



Nondestructive Evaluation Using Fiber Gratings for “Strain Imaging”

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Report Documentation Page

Form Approved
OMB No. 0704-0188

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1. REPORT DATE 13 JUL 2004		2. REPORT TYPE		3. DATES COVERED -	
4. TITLE AND SUBTITLE Nondestructive Evaluation Using Fiber Gratings for				5a. CONTRACT NUMBER F04611-02-C-0007	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Eric Udd				5d. PROJECT NUMBER 3005	
				5e. TASK NUMBER 02AG	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Blue Road Research,376 NE 219th Ave,Gresham,OR,97030				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT Arrays of multi-axis fiber grating sensors have been embedded into composite demonstration articles and used to support the identification and localization of both cut tow and Teflon tape defects. This presentation will overview the characteristics and performance of multi-axis fiber grating strain sensors to perform strain imaging and comparisons will be made to ultrasonic and eddy current techniques. Issues that will be addresssed will include the distance over which damage may be detected via "strain imaging," "strain imaging" through successive composite layers, and "strain imaging" through optical fibers. Strain images from cut tow and Teflon tape defects are distinctly different. The embedded multi-axis fiber grating strain sensors may be used to monitor both global strain characteristics such as deformation of the cylindrical composite demonstration article under pressure as well as local damage events that may be impacts. This paper will report progress on multi-axis fiber grating strain imaging systems and future plans.					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES 23	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

Acknowledgements

Blue Road Research would like to acknowledge funding support for this research effort from the SBIR Phase II Air Force Contract F04611-02-C-0007, “Fiber Grating Sensor Systems to Determine Motor Case Damage”. Dr. Greg Ruderman is the Technical Program Monitor

Strain Imaging

- Localization and identification of damage through detailed measurement of strain fields
- Information provided in seconds on demand with target accuracies comparable to ultrasound or eddy current
- Enabling technologies, multi-axis fiber grating strain sensors, improved spectral detection methods, processing algorithms

Strain Imaging Demonstration

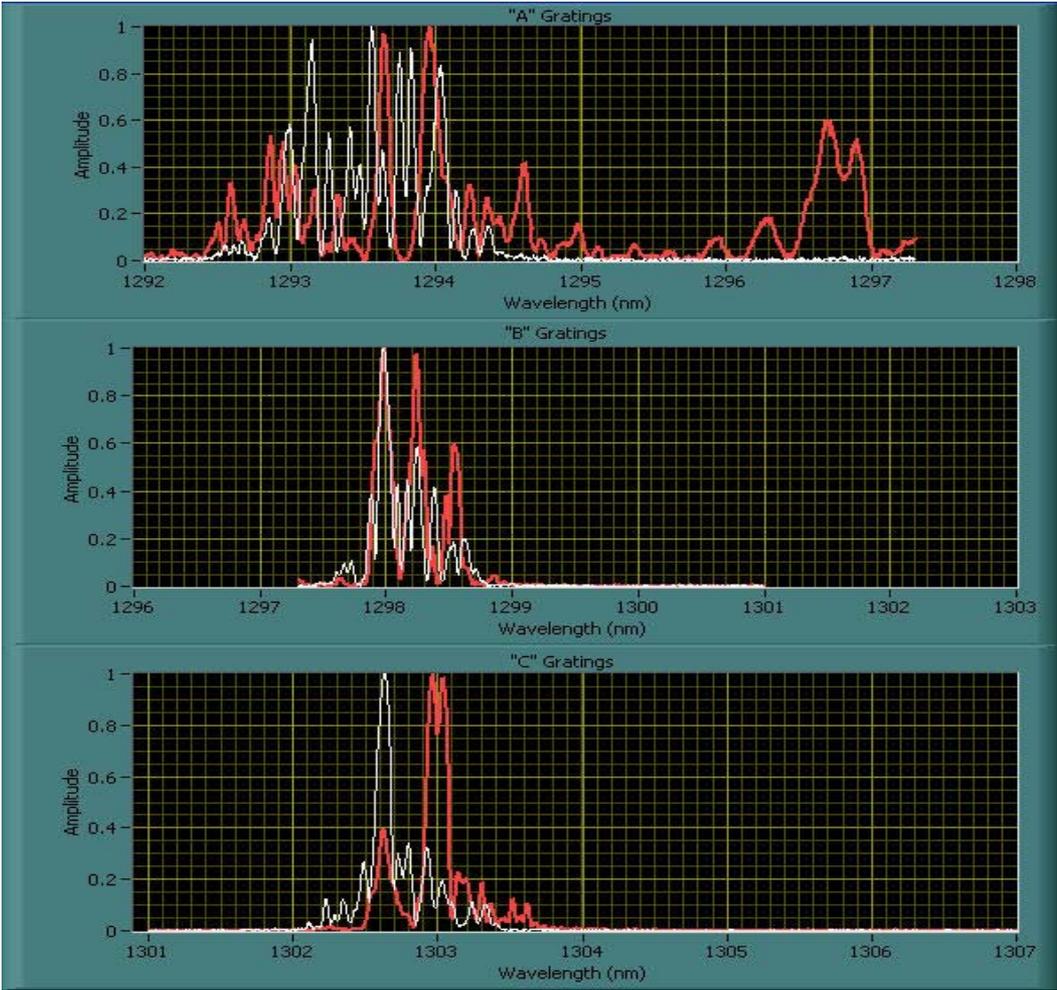
- Composite rocket motor filled with inert propellant
- Impacts at 5, 10, 15, and 20 ft-lbs energy
- Fiber arrays in region of damage read out with Blue Road Research Strain Imaging system and damage location plots shown

Strain Imaging Bottle Impact Test



Strain Imaging Bottle Impact Test

Grating Spectra Before Impact



Strain Imaging Bottle Impact Test Before Impact



Strain Imaging Bottle Impact Test

5 ft-lb Impact

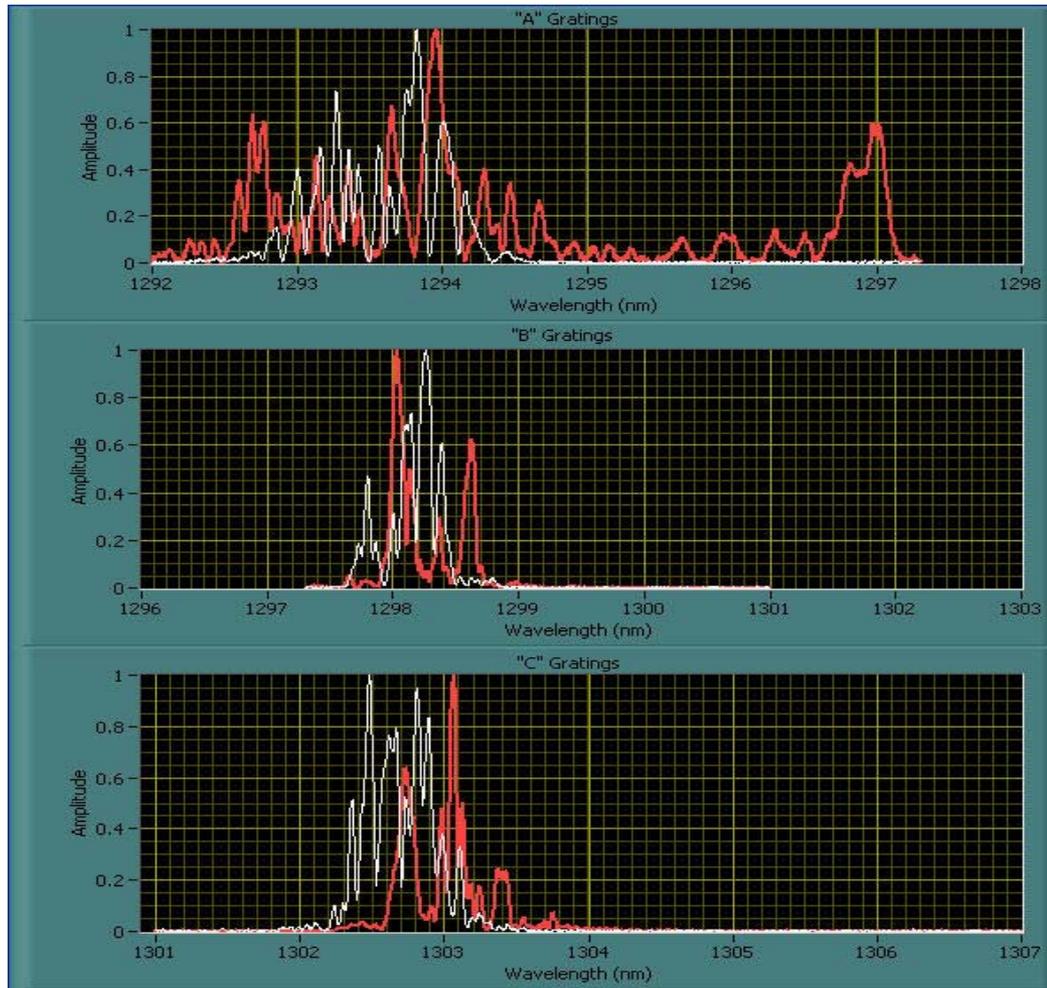


Strain Imaging Bottle Impact Test

5 ft-lb Impact



Strain Imaging Bottle Impact Test Grating Spectra After 5 ft-lb Impact

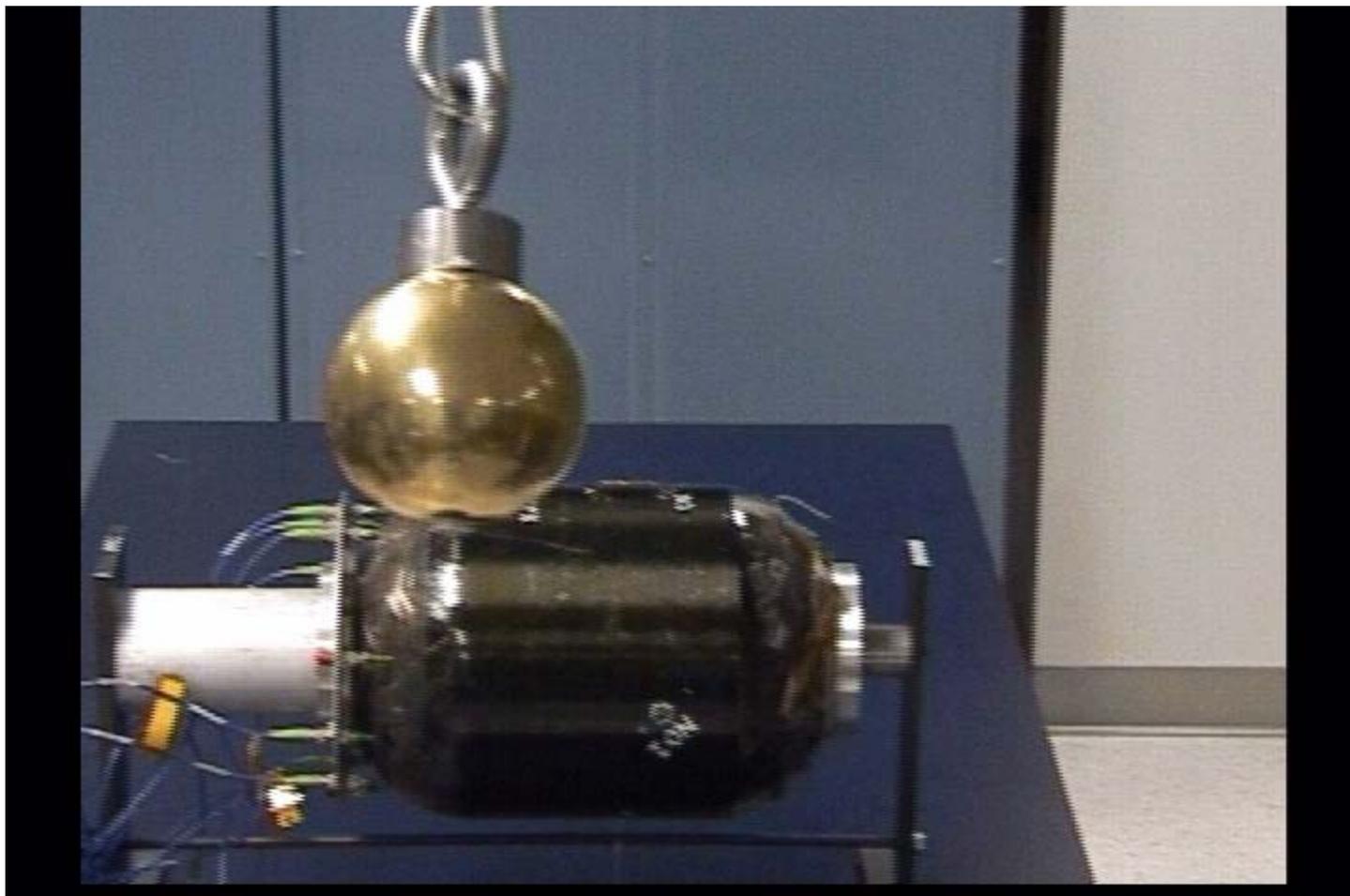


Strain Imaging Bottle Impact Test After 5 ft-lb Impact

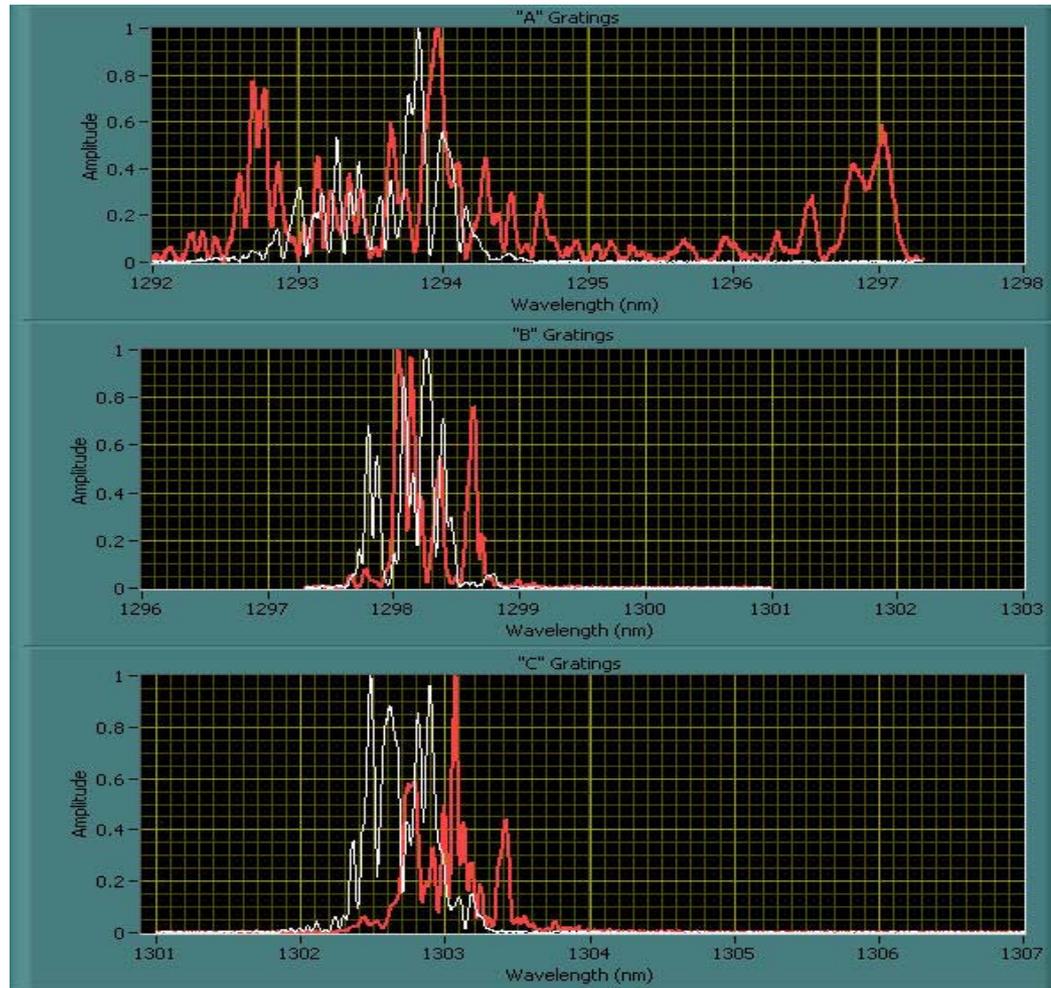


Strain Imaging Bottle Impact Test

10 ft-lb Impact



Strain Imaging Bottle Impact Test Grating Spectra After 10 ft-lb Impact



Strain Imaging Bottle Impact Test After 10 ft-lb Impact

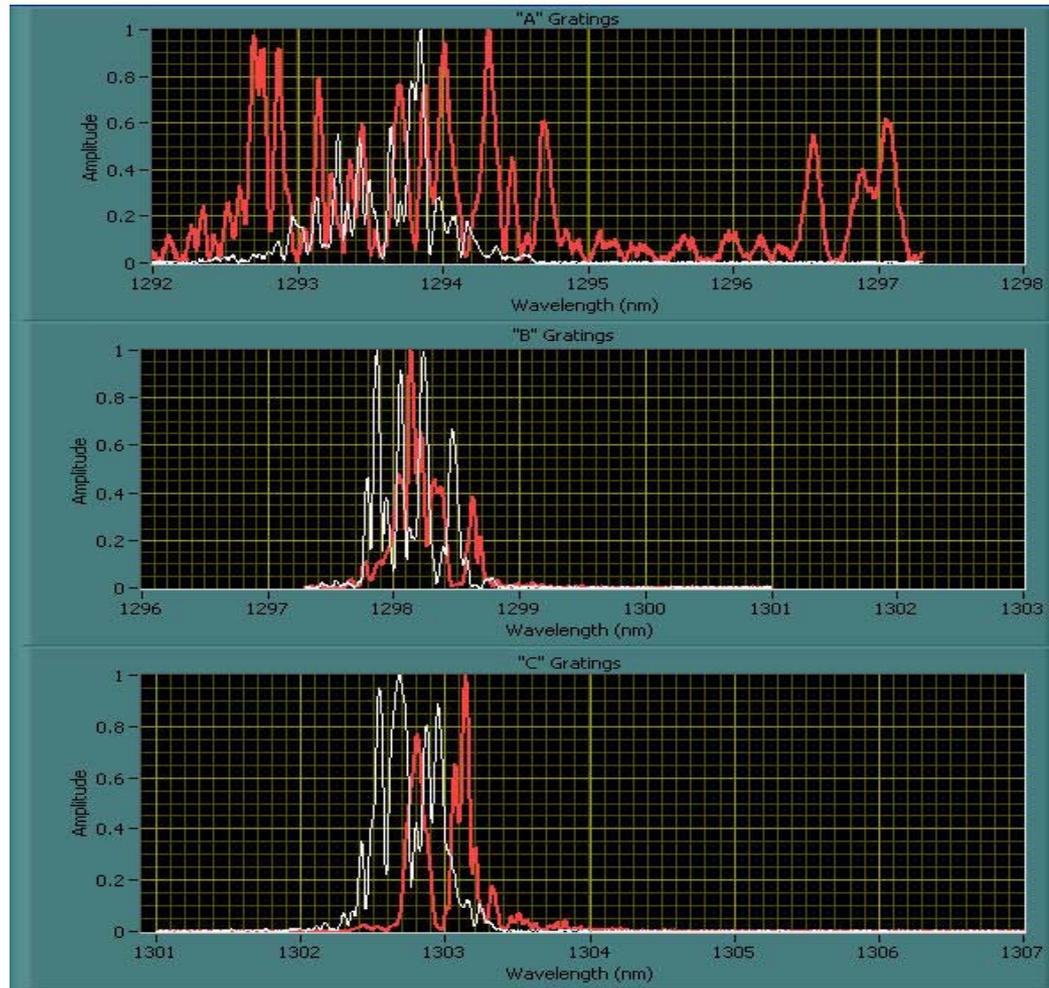


Strain Imaging Bottle Impact Test

15 ft-lb Impact



Strain Imaging Bottle Impact Test Grating Spectra After 15 ft-lb Impact

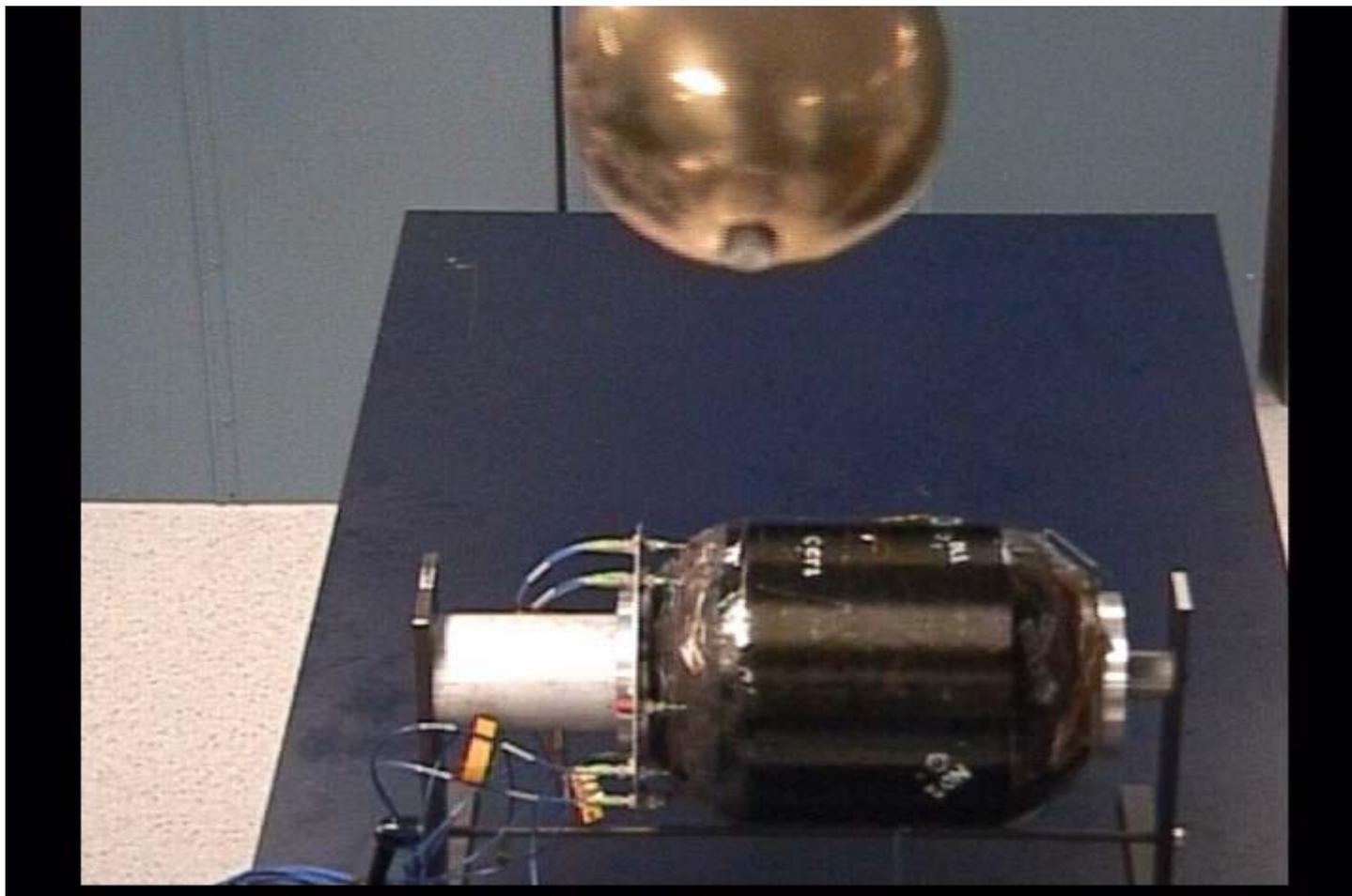


Strain Imaging Bottle Impact Test After 15 ft-lb Impact

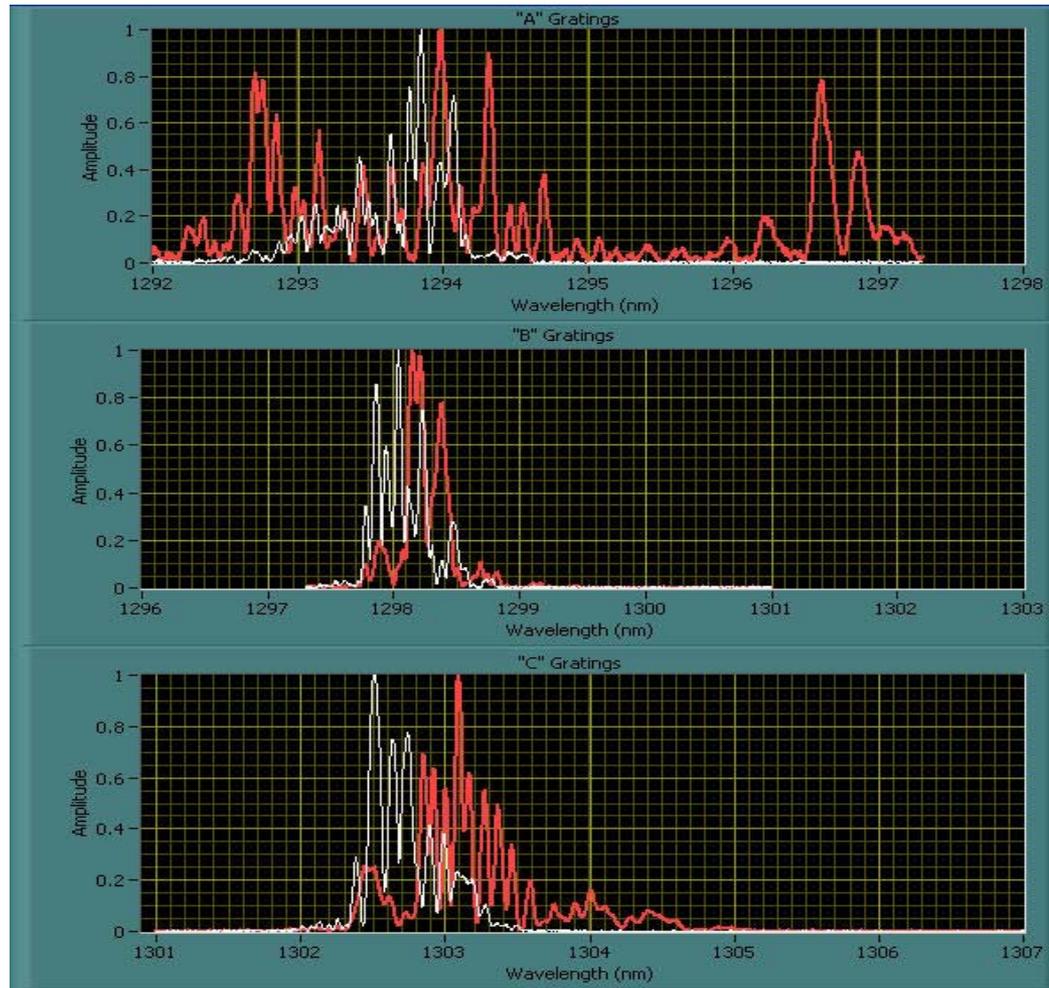


Strain Imaging Bottle Impact Test

20 ft-lb Impact



Strain Imaging Bottle Impact Test Grating Spectra After 20 ft-lb Impact

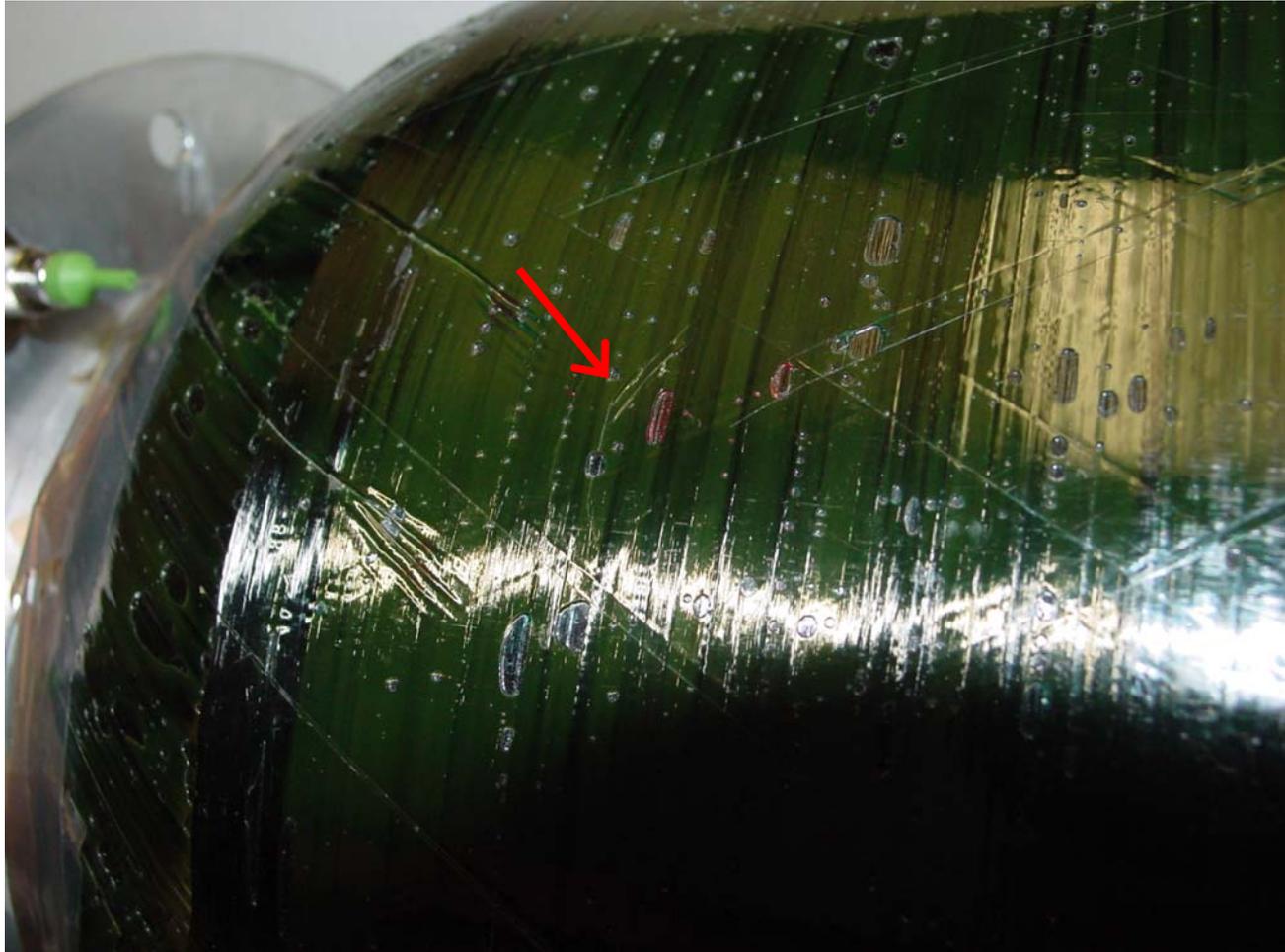


Strain Imaging Bottle Impact Test After 20 ft-lb Impact



Strain Imaging Bottle Impact Test

Damage Area After All Impacts



Strain Imaging Bottle Impact Test Damage Area After All Impacts



Summary

- Multi-axis fiber grating sensors successfully used to perform “strain imaging” to locate damage
- Multiple impact levels visible
- Damage detected with “strain imaging” that could be missed via physical inspection