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AD-A205 176

DOCUMENTATION PAGE

(2)

1a. REPOI	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AU	3. DISTRIBUTION / AVAILABILITY OF REPORT Approved for public release; distribution unlimited.
2b. DECLASSIFICATION / DOWNGRA SCHEDULE	
4. PERFORMING ORGANIZATION NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S) ARO 24513.8-EG
6a. NAME OF PERFORMING ORGANIZATION Univ. of Houston	6b. OFFICE SYMBOL (If applicable)
6c. ADDRESS (City, State, and ZIP Code) Houston, TX 77006	7a. NAME OF MONITORING ORGANIZATION U. S. Army Research Office
	7b. ADDRESS (City, State, and ZIP Code) P. O. Box 12211 Research Triangle Park, NC 27709-2211
8a. NAME OF FUNDING / SPONSORING ORGANIZATION U. S. Army Research Office	8b. OFFICE SYMBOL (If applicable)
8c. ADDRESS (City, State, and ZIP Code) P. O. Box 12211 Research Triangle Park, NC 27709-2211	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER DAAL03-87-K-0009
	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO.

11. TITLE (Include Security Classification)
Nondestructive Evaluation of Stress Using Ultrasound and Pulsed Heat

12. PERSONAL AUTHOR(S)
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13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Final	FROM 12/1/86 TO 11/30/88	January 1989	3

16. SUPPLEMENTARY NOTATION
The view, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.

17. COSATI CODES		
FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
Nondestructive Evaluation; Ultrasonic Sound; Pulsed Heat; Acoustoelastic Phenomenon; Metal Stress

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

1. Unique instrumentation was developed for high-precision time-resolved ultrasonic velocity measurement. Such instrumentation is not available commercially nor, as far as is known, has such a capability ever been developed previously. It has a significant potential for materials studies and possibly other areas as well, as for instance noninvasive biomedical applications.

2. It was demonstrated that with such instrumentation, applied stress even of modest values can be detected at depths of at least 1 cm in aluminum. Furthermore, such detection was shown to be quantitative, i.e., the amplitude of the effect is proportional to stress magnitude, and its shape is responsive in the predicted manner to locality of the stress. In view of item 3, below, it is evident that this concept is a viable basis for nondestructive characterization of subsurface residual stress in metals.

20. DISTRIBUTION / AVAILABILITY OF ABSTRACT	21. ABSTRACT SECURITY CLASSIFICATION
☐ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL	22b TELEPHONE (Include Area Code) / 22c. OFFICE SYMBOL

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SECURITY CLASSIFICATION OF THIS PAGE
UNCLASSIFIED

3. Methods for data inversion to obtain stress profiles from measured velocity were explored and it was found that two techniques give good results with simulated data and relatively large amounts of additive noise, namely: (a) generalized matrix inversion with constraints and (b) least mean squares parameter fitting.

ARO 24513-8-EG

FINAL REPORT

NONDESTRUCTIVE EVALUATION OF STRESS USING ULTRASOUND AND PULSED HEAT

UNIVERSITY OF HOUSTON
ELECTRICAL ENGINEERING DEPARTMENT

Period covered by report:
1 December 1986 - 30 November 1988

ARO PROJECT NUMBER 24513-EG
CONTRACT NUMBER DAAL03-87-0009

Submitted by: Wallace L. Anderson

FINAL REPORT
ARO PROJECT NUMBER 24513-EG
CONTRACT NUMBER DAAL03-87-0009
Wallace L. Anderson, Principal Investigator

The problem studied

Investigation was made of a possible method for nondestructive characterization of residual stress in metals, based on a nonlinear acoustoelastic phenomenon involving ultrasonic velocity, stress and temperature. Details have been presented in previous reports.

Summary of important results

1. Unique instrumentation was developed for high-precision time-resolved ultrasonic velocity measurement. Such instrumentation is not available commercially nor, as far as is known, has such a capability ever been developed previously. It has a significant potential for materials studies and possibly other areas as well, as for instance noninvasive biomedical applications.

2. It was demonstrated that with such instrumentation, applied stress even of modest values can be detected at depths of at least 1 cm in aluminum. Furthermore, such detection was shown to be quantitative, i.e., the amplitude of the effect is proportional to stress magnitude, and its shape is responsive in the predicted manner to locality of the stress. In view of item 3, below, it is evident that this concept is a viable basis for nondestructive characterization of subsurface residual stress in metals.

3. Methods for data inversion to obtain stress profiles from measured velocity were explored and it was found that two techniques give good results with simulated data and relatively large amounts of additive noise, namely: (a) generalized matrix inversion with constraints and (b) least mean squares parameter fitting.

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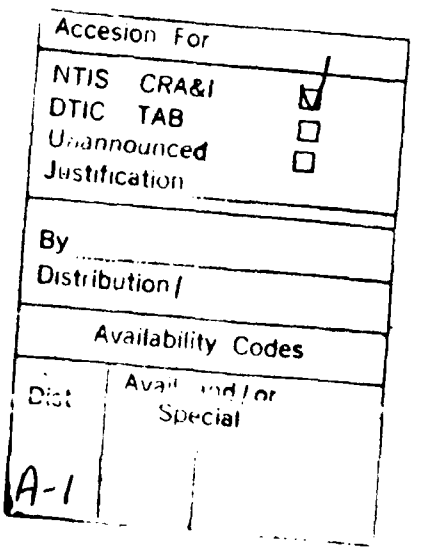

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Publications

Anderson, W. L., Peng Xiang and C. E. Jensen, "Subsurface Stress Detection Using Ultrasonics and Time-Varying Temperature", *16th Symposium on Nondestructive Evaluation*, San Antonio, Texas, April 21-23, 1987.

Anderson, W. L., Y. Motiwala and C. E. Jensen, "Thermal Effects on Ultrasonic Waves in the Presence of Stress", *Proceedings Ultrasonics International 87,* Butterworth & Co. Ltd.,1987, pp. 532-536.

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Anderson, W. L., "Effects of Interaction Between Stress and Temperature on Ultrasound Velocity", *Review of Progress in Quantitative Nondestructive Evaluation*, July 31-August 5, 1988, University of California at San Diego, La Jolla, CA (in print).

Presentations at professional meetings

Anderson, W. L., Peng Xiang and C. E. Jensen, "Subsurface Stress Detection Using Ultrasonics and Time-Varying Temperature", *16th Symposium on Nondestructive Evaluation*, San Antonio, Texas, April 21-23, 1987.

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