REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.

1. REPORT DATE *(DD-MM-YYYY)*
04/22/2004

2. REPORT TYPE
Technical Report

3. DATES COVERED *(From - To)*

4. TITLE AND SUBTITLE

SEM Study of deformation and failure Mechanisms in Strained Elastomers

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

C. T. Liu; T.W. Hawkins; A. Brand; Fu-Pen Chiang

5d. PROJECT NUMBER
2302

5e. TASK NUMBER
0378

5f. WORK UNIT NUMBER
23020378

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Air Force Research Laboratory (AFMC)
AFRL/PRS
5 Pollux Drive
Edwards AFB, CA 93524-7048

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Air Force Research Laboratory (AFMC)
AFRL/PRS
5 Pollux Drive
Edwards AFB, CA 93524-7048

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S NUMBER(S)

AFRL-PR-ED-VG-2004-136

12. DISTRIBUTION / AVAILABILITY STATEMENT

Approved for public release; distribution unlimited.

13. SUPPLEMENTARY NOTES
165TH Spring Technical Meeting of the Rubber Division, ACS
Grand Rapids, MI, 17-19 May 2004

14. ABSTRACT

BEST AVAILABLE COPY

20040524 022

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
					Linda Talon
a. REPORT	b. ABSTRACT	c. THIS PAGE	A	17	19b. TELEPHONE NUMBER *(include area code)*
Unclassified	Unclassified	Unclassified			(661) 275-5283

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. 239.18

SEM Study of Deformation and Failure Mechanisms in Strained Elastomers

C. T. Liu, T. W. Hawkins, and A. Brand
AFRL/PRS
Edwards AFB CA, 93524-7680

Fu-Pen Chiang
Department of mechanical Engineering
State University of New York
Stony Brook, N.Y. 11790

Approved for public release; distribution unlimited

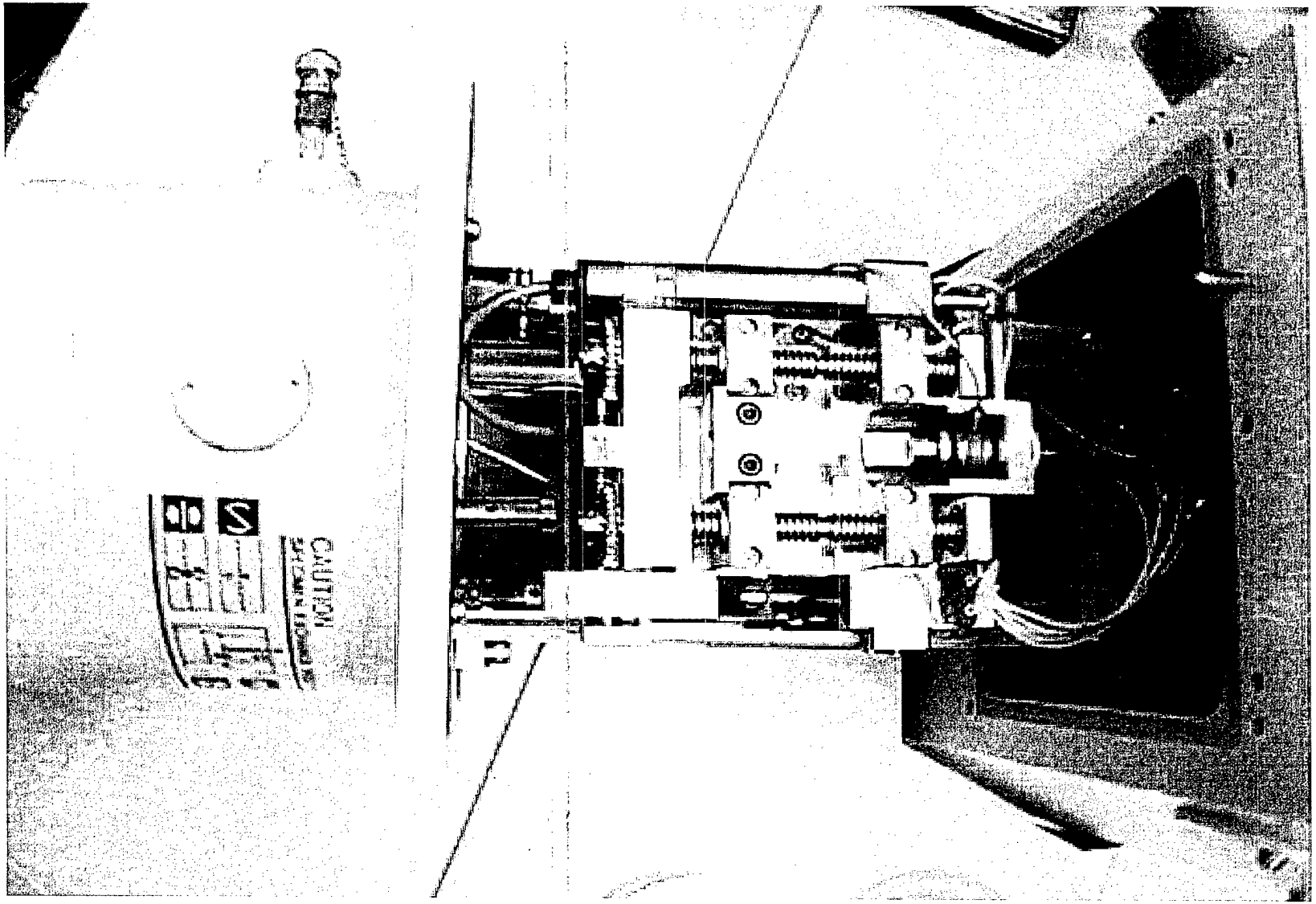
Objectives

- Investigate the deformation and failure mechanisms on meso and macro scales in a particulate composite and Solithane 113.

- Determine the strain fields on the meso and macro scales of the two materials.

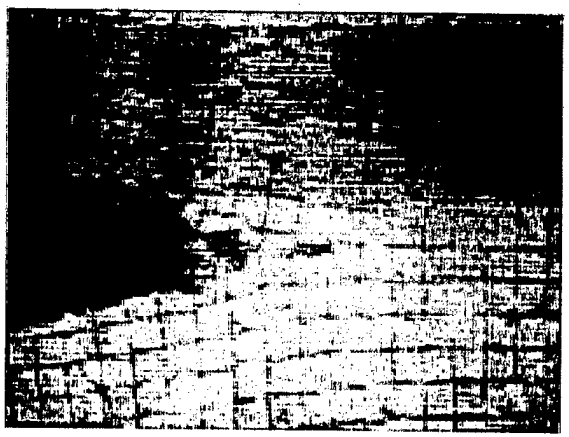
Approved for public release; distribution unlimited

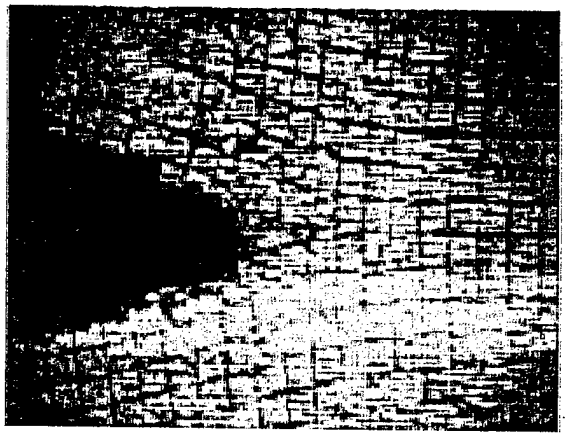
Testing Set-Up



Approved for public release; distribution unlimited

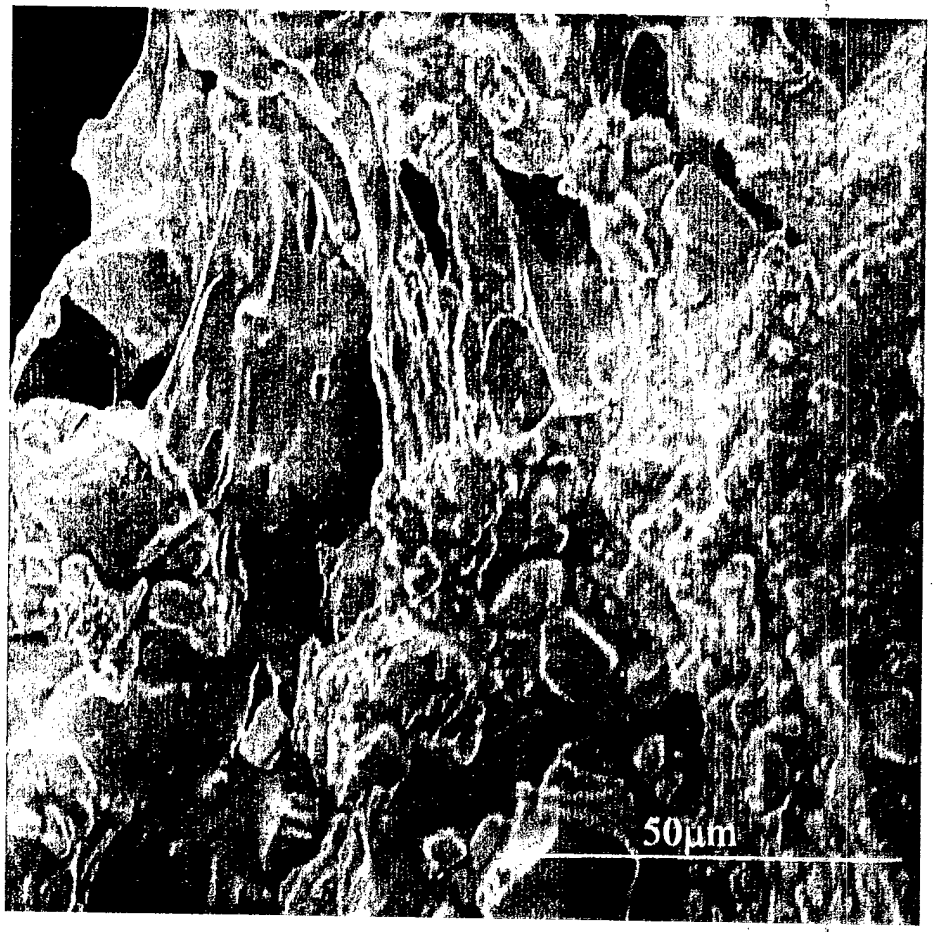
Crack Tip Profile

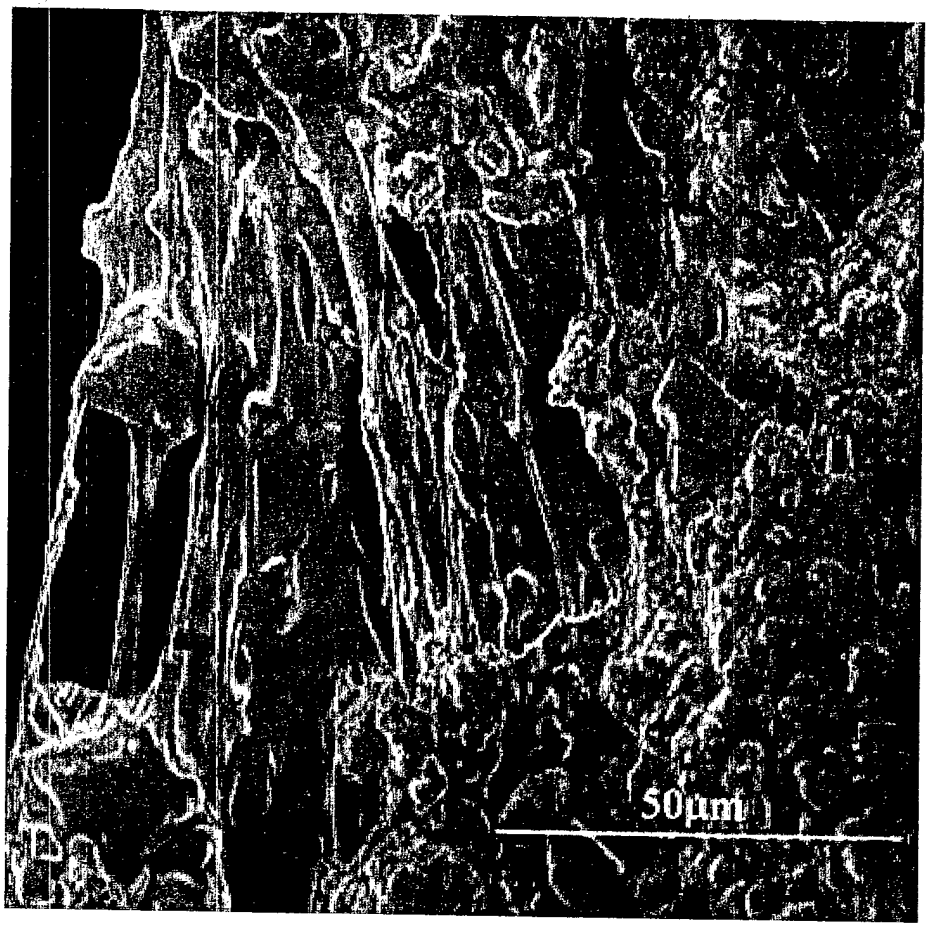




Approved for public release; distribution unlimited

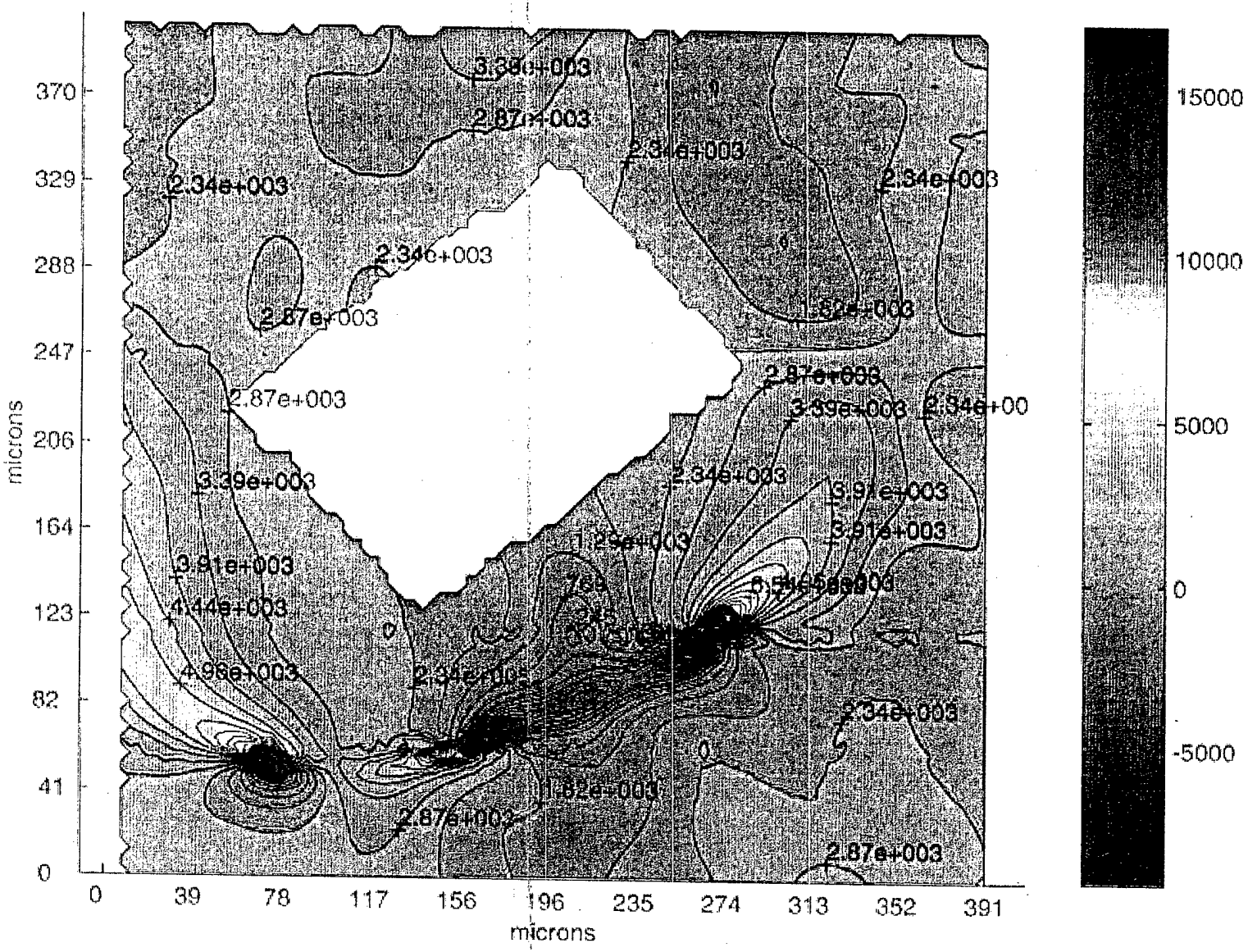
Local Damage at Crack Tip



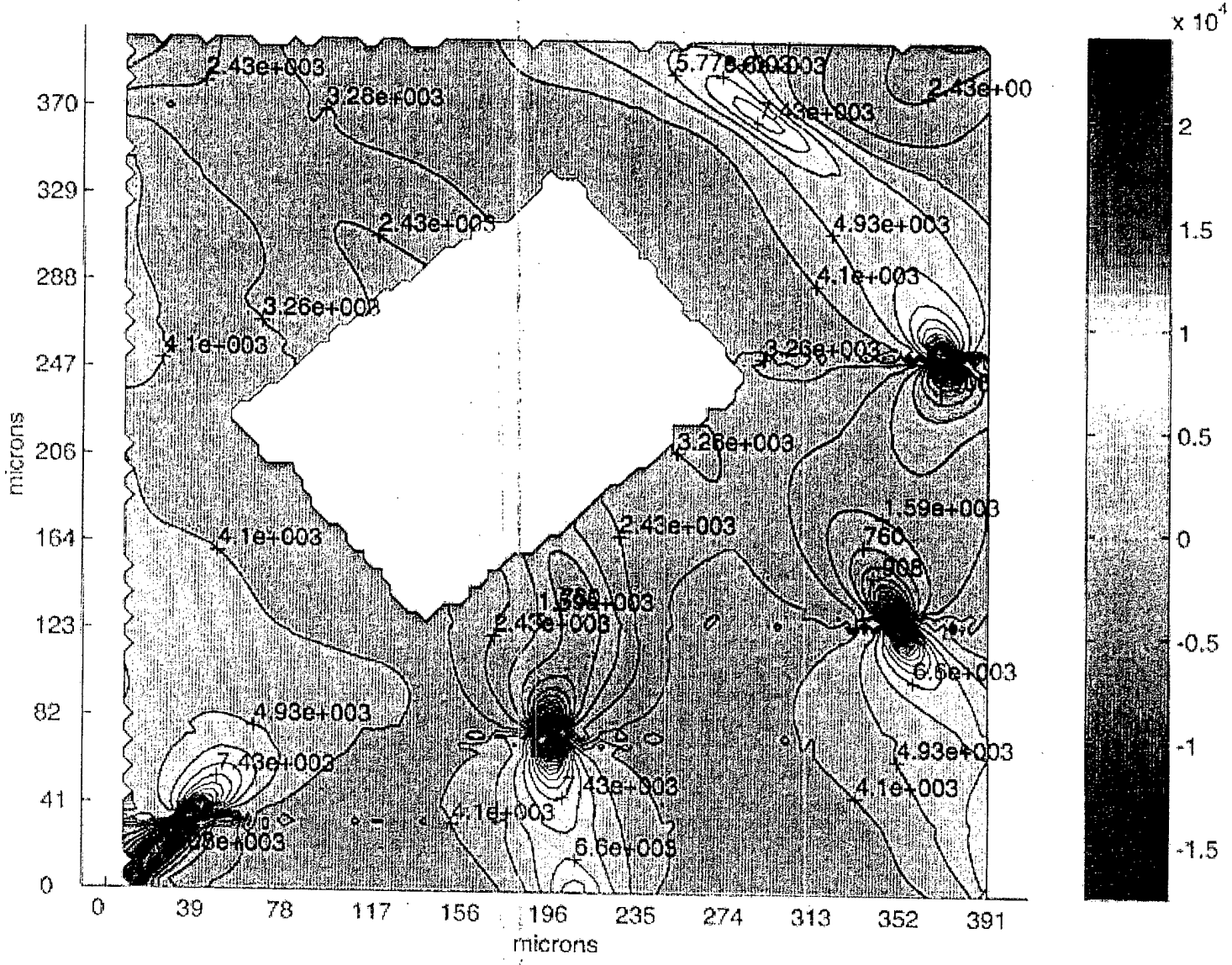


Approved for public release; distribution unlimited

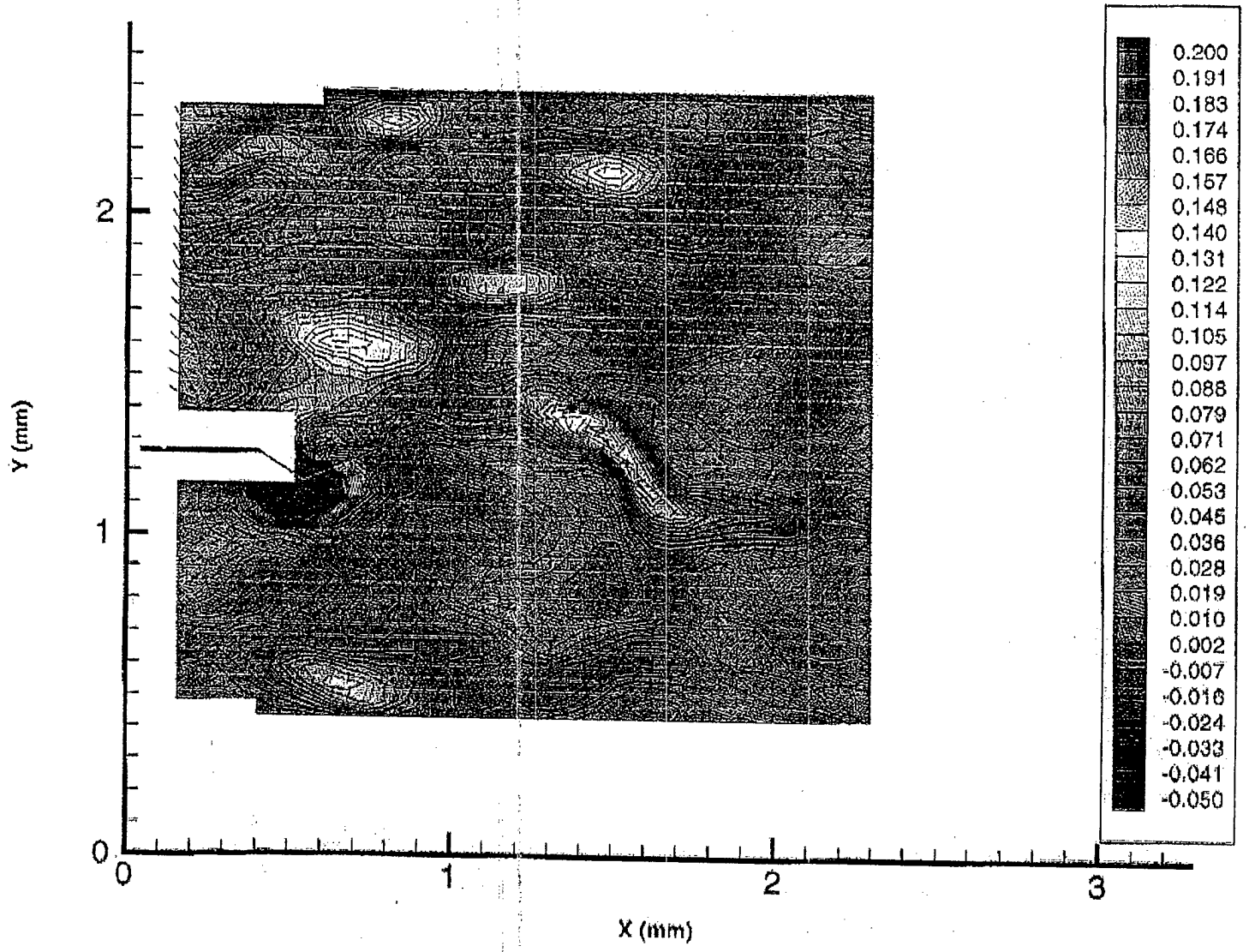
ε_x for 11.34 psi at 30 sec



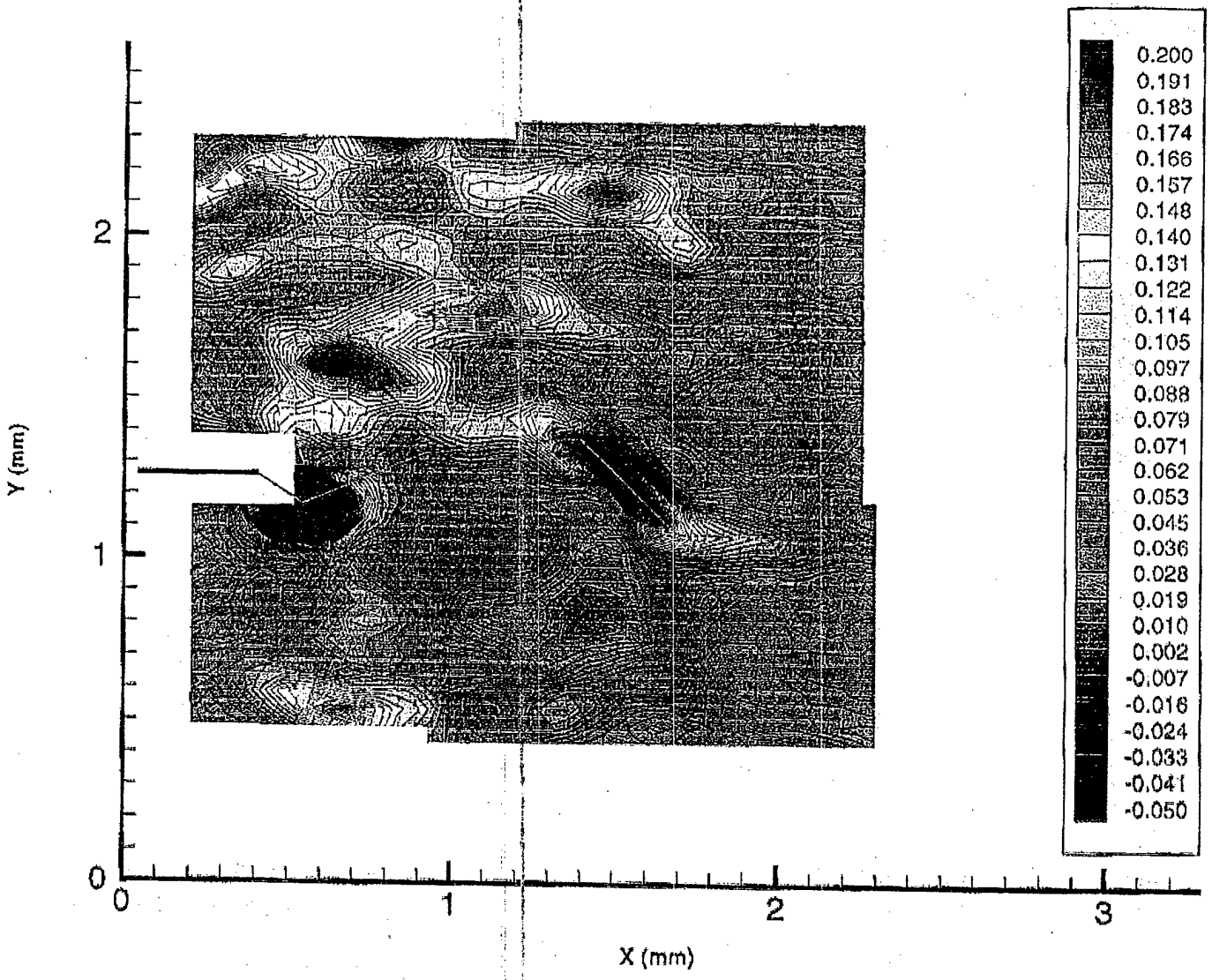
ε_y for 11.34 psi at 30 min



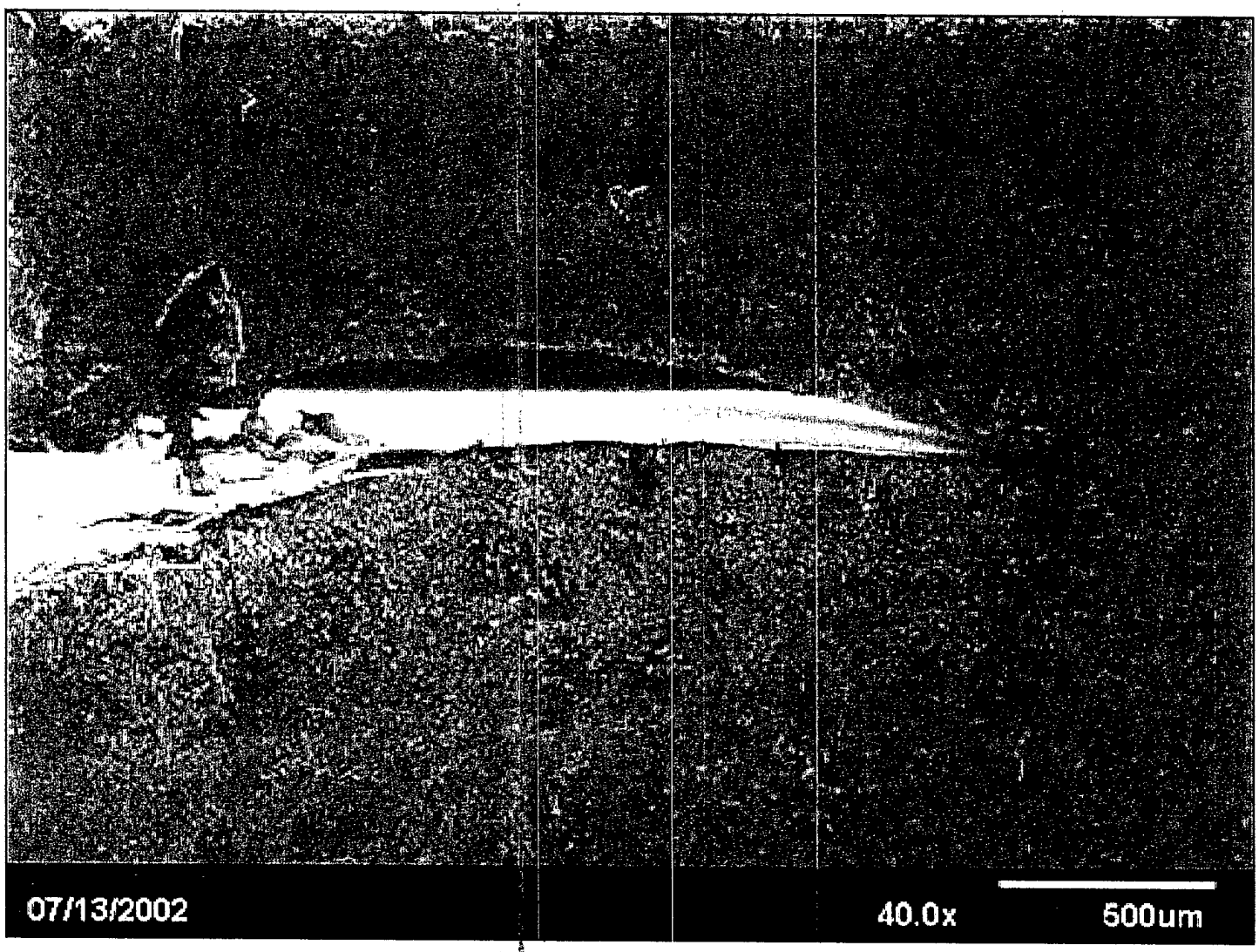
Maximum Principal Strain Distribution of 6.0% Far Field Strain During Loading



Maximum Principal Strain Distribution of 8.0% Far Field Strain During Loading

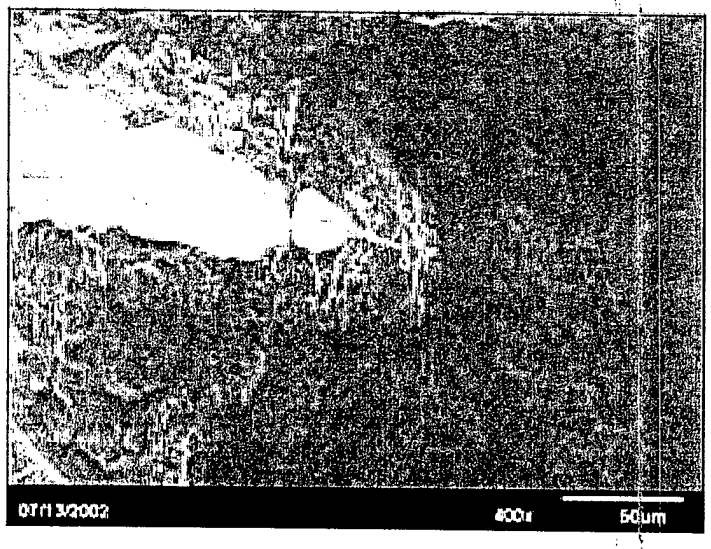


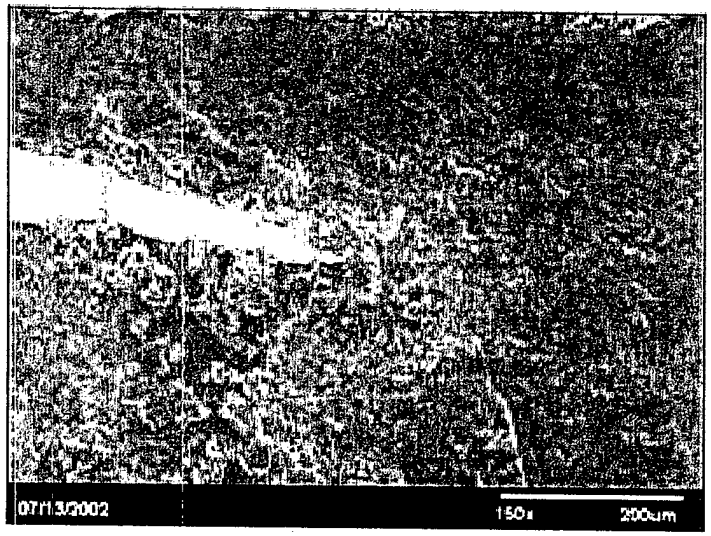
Side View of Crack Tip at 40x.

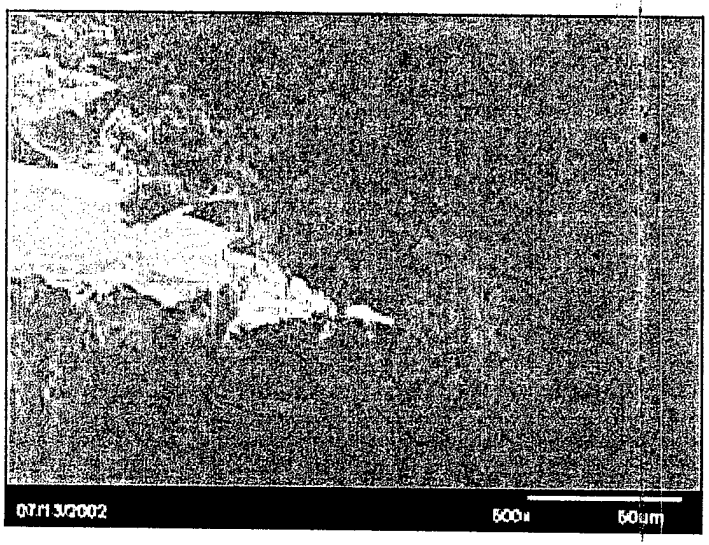


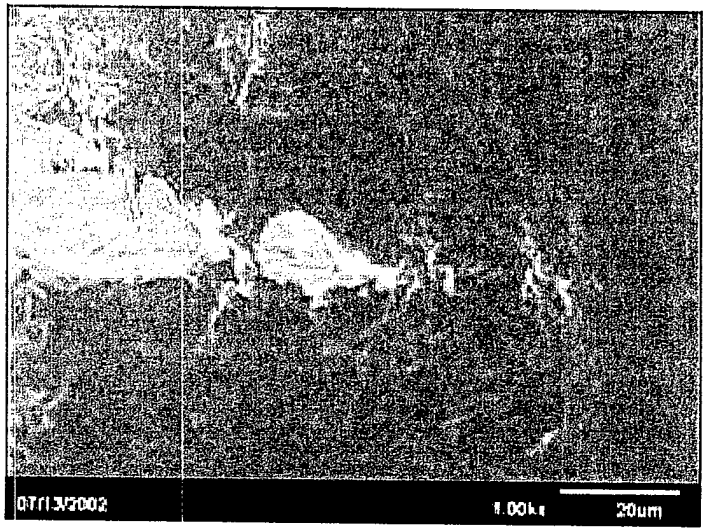
Approved for public release; distribution unlimited

Side View of Crack Tip at 150x, 400x, 500x, and 1000x.







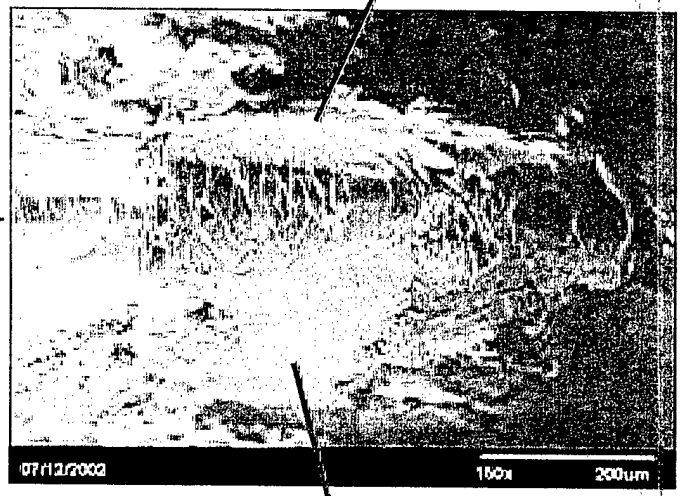


Approved for public release; distribution unlimited

SEM Pictures of Top View of Crack Tip at 150x and 250x.

Upper surface of the crack

Crack tip

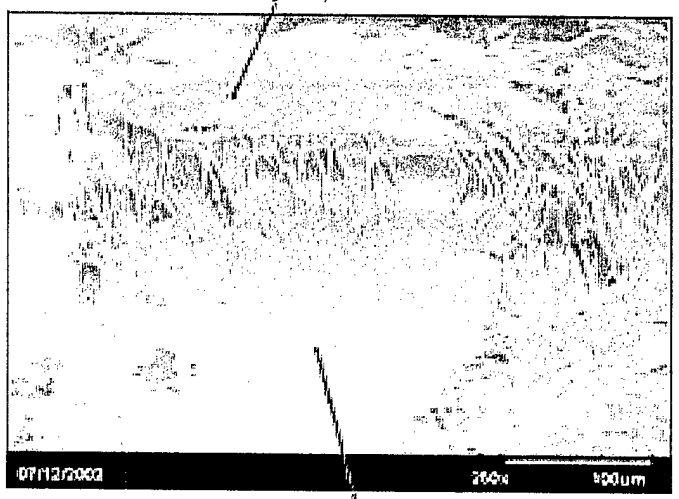


Lower surface of the crack

Crack tip

Crack tip

Upper surface of the crack

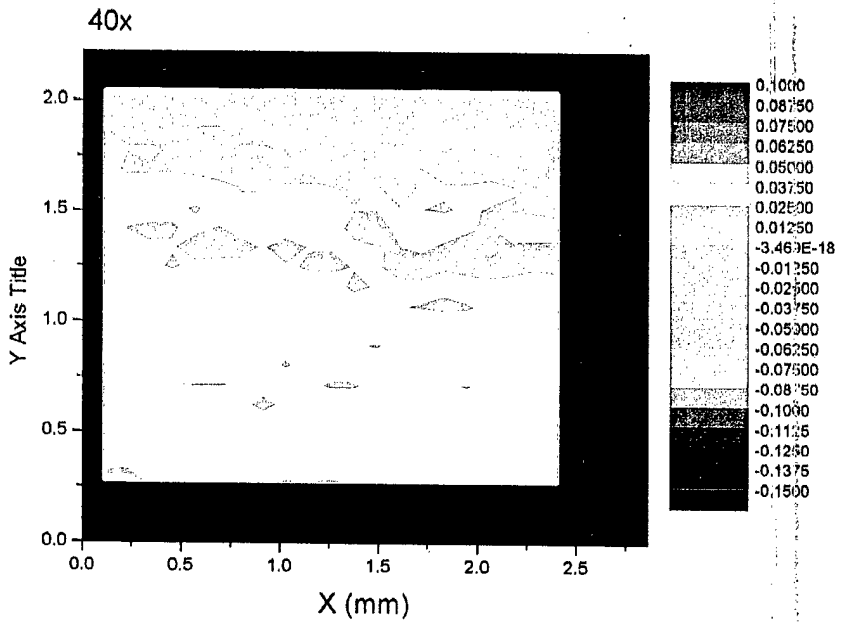


Crack tip

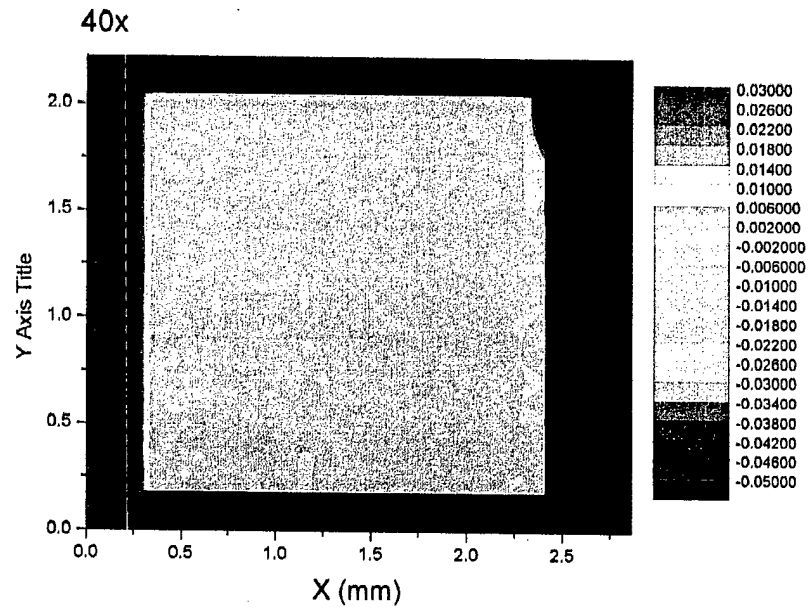
Lower surface of the crack

Approved for public release; distribution unlimited

Strain Distributions (2.5mm x 2.0mm)



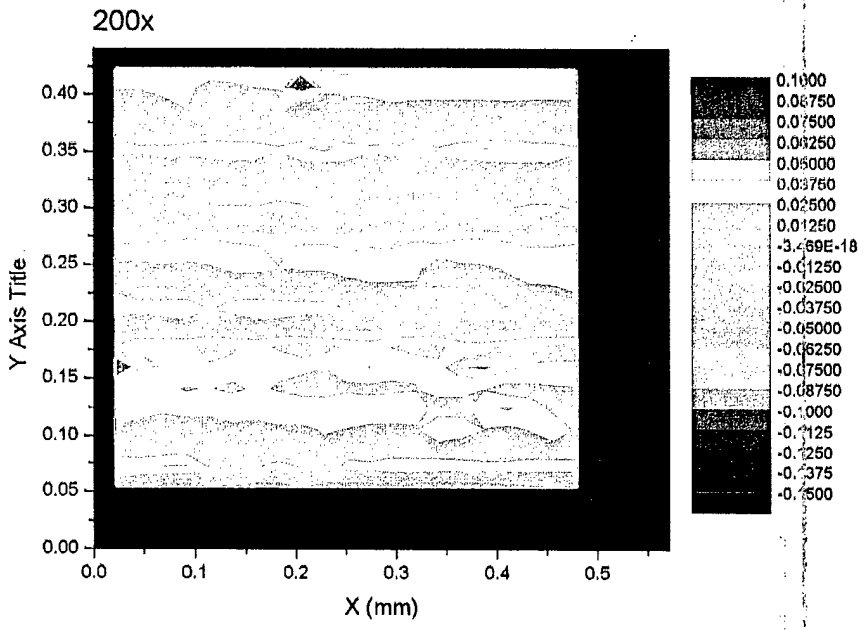
ε_{yy} field, Load = 52 grams



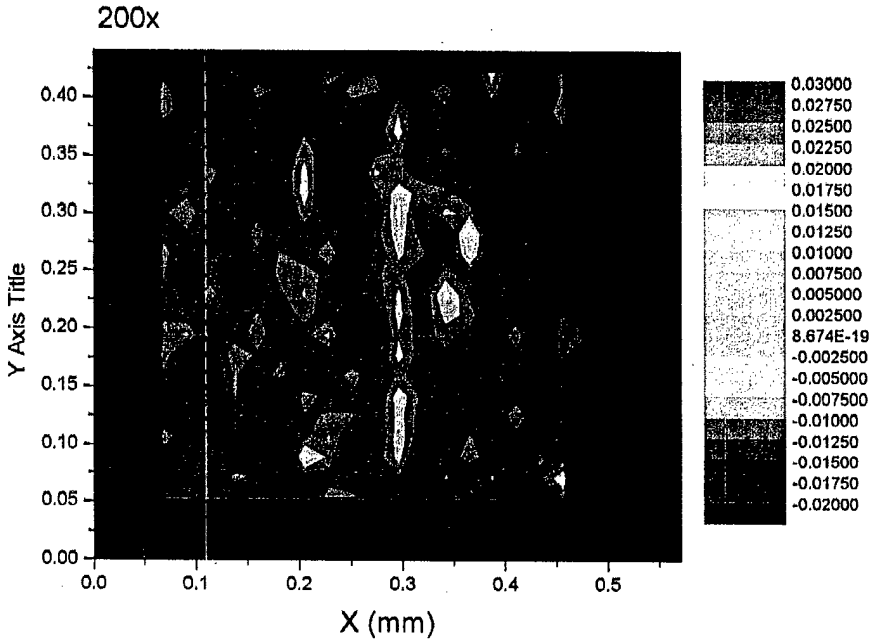
ε_{xx} field, Load = 52 grams

Approved for public release; distribution unlimited

Strain Distributions (0.5mm x 0.45mm)



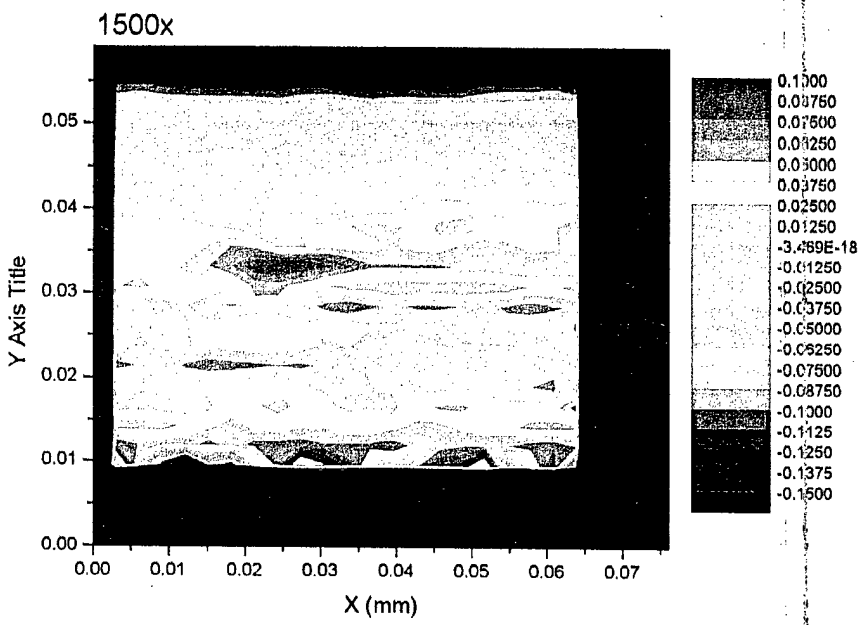
ε_{yy} field, Load = 47 grams



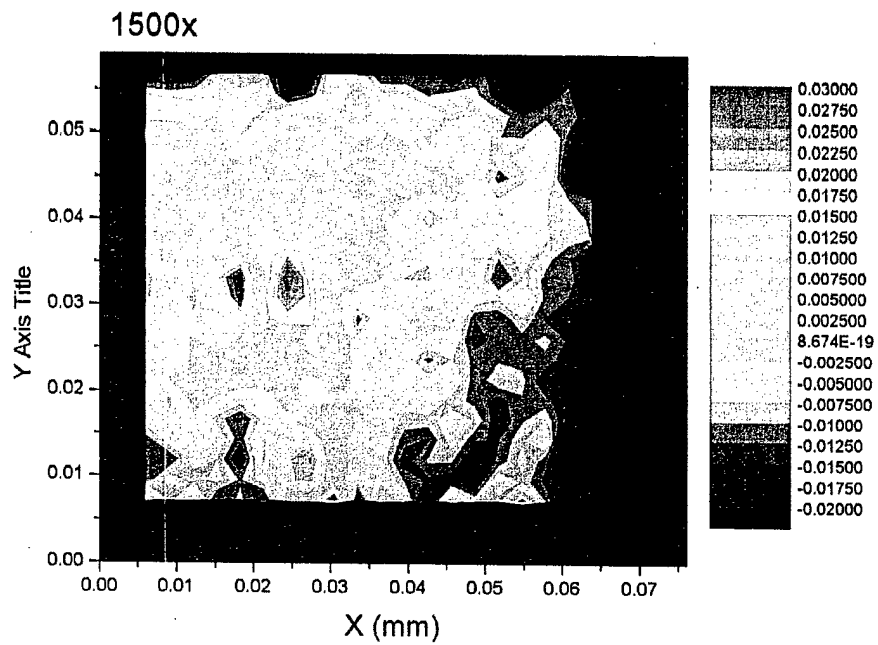
ε_{xx} field, Load = 47 grams

Approved for public release; distribution unlimited

Strain Distributions (0.065mm x 0.055mm)



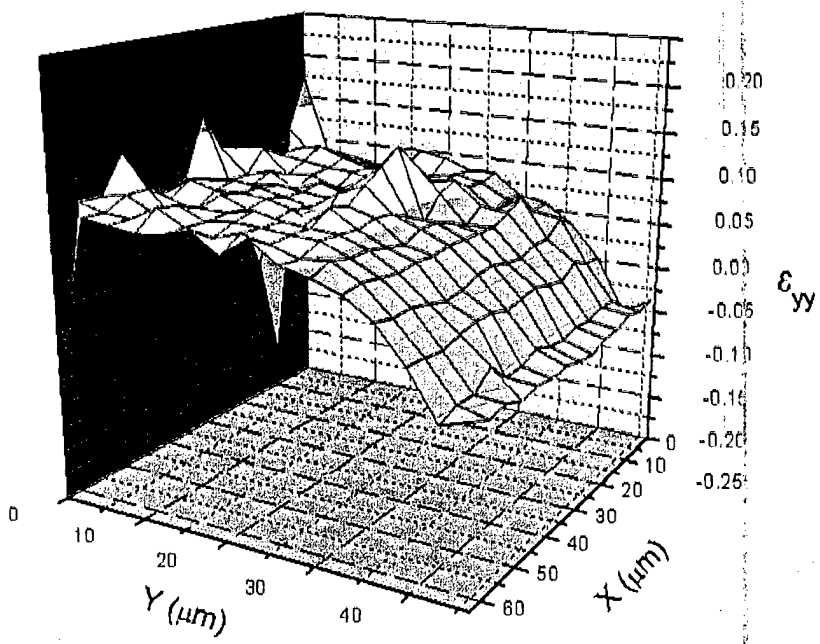
ε_{yy} field, Load = 49 grams



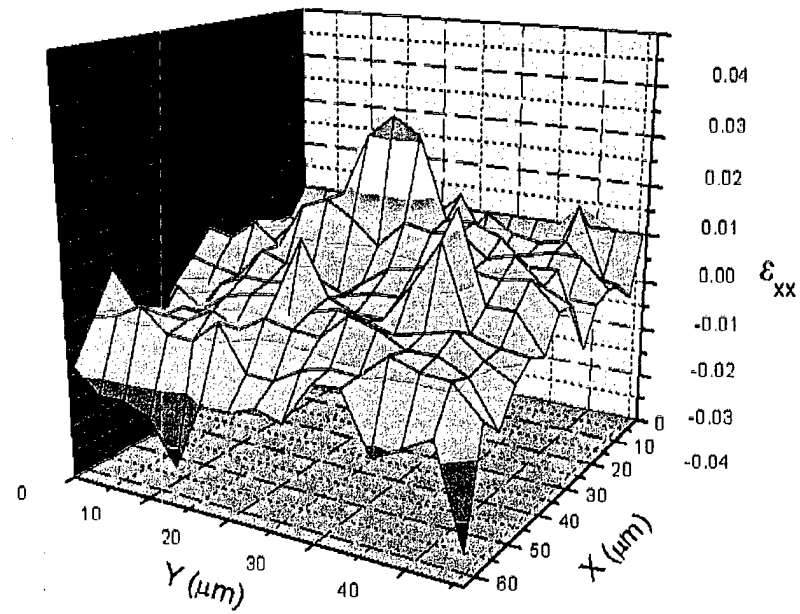
ε_{xx} field, Load = 49 grams

Approved for public release; distribution unlimited

Strain Distributions (0.065mm x 0.055mm)



ε_{yy} field (3-D), Load = 49 grams



ε_{xx} field (3-D), Load = 49 grams

Approved for public release; distribution unlimited

Conclusions

- On the meso-scale, microstructure has a significant effect on the strain distributions.
- The basic crack growth mechanism consists of the coalescence of voids with the crack tip.
- The local deformation, damage mechanism, and crack growth mechanism in the two materials are similar.
- In the two materials, highly damaged regions, or failure process zones, are formed at the crack tip.

Approved for public release; distribution unlimited