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TP-FY99-0132

✓ Spreadsheet
✓ DTS

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FROM: PROI (TI) (STINFO)

9 June 1999

SUBJECT: Authorization for Release of Technical Information, Control Number: AFRL-PR-ED-TP-FY99-0132
C.T. Liu, "Effects of Microstructure on Damage Evolution, Strain Inhomogeneity, and Fracture in a Particulate Composite"
Presentation slides/Invited Lecture
International Conference/Brussels, Belgium
(Public Release)

Effects of Microstructure on Damage Evolution, Strain Inhomogeneity, and Fracture in a Particulate Composite

C.T. Liu

Air Force Research Laboratory

AFRL/PRSM

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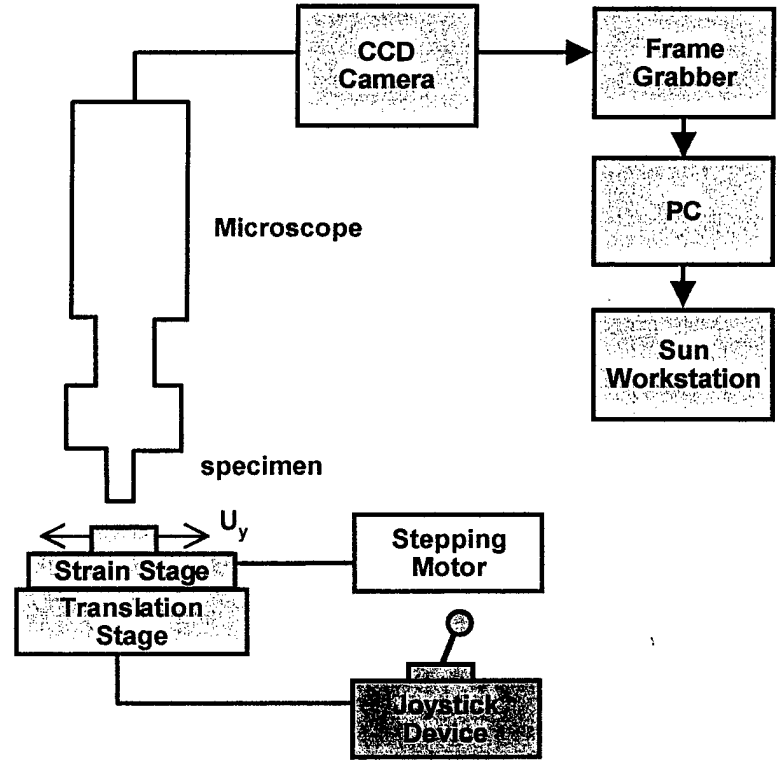
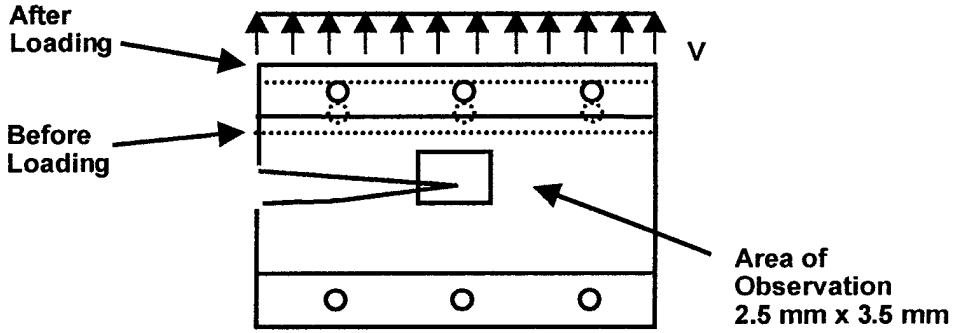
Edwards AFB, CA 03524-7680

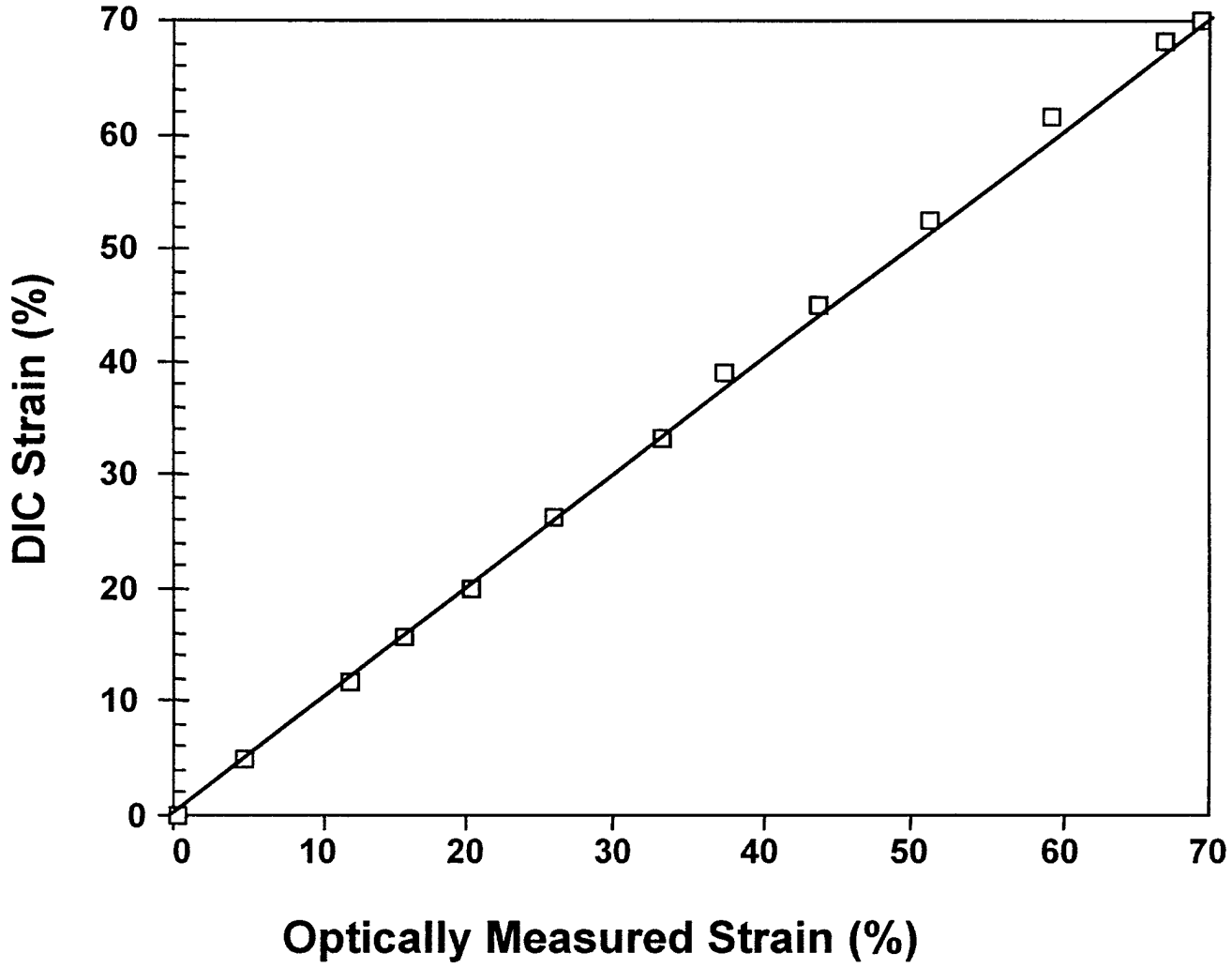
Objective

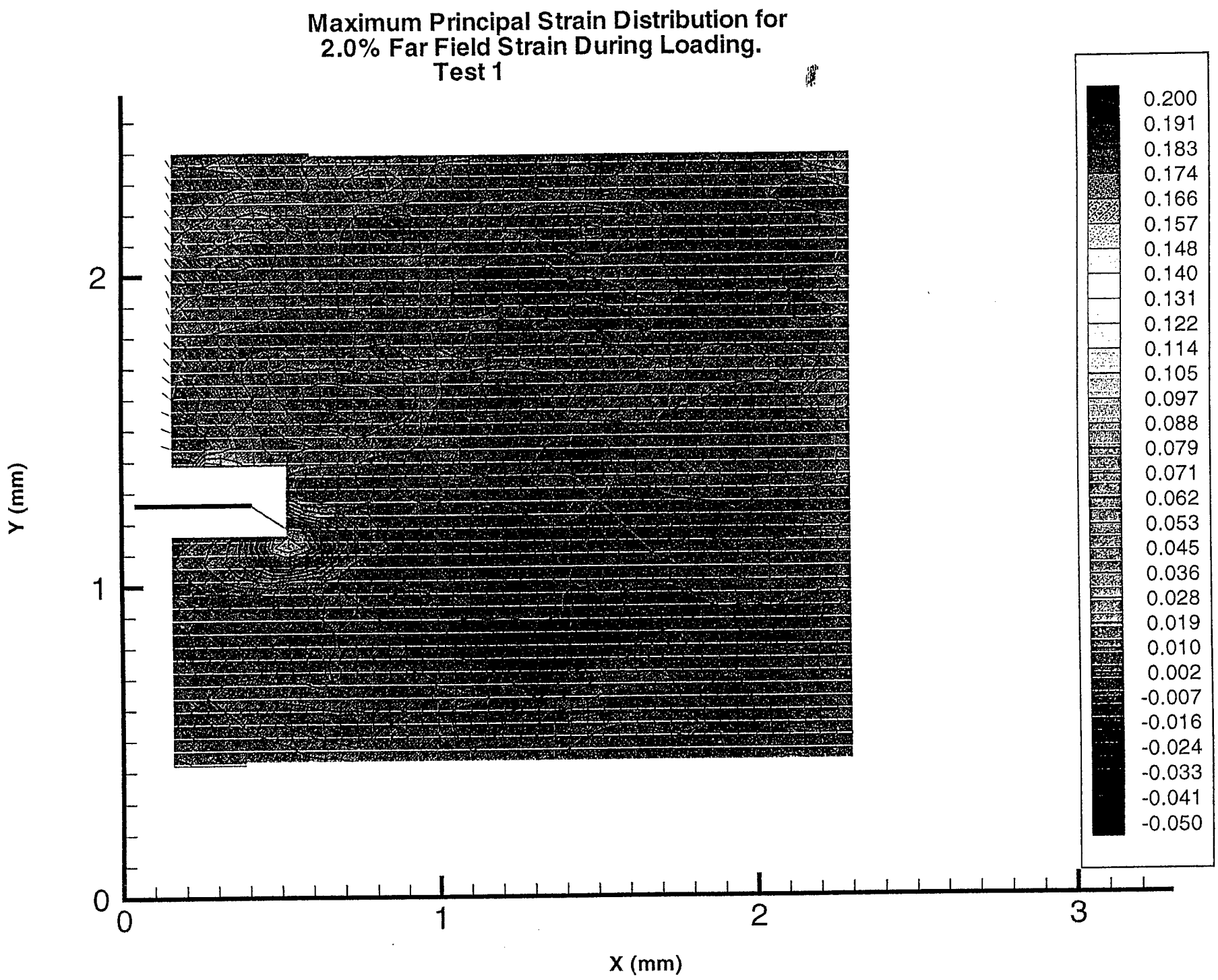
- **Investigate the Effects of Microstructure of a Particulate Composite Material on Damage Mechanisms, Strain Fields, and Local Fracture Near the Crack Tip.**

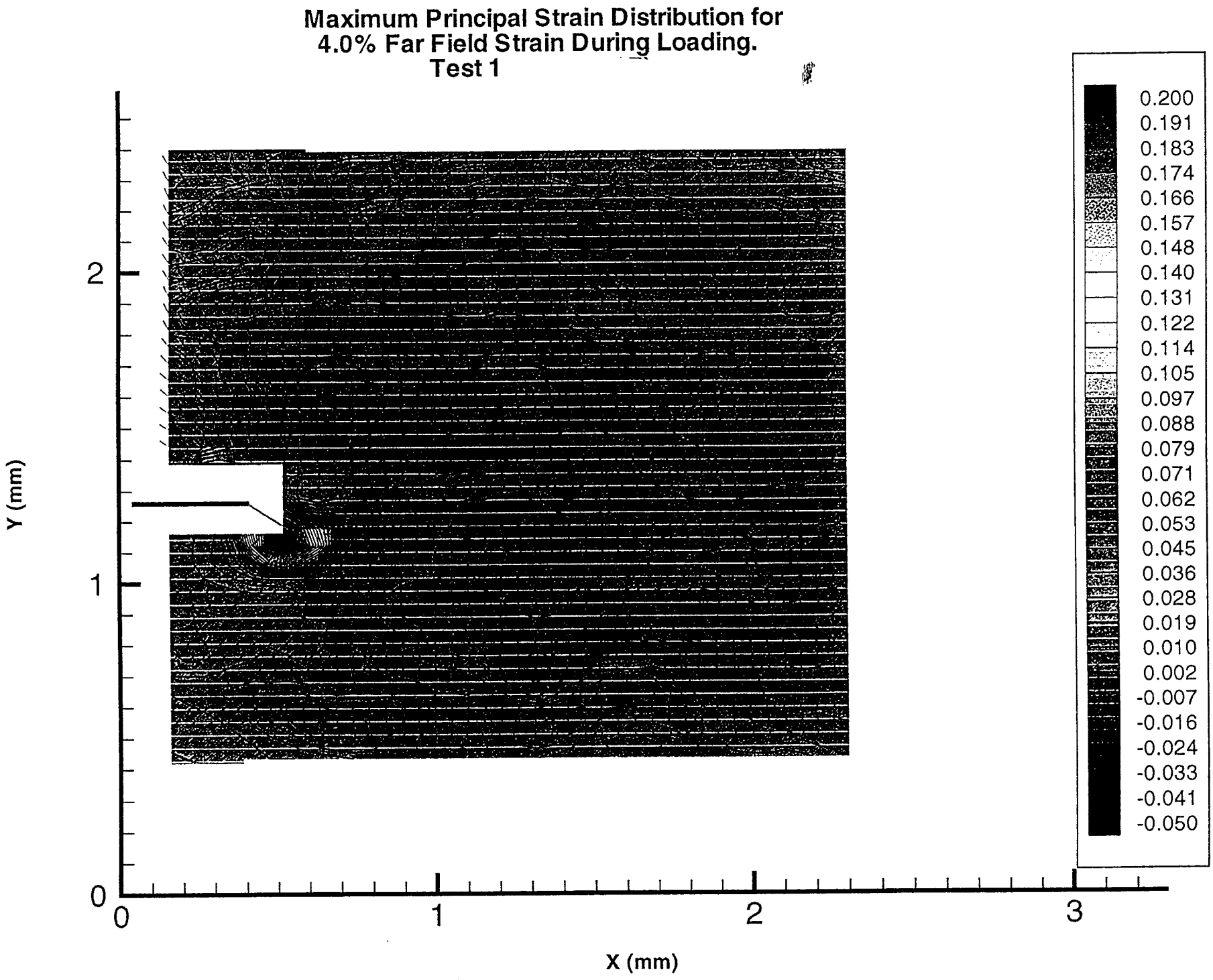

CCD Camera
Frame Grabber
PC
Sun Workstation
Microscope
specimen
U_y
Strain Stage
Translation Stage
Stepping Motor
Joystick Device


After Loading
Before Loading
V
Area of Observation
2.5 mm x 3.5 mm

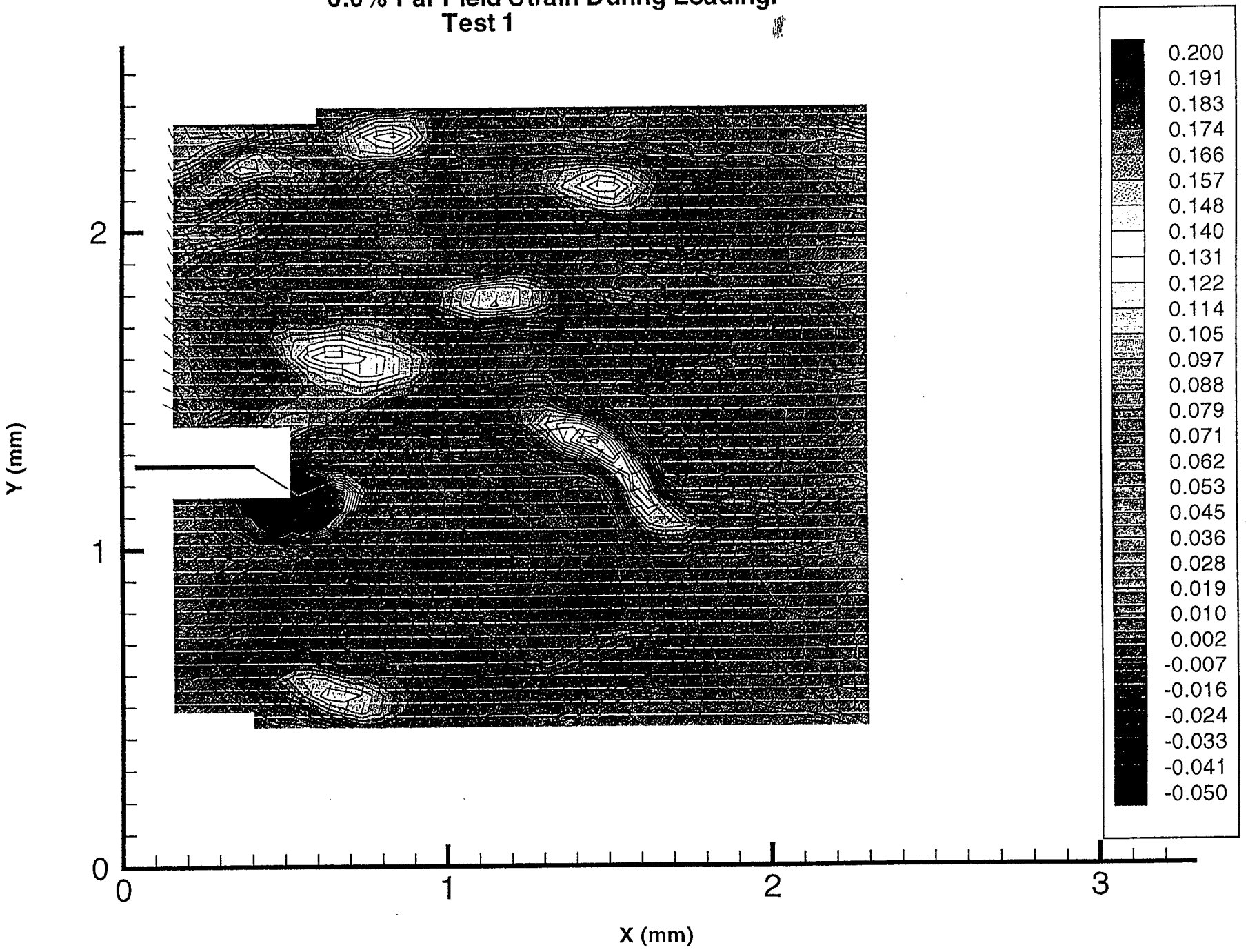
Calibration

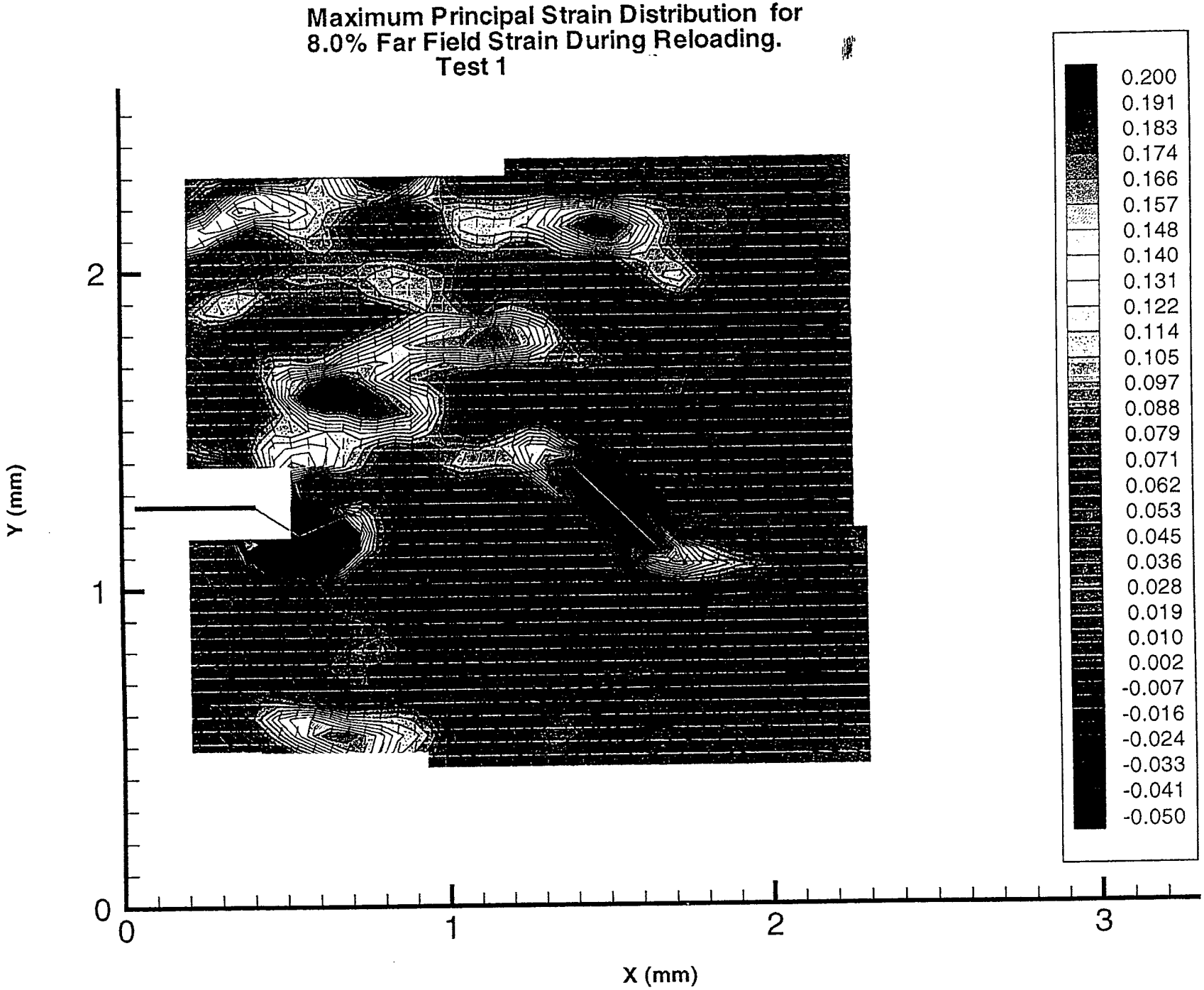


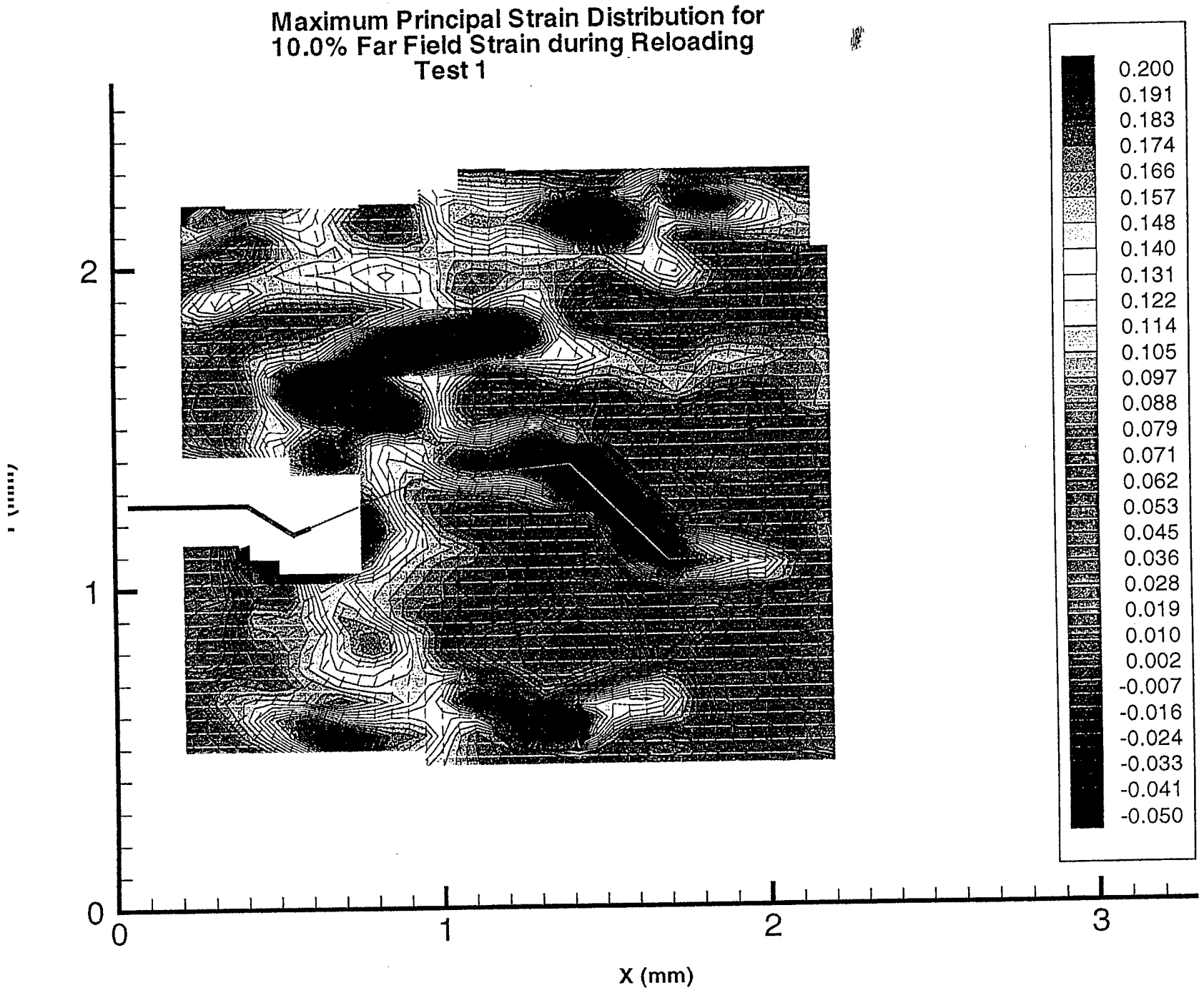

Maximum Principal Strain Distribution for
2.0% Far Field Strain During Loading.
Test 1
0.200
0.191
0.183
0.174
0.166
0.157
0.148
0.140
0.131
0.122
0.114
0.105
0.097
0.088
0.079
0.071
0.062
0.053
0.045
0.036
0.028
0.019
0.010
0.002
-0.007
-0.016
-0.024
-0.033
-0.041
-0.050
Y (mm)
X (mm)
0
1
2
3

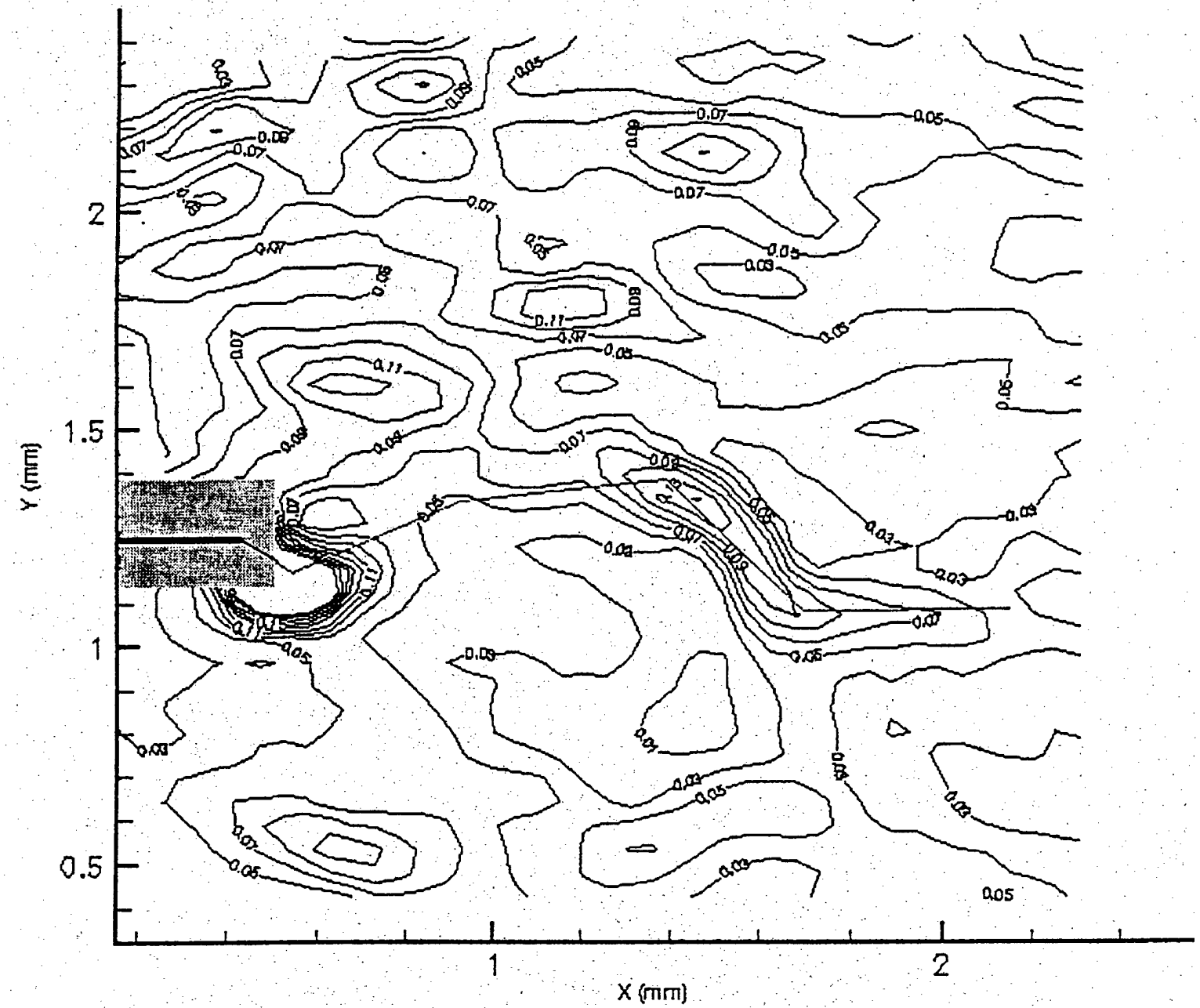

Maximum Principal Strain Distribution for
4.0% Far Field Strain During Loading.
Test 1
0.200
0.191
0.183
0.174
0.166
0.157
0.148
0.140
0.131
0.122
0.114
0.105
0.097
0.088
0.079
0.071
0.062
0.053
0.045
0.036
0.028
0.019
0.010
0.002
-0.007
-0.016
-0.024
-0.033
-0.041
-0.050
Y (mm)
X (mm)
0
1
2
0
1
2
3

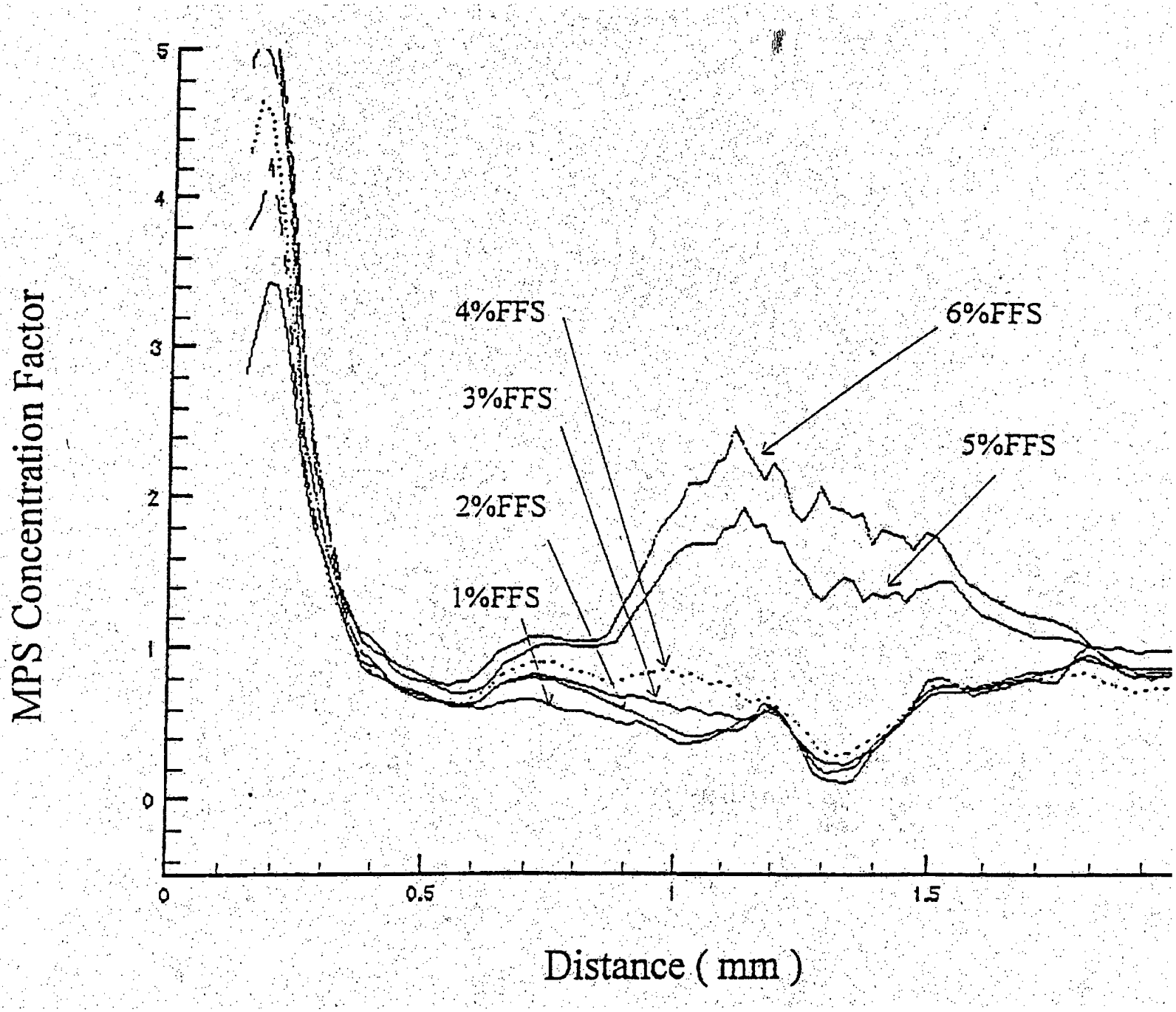
Maximum Principal Strain Distribution for
6.0% Far Field Strain During Loading.
Test 1

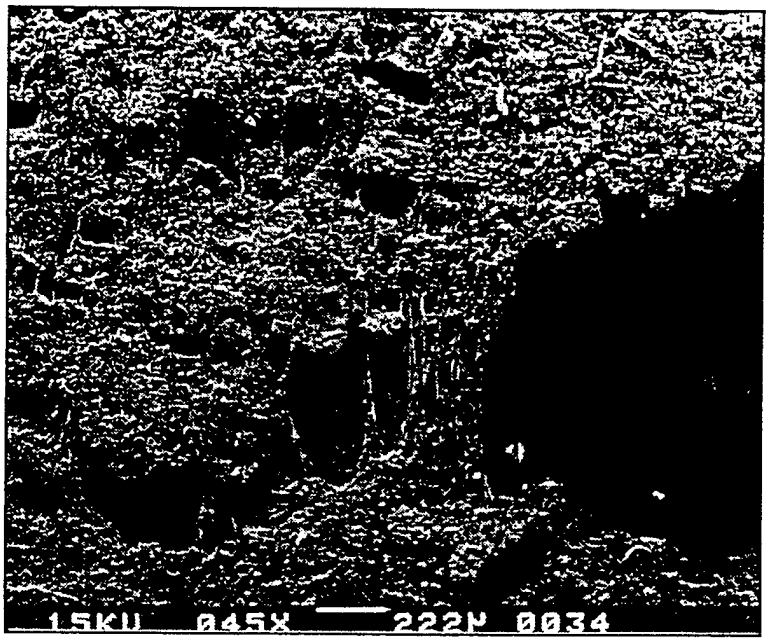



Maximum Principal Strain Distribution for
8.0% Far Field Strain During Reloading.
Test 1
0.200
0.191
0.183
0.174
0.166
0.157
0.148
0.140
0.131
0.122
0.114
0.105
0.097
0.088
0.079
0.071
0.062
0.053
0.045
0.036
0.028
0.019
0.010
0.002
-0.007
-0.016
-0.024
-0.033
-0.041
-0.050
Y (mm)
X (mm)
0
1
2
3


Maximum Principal Strain Distribution for
10.0% Far Field Strain during Reloading
Test 1
0.200
0.191
0.183
0.174
0.166
0.157
0.148
0.140
0.131
0.122
0.114
0.105
0.097
0.088
0.079
0.071
0.062
0.053
0.045
0.036
0.028
0.019
0.010
0.002
-0.007
-0.016
-0.024
-0.033
-0.041
-0.050
0
1
2
0
1
2
3
X (mm)

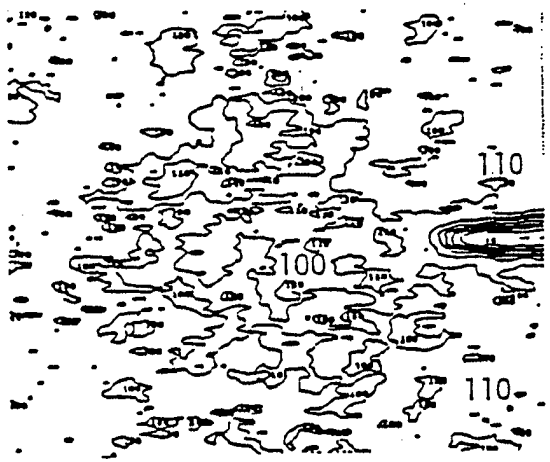

Y (mm)
X (mm)
0.5
1
1.5
2
1
2


MPS Concentration Factor
5
4
3
2
1
0
0
0.5
1
1.5
Distance (mm)
4%FFS
3%FFS
2%FFS
1%FFS
6%FFS
5%FFS

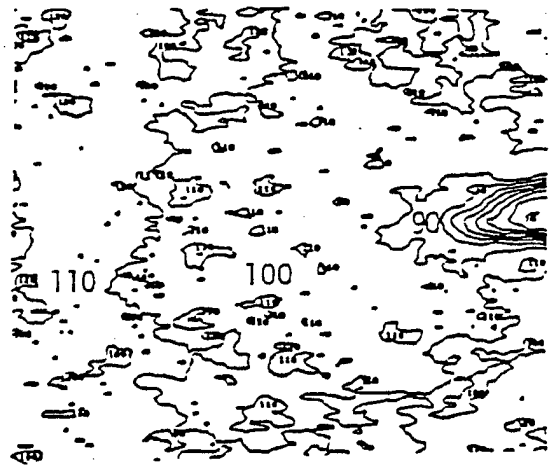

15KV 045X 222M 0034


15KV 2.25KX 4.44M 0041

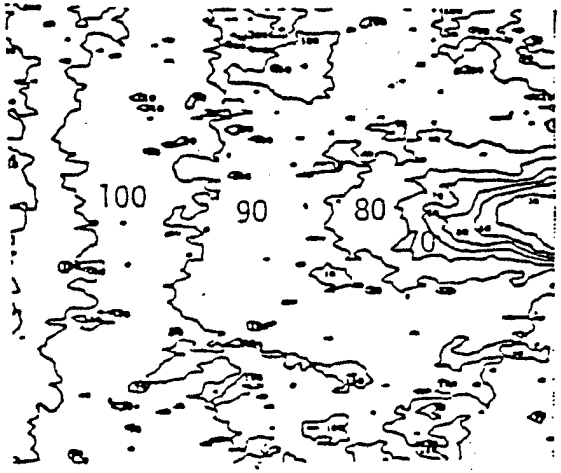
Iso-Intensity Contour Plots of I_t Near Crack Tip



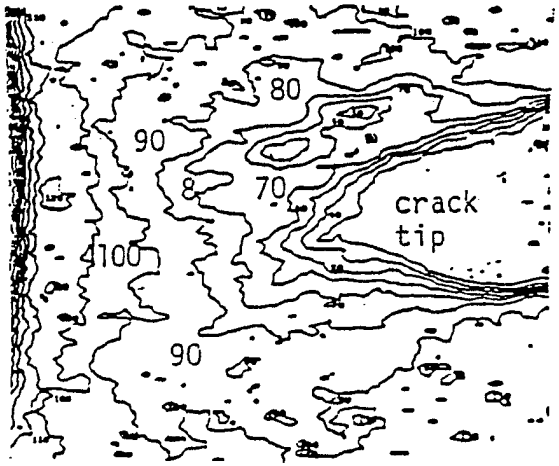
(a) ϵ = 3%



(b) ϵ = 6%

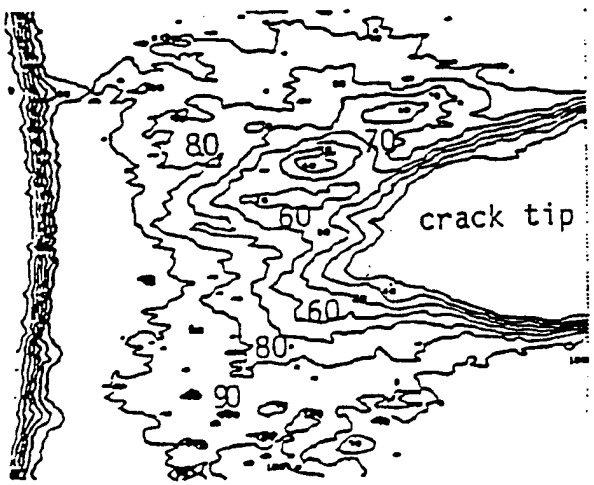


(c) ϵ = 9%

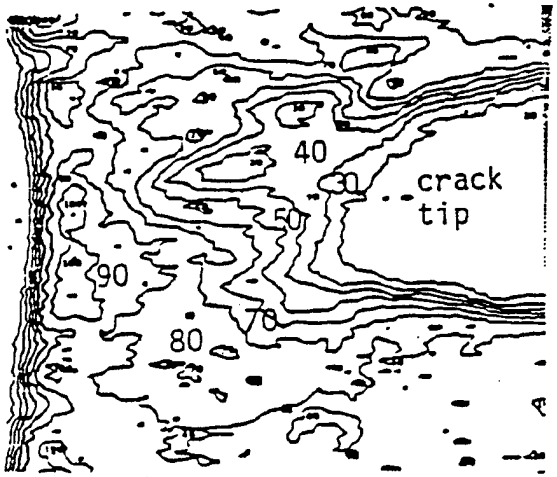


(d) ϵ = 12%

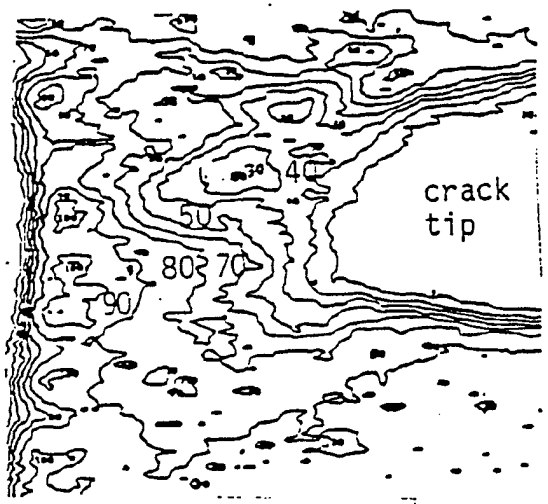
Iso-Intensity Contour Plots of I_t Near Crack Tip



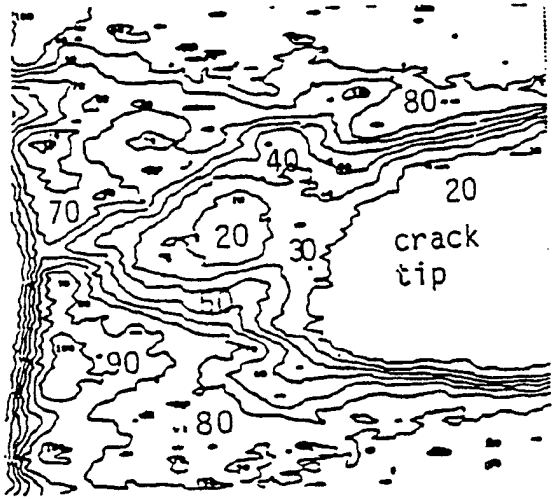
(e) ϵ = 13.5%



(f) ϵ = 13.5%

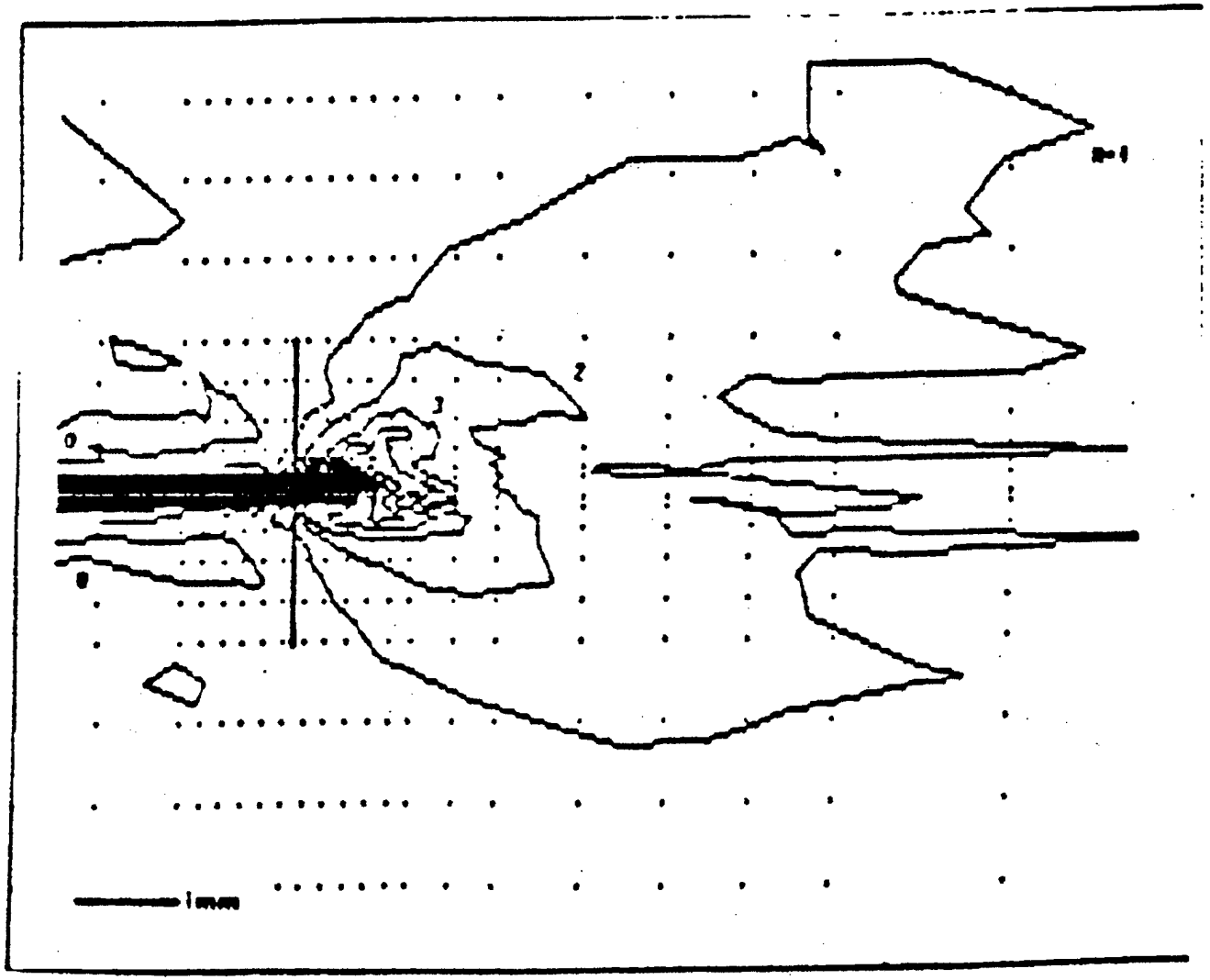


(g) ϵ = 13.5%



(h) ϵ =13.5%

Normal Strain (Experimental Result)



Conclusions

1) The Heterogeneity of the Microstructure Plays a Key Role for Local Damage and Strain Distributions Near the Crack Tip.
2) The High Strain Field Is Localized Within I Mm of the Crack Tip.
3) Damage Saturation at the Crack Tip Precedes Crack Growth.
4) The Damage Distribution Is Roughly Commensurate With the Strain Distribution in the Specimen.
5) The Crack Growth process Consists of Blunt-Growth-Blunt and Slow-Fast-Slow Phenomena.