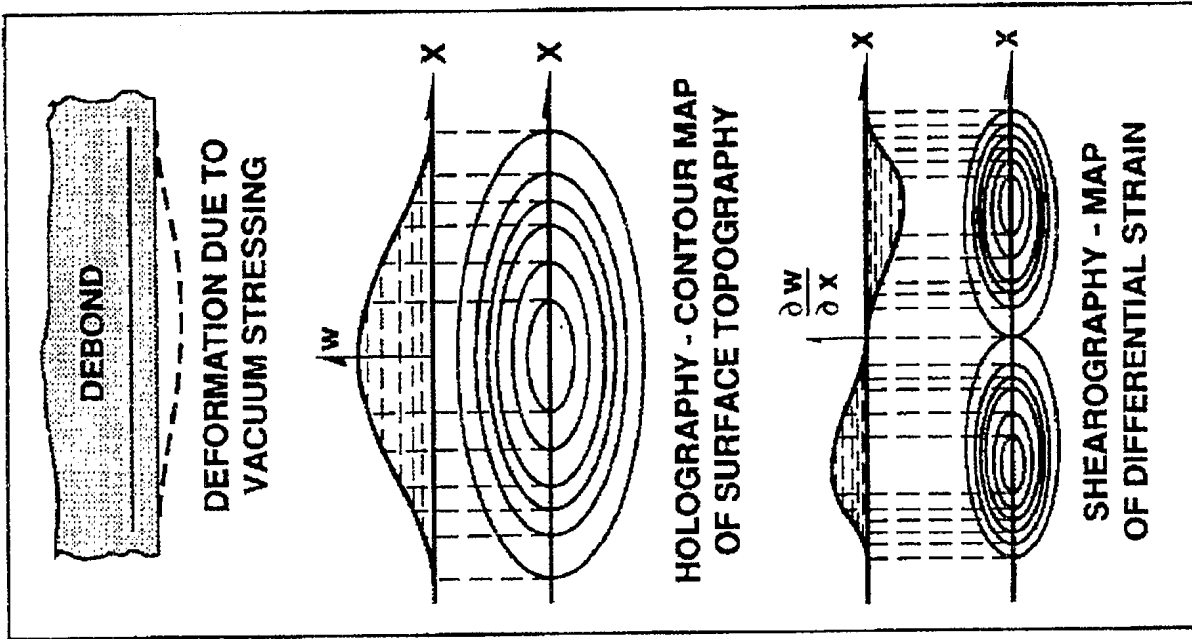
NDE Techniques

Ultrasonics - thickness, disbond

Shearography - disbond

Thermography - disbond

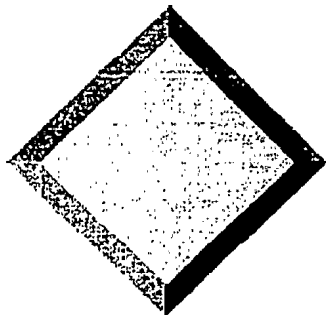
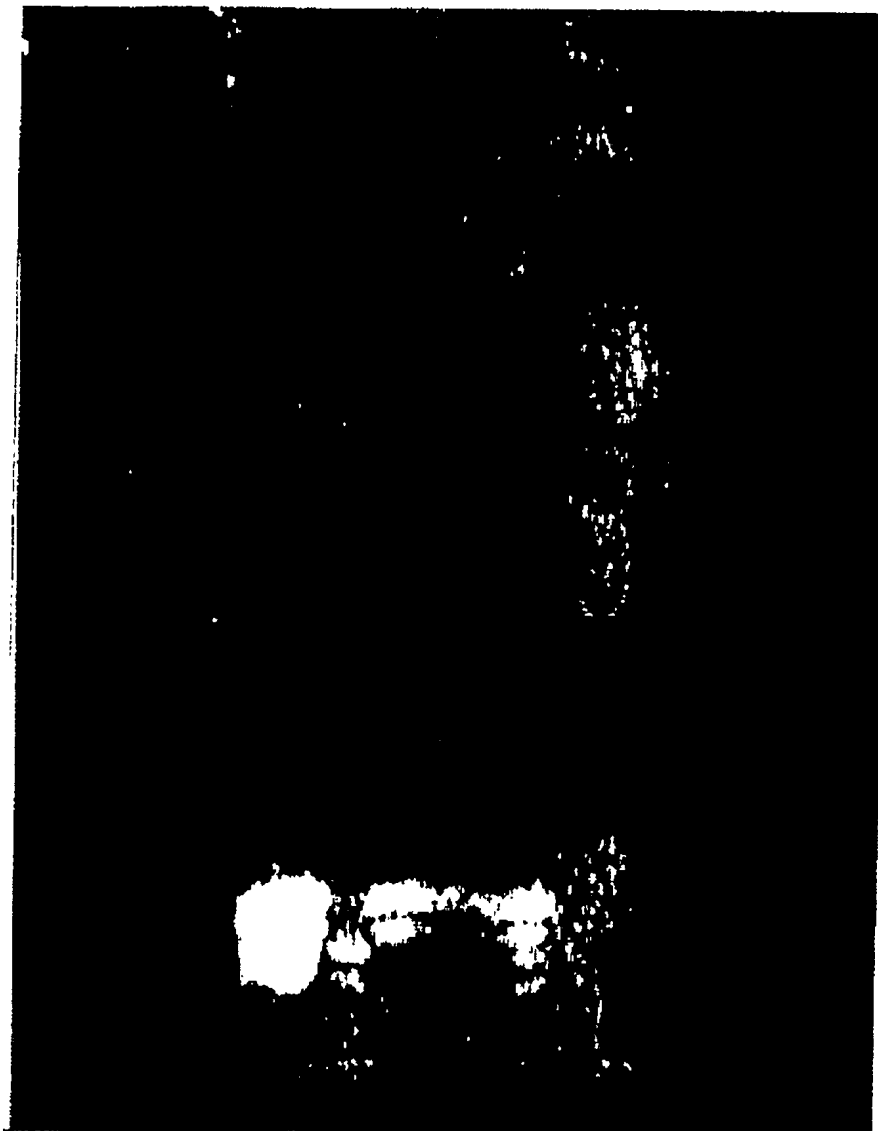
THEORY OF SHEAROGRAPHY



- Full field video strain gauge
- Uses phase relationship between two light waves
- Sensitive to $1/2\lambda$ changes in surface of object $\rightarrow \sim 1/4 \mu\text{m}$

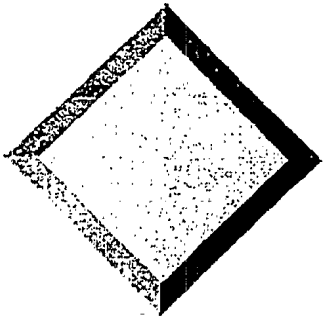
NDE of Urethane-Coated Metals

SHEAROGRAPHY RESULTS



NDE of Urethane-Coated Metals

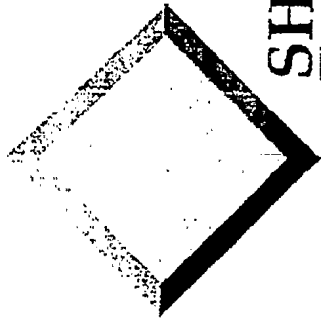
THERMOGRAPHY RESULTS



NO DEVELOPER
8-FRAME AVERAGING
NO CONTRAST ENHANCEMENT

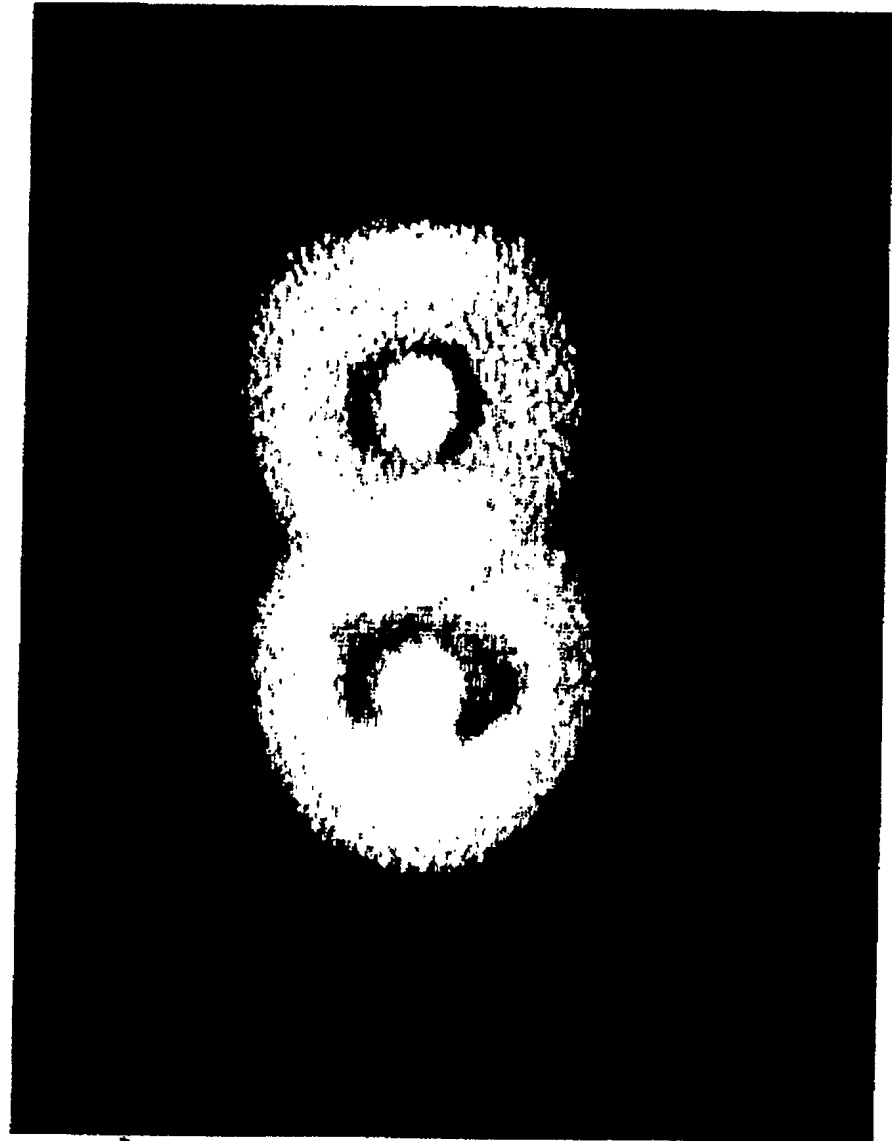


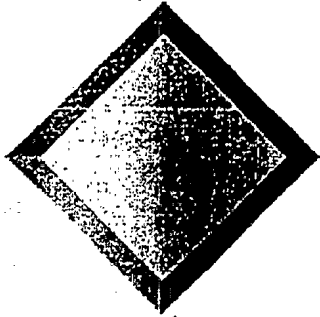
PENETRANT DEVELOPER
NO IMAGE AVERAGING
NO CONTRAST ENHANCEMENT



NDE of Thick, Sandwich Composites

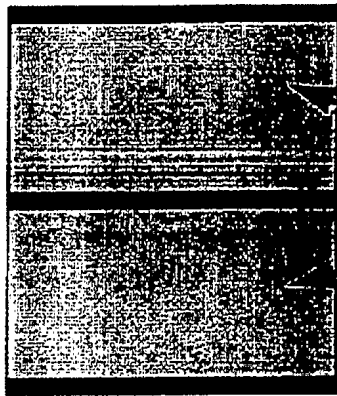
SHEAROGRAPHY RESULTS - IMPACT DAMA





NDE of Thick, Sandwich Composites

COMBINING THIN COMPOSITE LAMINATES
WITH VARIOUS CORE MATERIALS



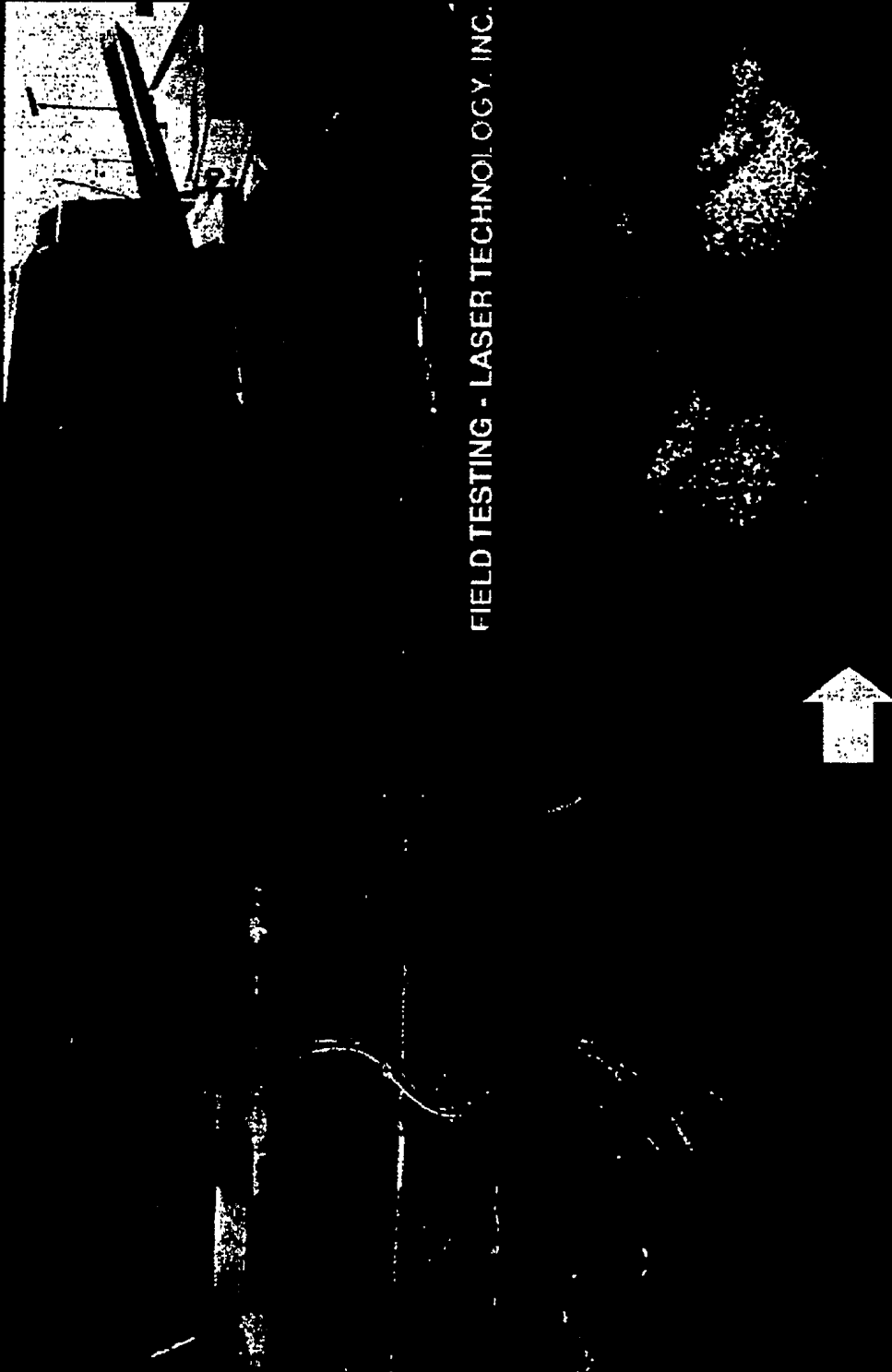
FOAM or HONEYCOMB

WEIGHT SAVINGS
SIGNATURE REDUCTIONS

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

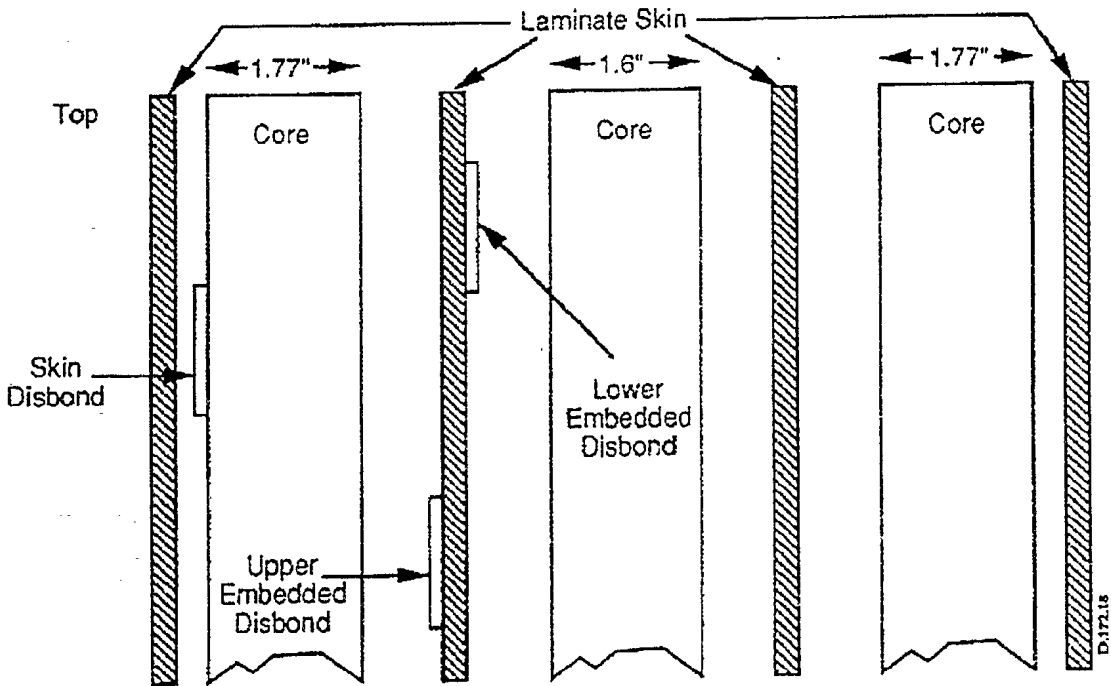
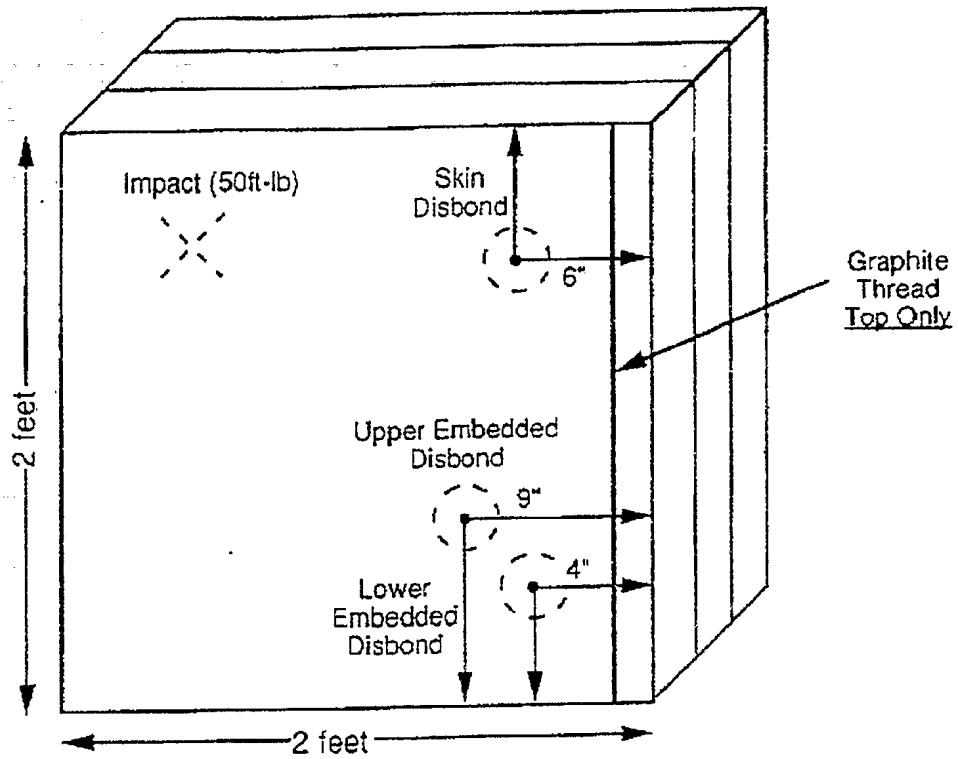
SHEAROGRAPHY NDE, QUARTER SCALE MAST

AFTER 2nd AIR BLAST TEST

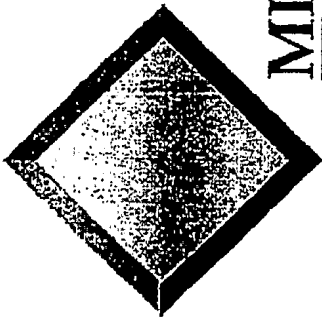


FIELD TESTING - LASER TECHNOLOGY, INC.

NDE INDICATIONS - SKIN/CORE DISBONDS



Exploded View (not to scale)



NDE of Thick, Sandwich Composites

MICROWAVE NDE SETUP

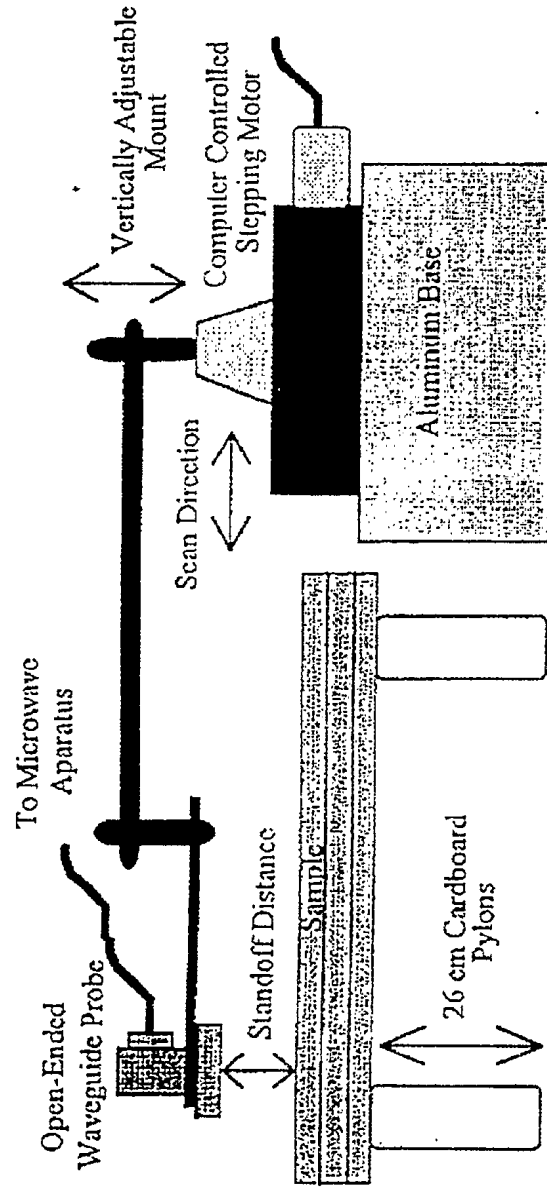


Figure 2: Scanner using a stepping motor.

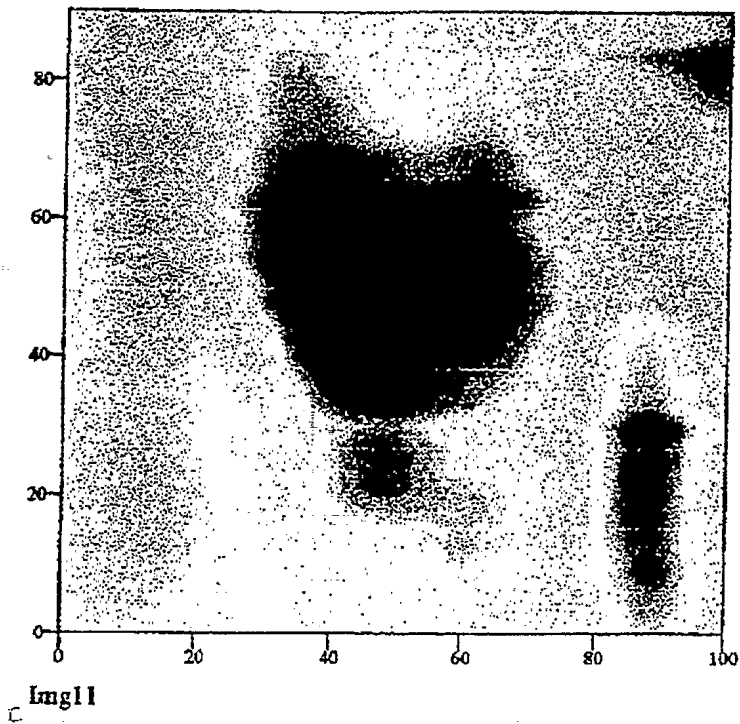


Image 11a: The contour plot of the scan of the upper embedded delamination (Defect 3) for the honeycomb sample at 9.1 GHz at an 17 mm standoff distance.

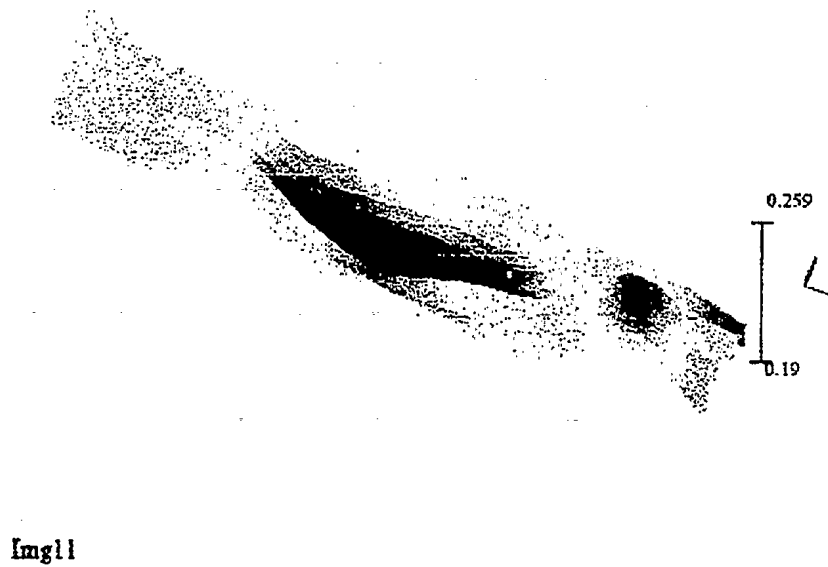


Image 11a: The contour plot of the scan of the upper embedded delamination (Defect 3) for the honeycomb sample at 9.1 GHz at an 17 mm standoff distance.

NDE of Thick, Sandwich Composites

MICROWAVE RESULTS

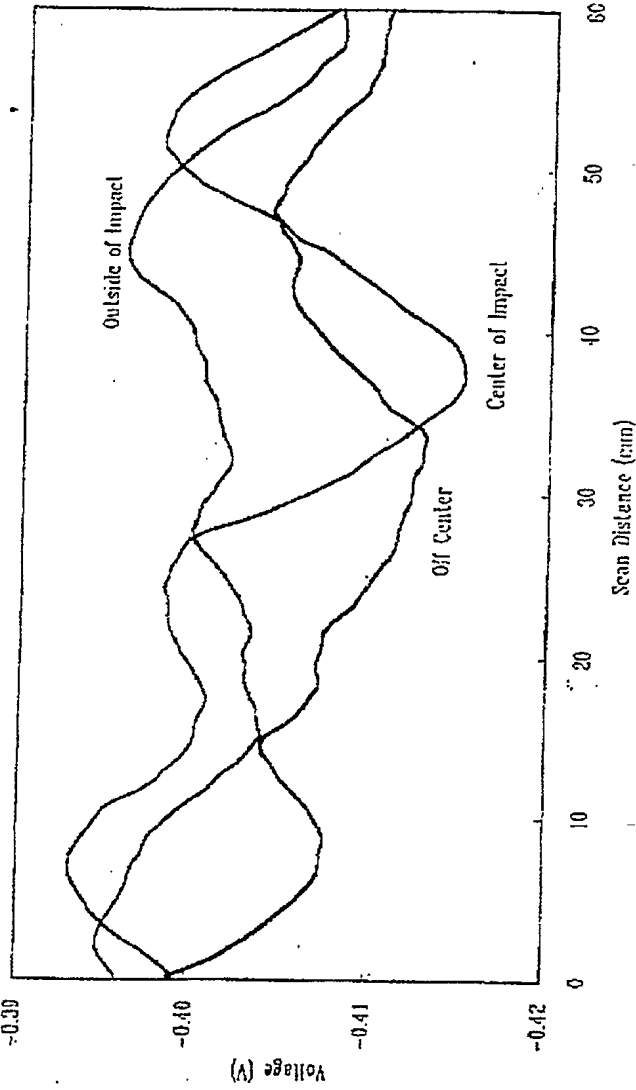
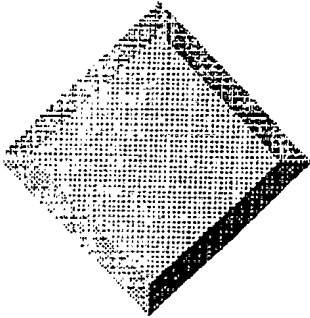


Figure 23: Three line scans of the impact damage of the honeycomb sample from the opposite side at 6 GHz.



NDE of Thick Section, Layered Materials

- **INSPECTION THROUGH LAYERED MATERIALS**
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- **THICK, SANDWICH COMPOSITES**

