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(Statement A)

Multi-Scale Strain Measurements of a Polymeric Material

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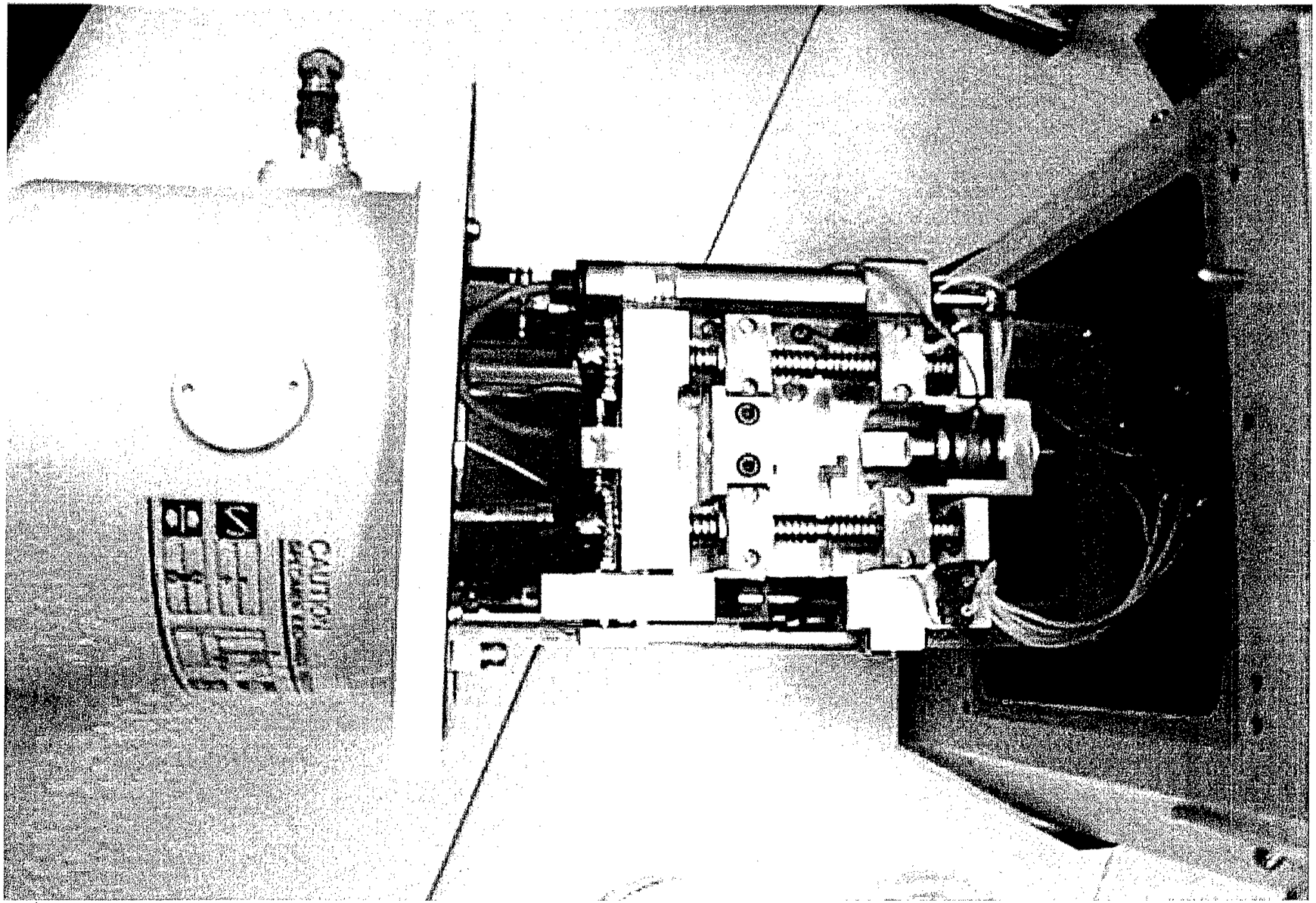
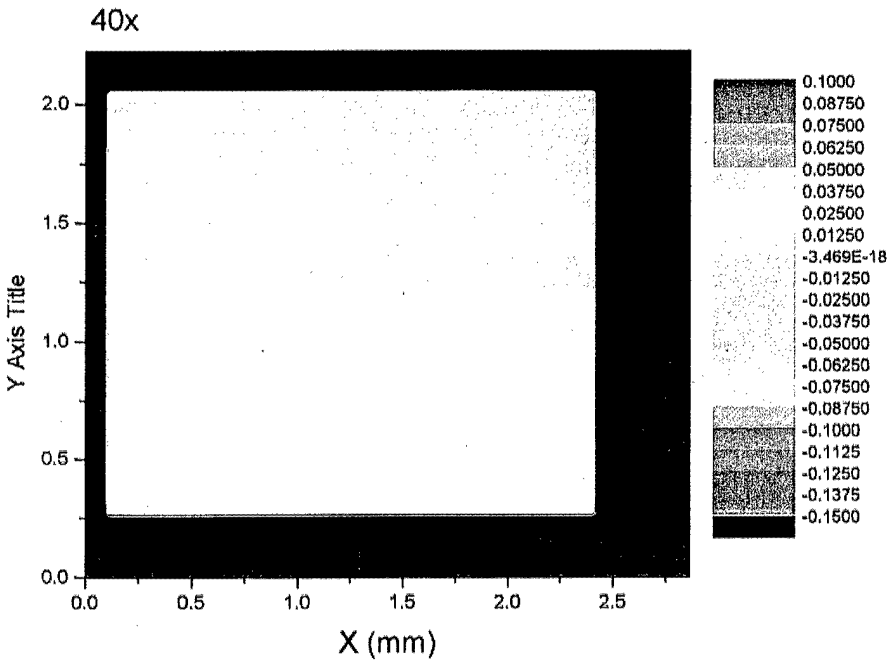
Objectives

- Determine the Displacement and Strain Fields in a Polymeric Material
- Investigate the Local Damage Mechanisms and Failure Behavior near the Crack Tip

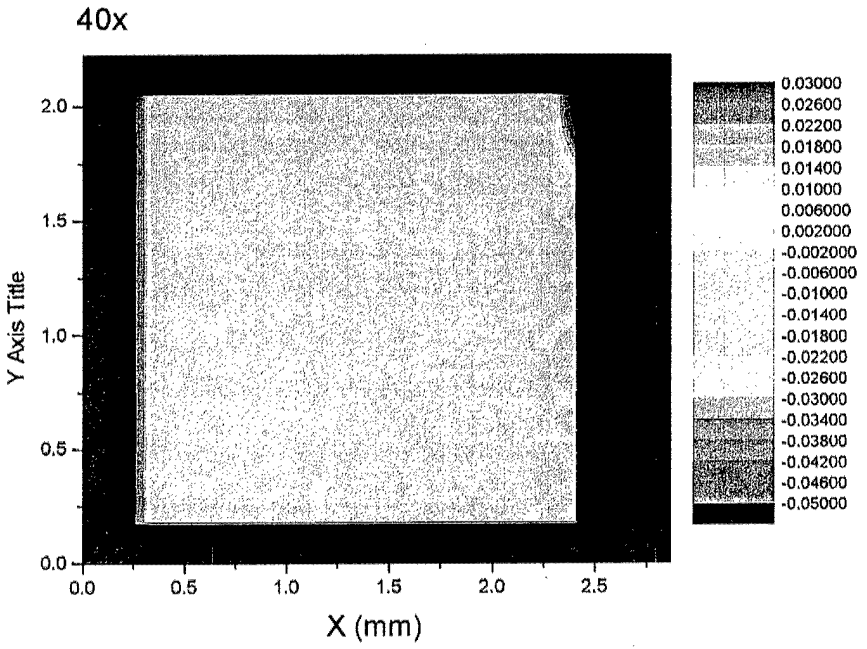
Testing Set-Up



Strain Distributions (2.5mm x 2.0mm)

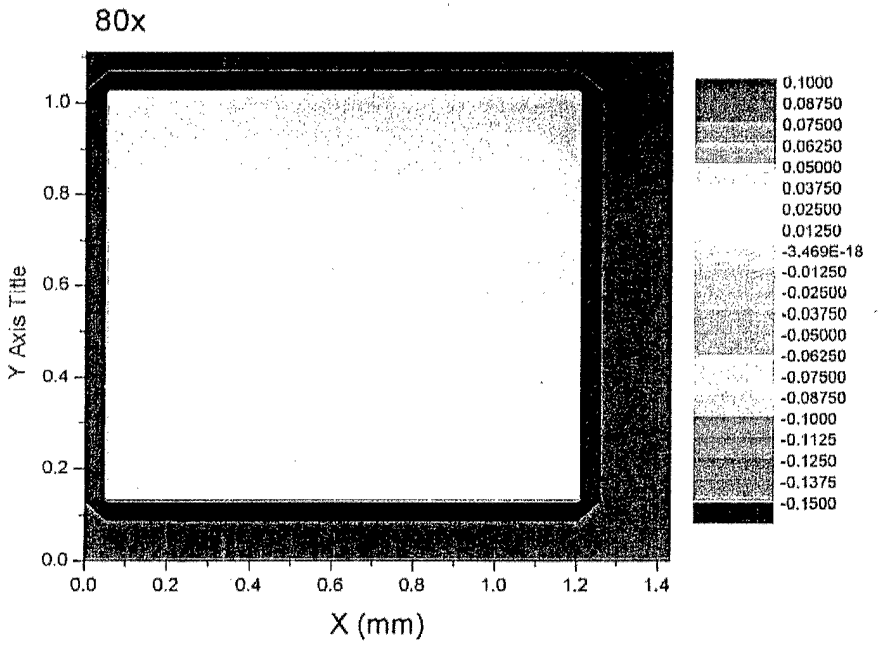


ε_{yy} field, Load = 52 grams

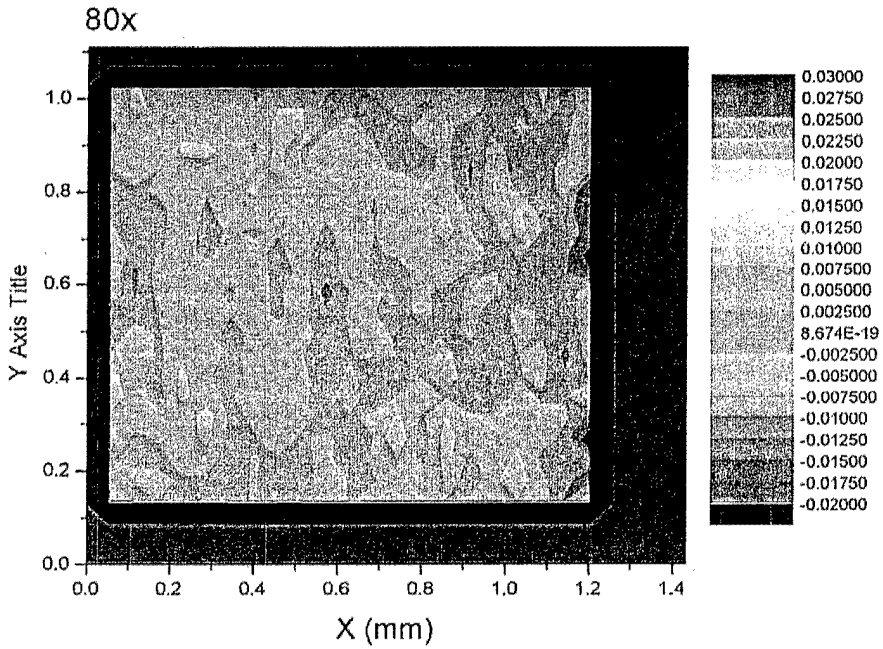


ε_{xx} field, Load = 52 grams

Strain Distributions (1.2mm x 1.0mm)

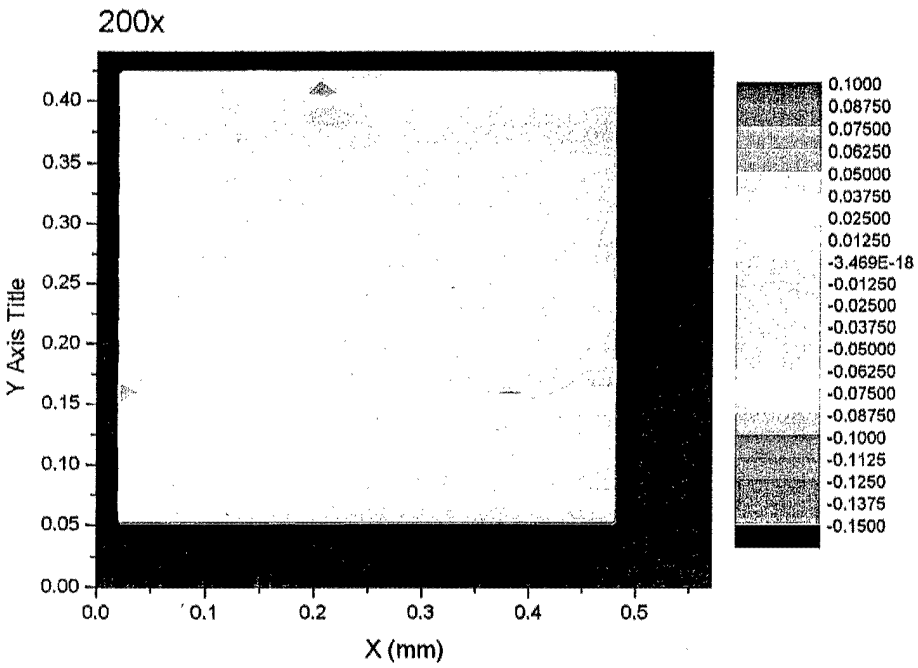


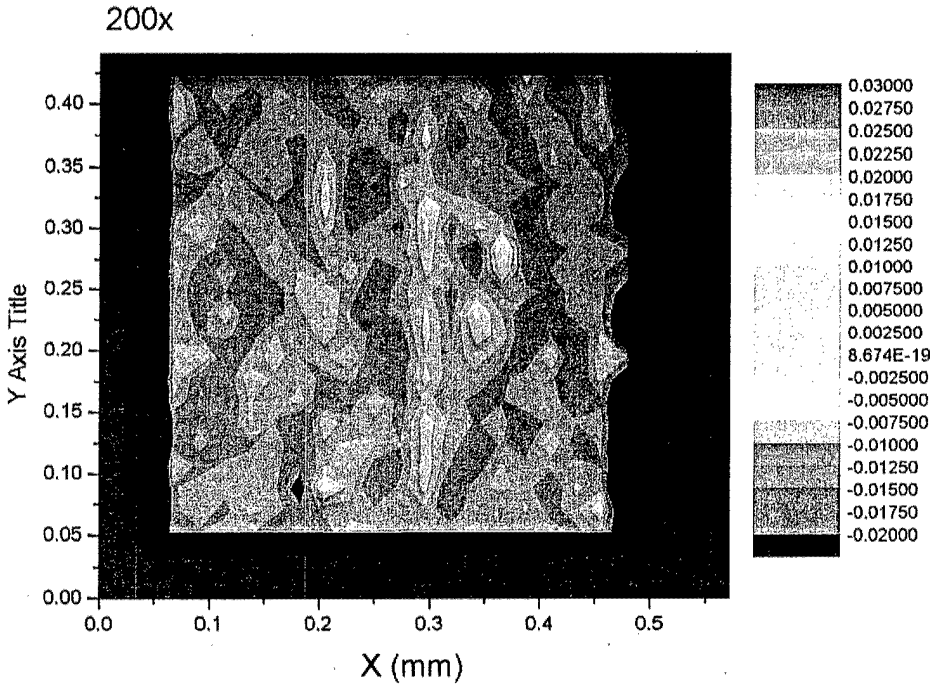
ε_{yy} field, Load = 41 grams



ε_{xx} field, Load = 41 grams

Strain Distributions (0.5mm x 0.45mm)

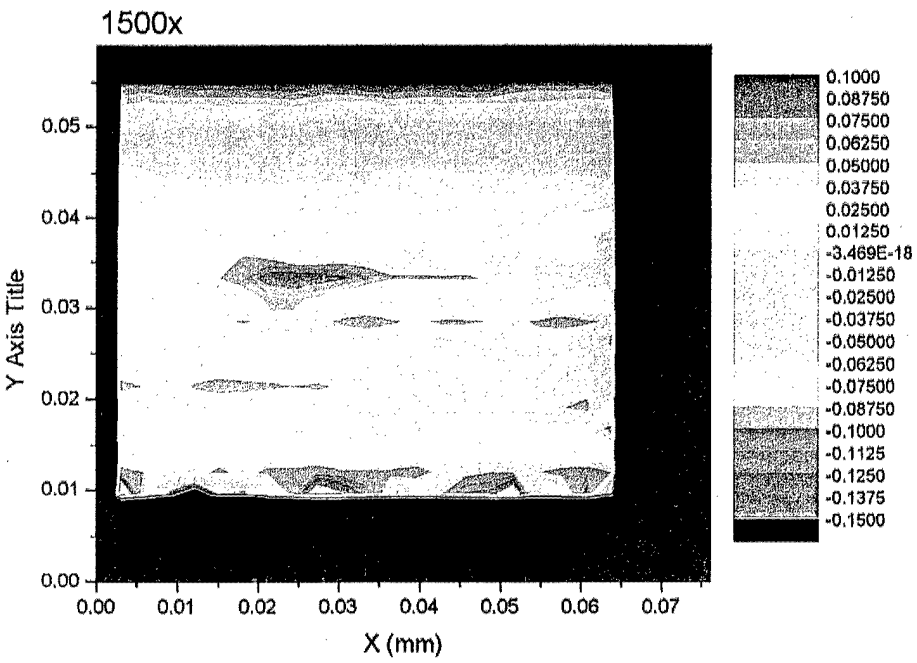




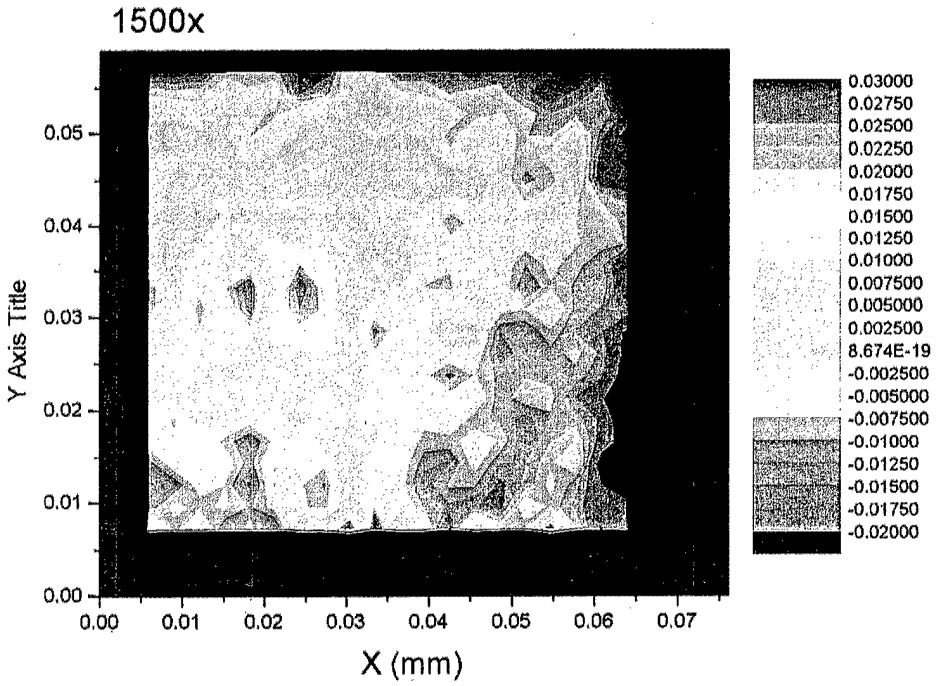
ε_{yy} field, Load = 47 grams

ε_{xx} field, Load = 47 grams

Strain Distributions (0.065mm x 0.055mm)

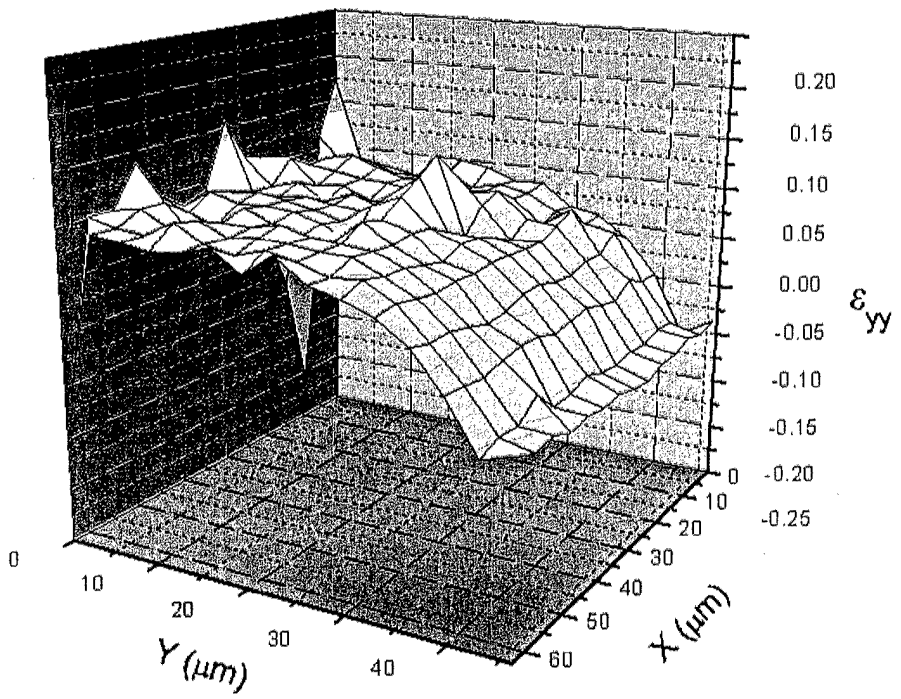


ε_{yy} field, Load = 49 grams

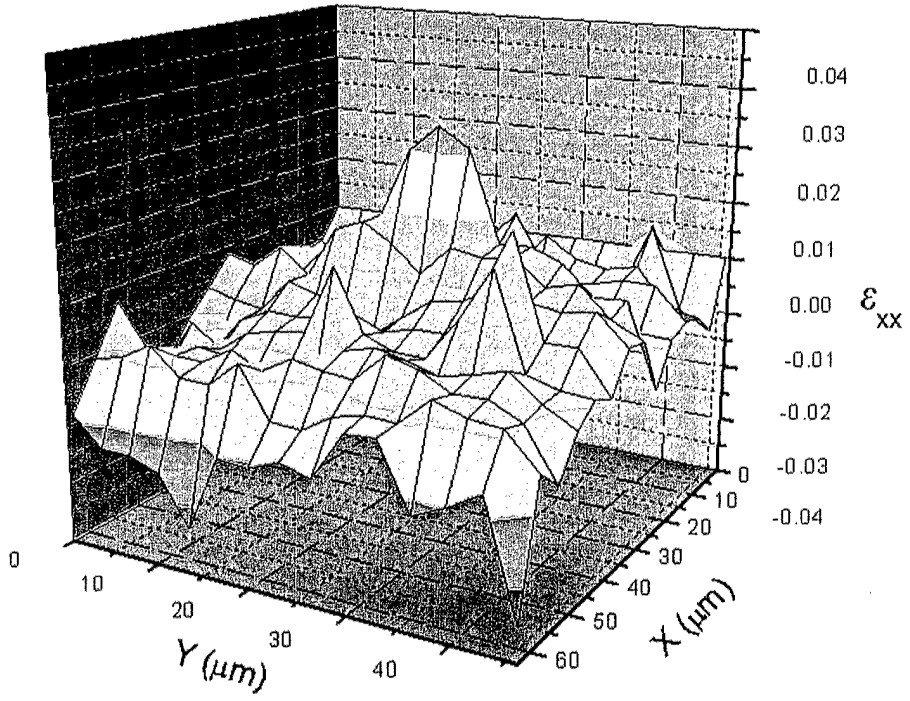


ε_{xx} field, Load = 49 grams

Strain Distribution (0.065mm x 0.055mm)



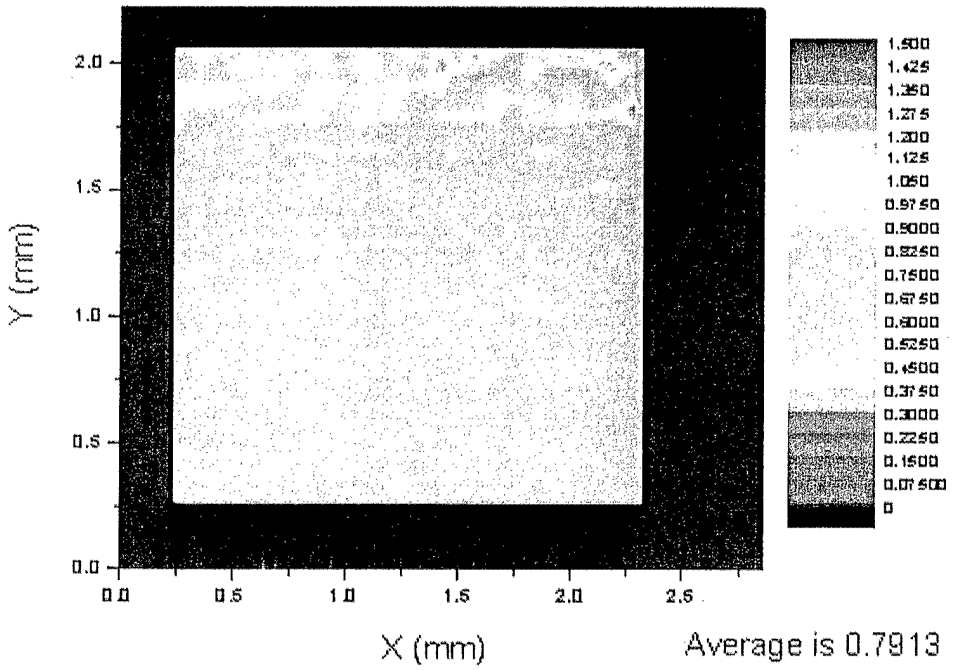
ε_{yy} field (3-D), Load = 49 grams



ε_{xx} field (3-D), Load = 49 grams

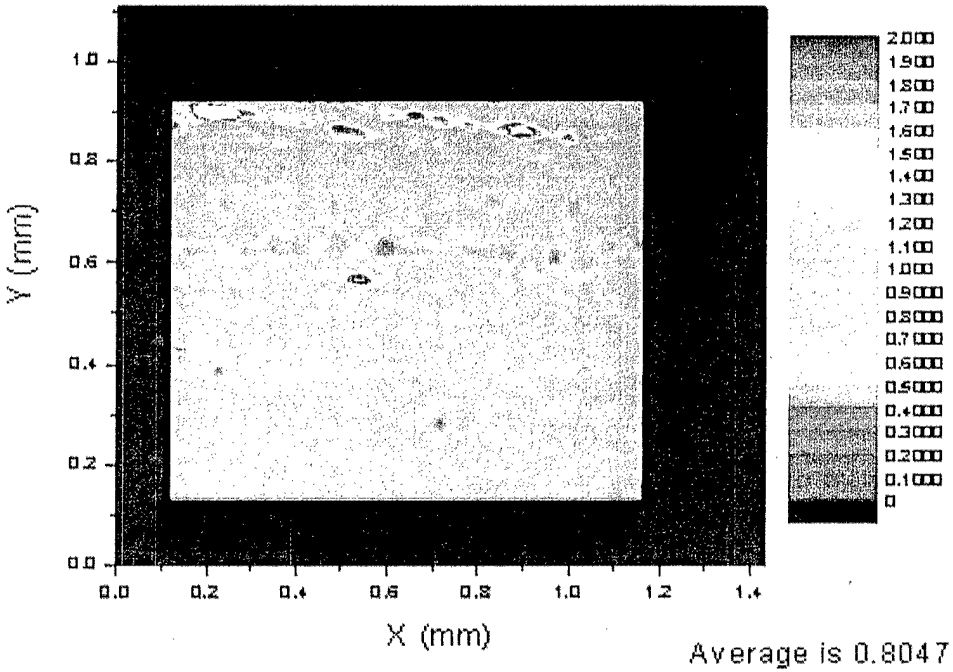
Strain Ratio ($-\varepsilon_{xx}/\varepsilon_{yy}$) Distributions at Different Magnifications

40x "Poisson Ratio" distribution



Average is 0.7913

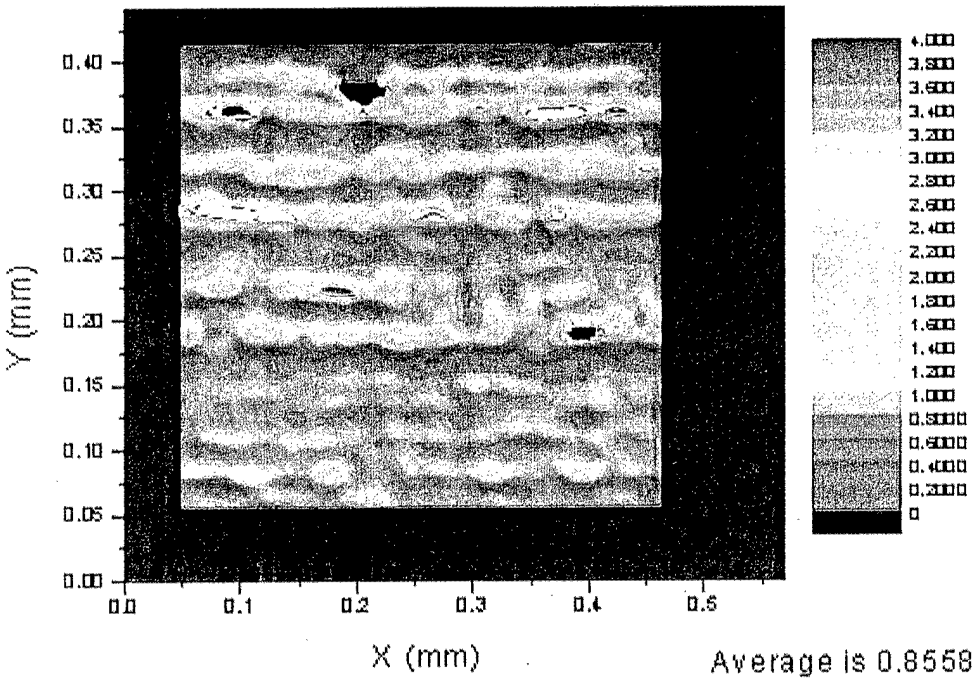
80x



Average is 0.8047

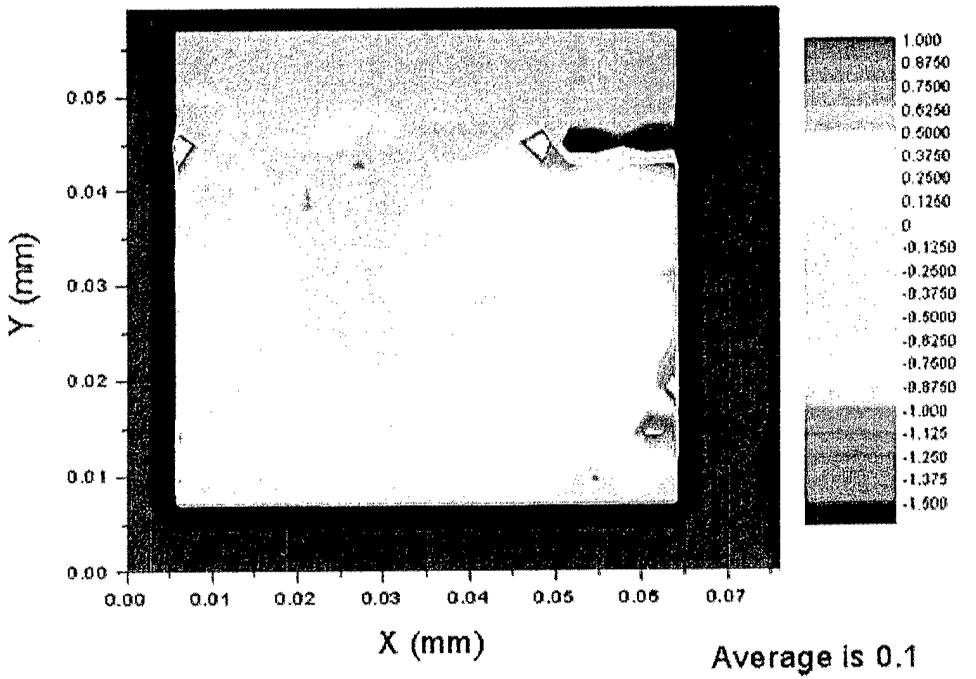
Strain Ratio ($-\varepsilon_{xx}/\varepsilon_{yy}$) Distributions at Different Magnifications

200x



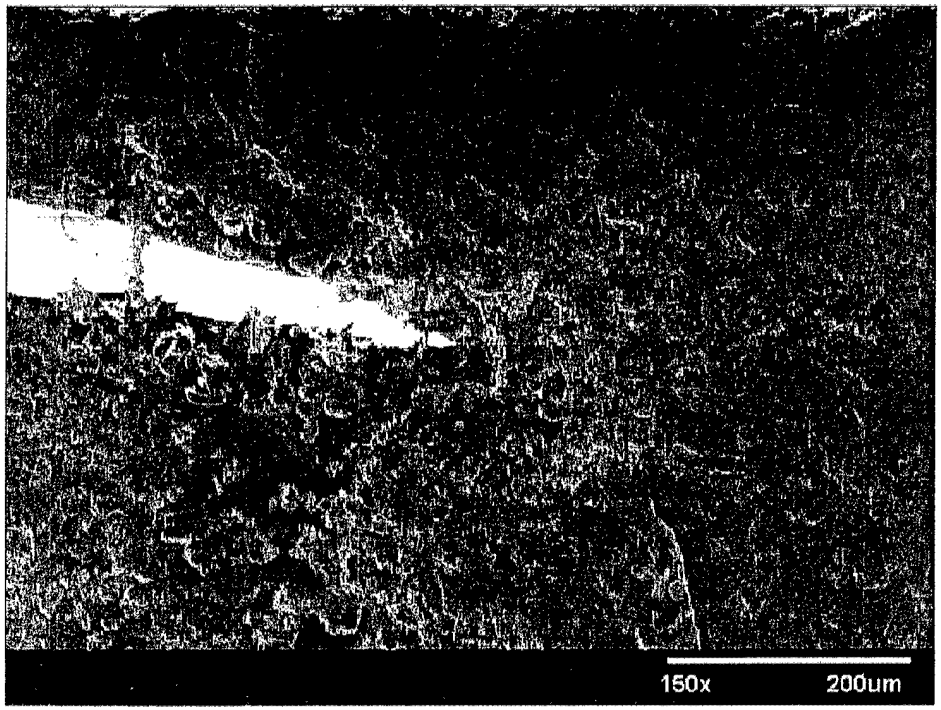
Average is 0.8558

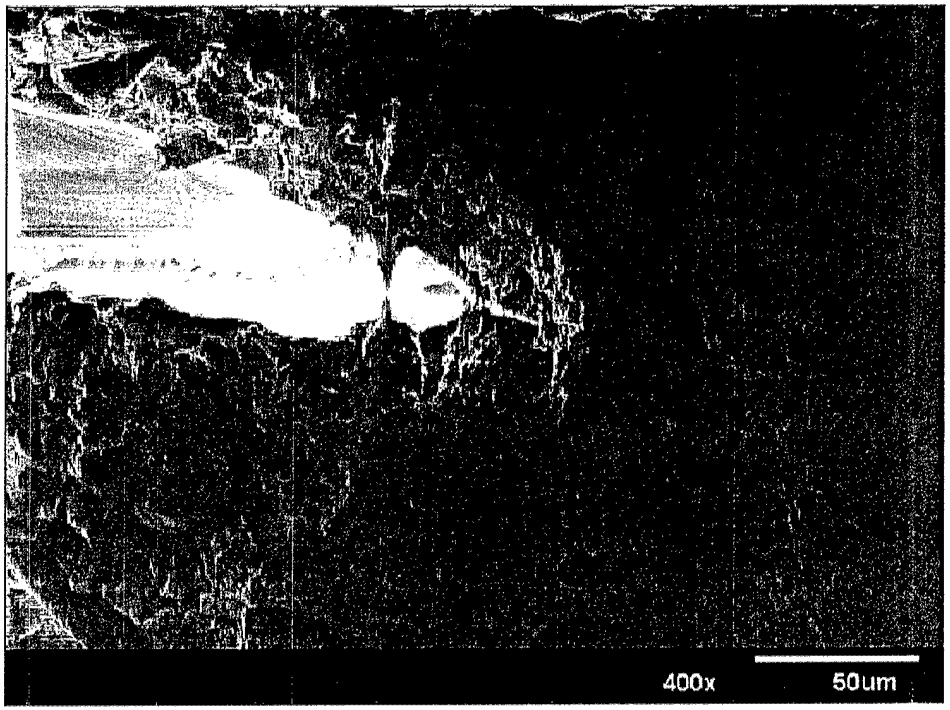
1500x



Average is 0.1

Side View of Crack Tip at 150x & 400x





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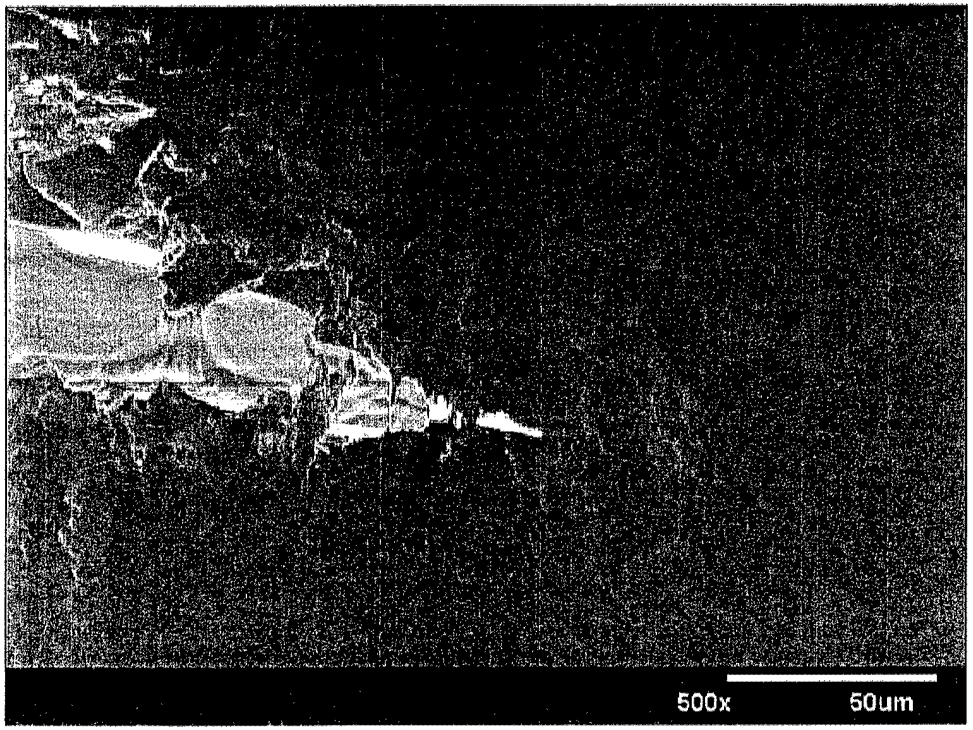
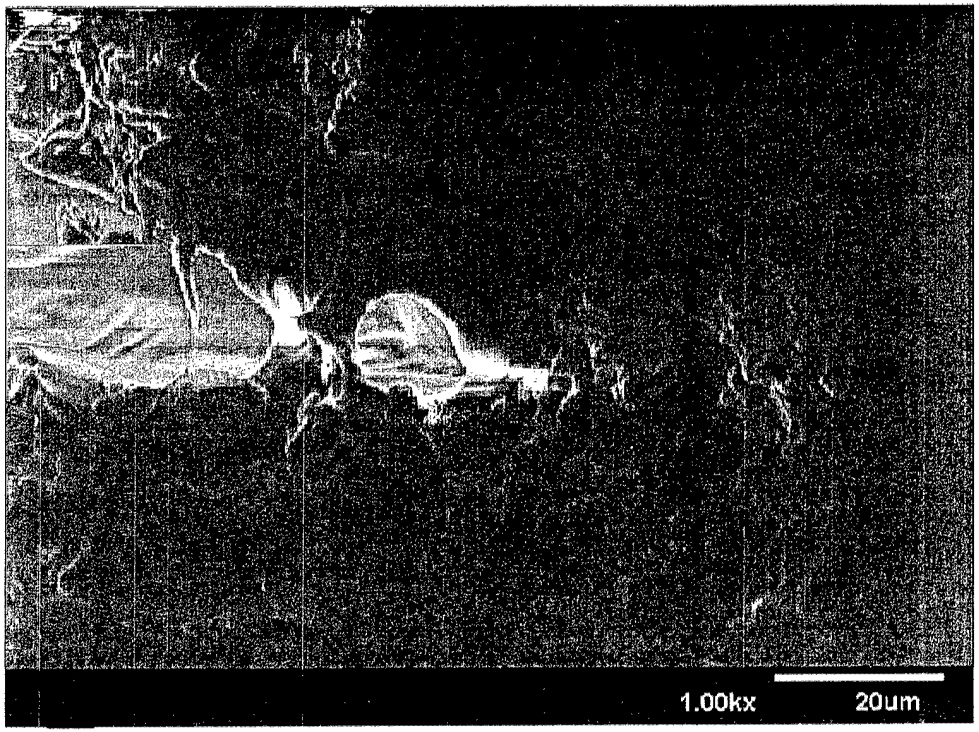
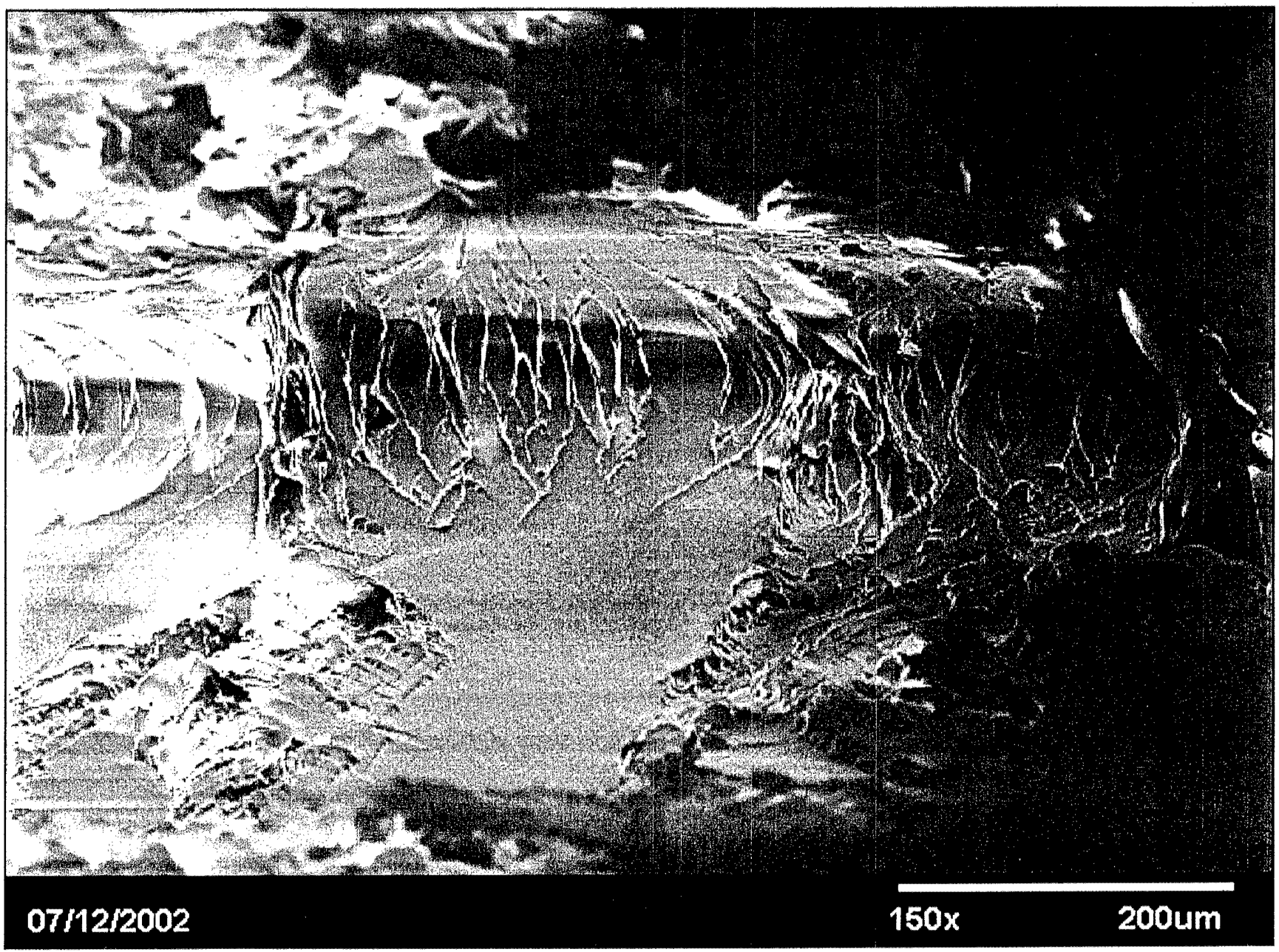
Side View of Crack Tip at 500x & 1000x

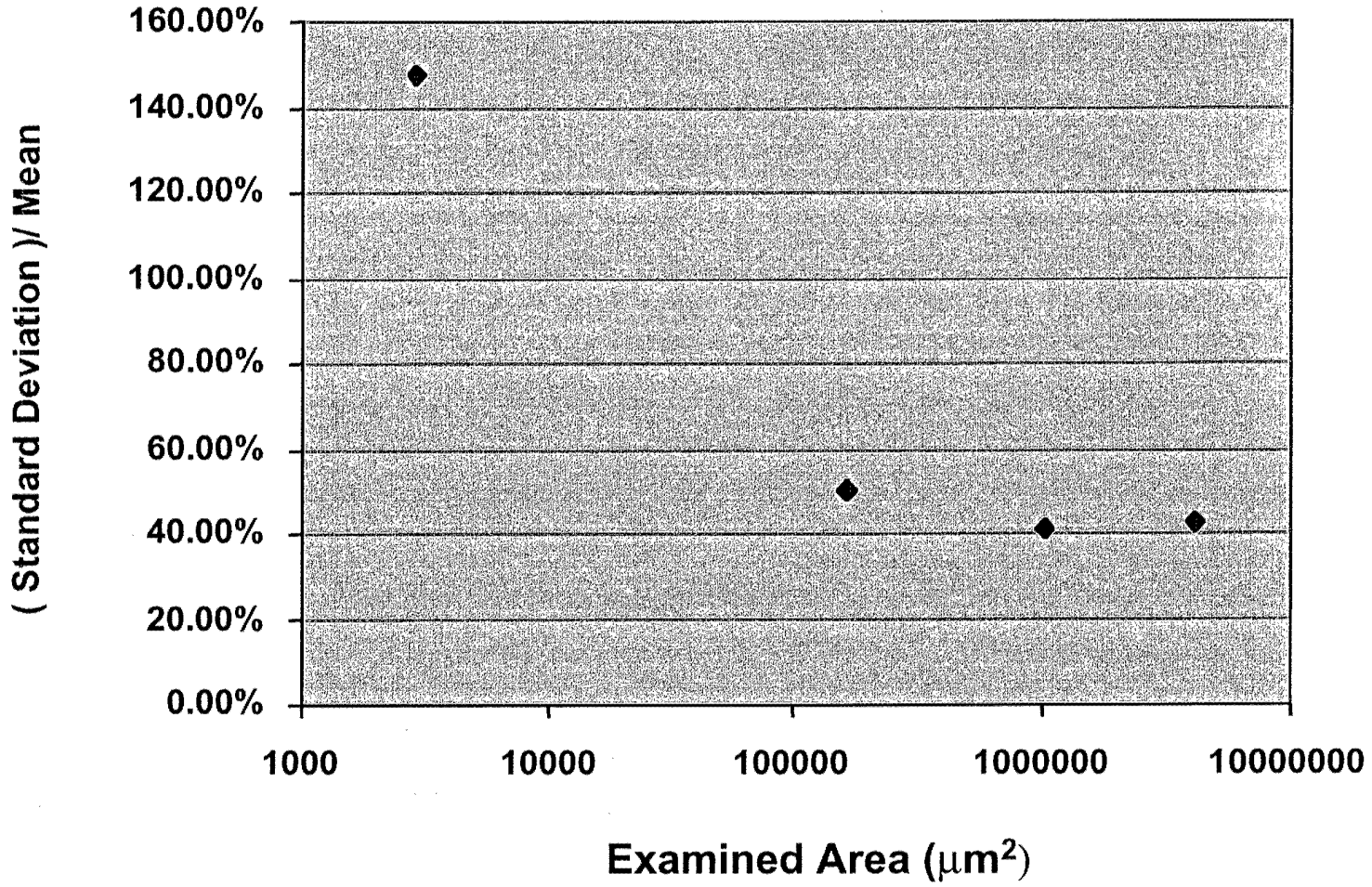




Crack Tip Top View



Standard Deviation / Mean of ε_{xx} Vs. Examined Area



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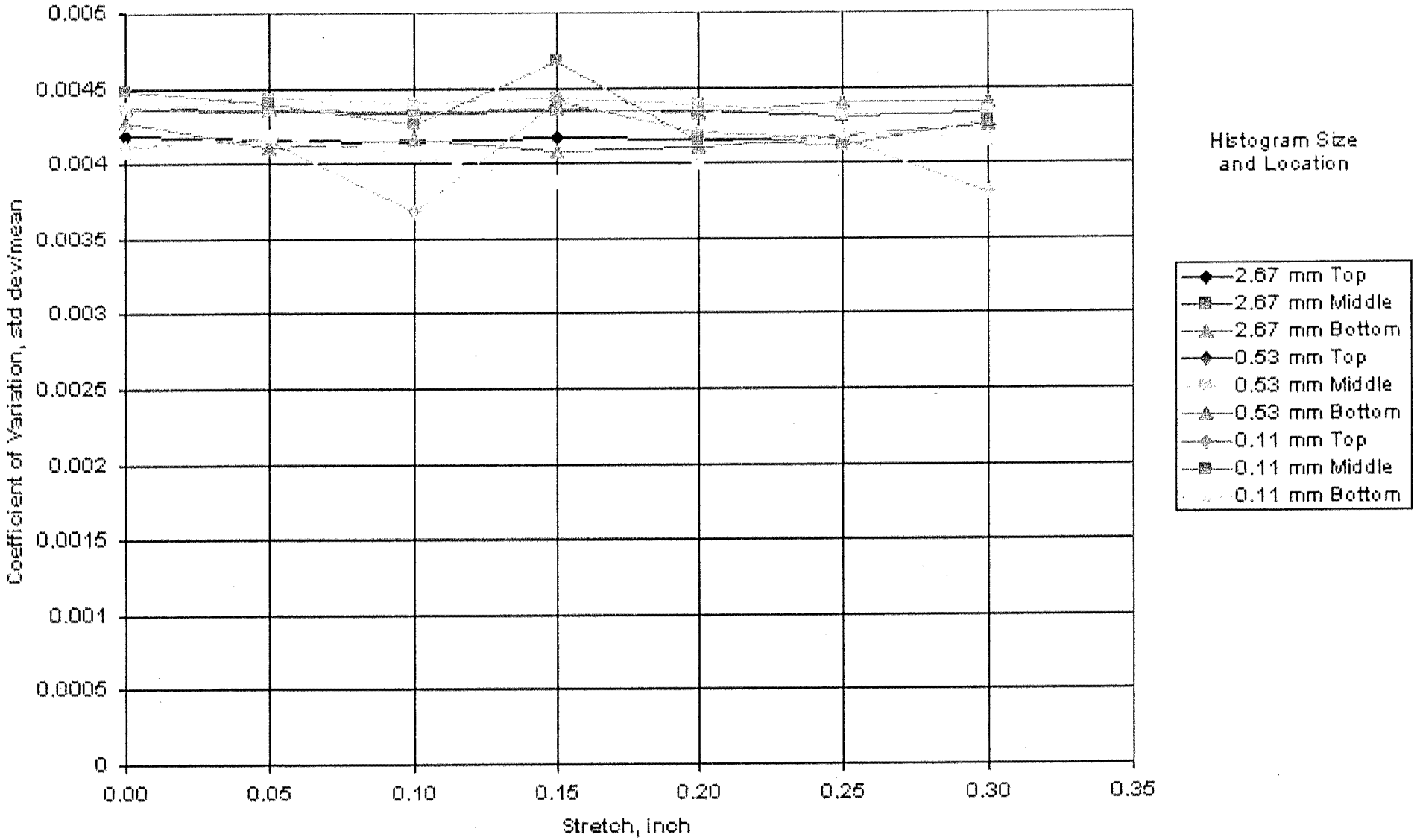
Coefficient of Variation of X-Ray Intensity



Conclusions

- The strain distributions vary with the size of the area, A, in which the data were analyzed.
- When the size of A is smaller or equal to 1.5 mm .x 1.5mm.the nonuniformity of the strain distributions is increased. Especially, when the size of A is equal to 0.065 mm. X 0.055 mm, both tensile and compressive strain fields exist in the small area
- The representative area, which is defined as an area in which the material's microstructure has no significant effect on the strain distribution, of the material considered is 1.5 mm x 1.5 mm.
- A highly damaged region of 20-50 micron long is developed at the crack tip.
- The crack growth mechanism involves voids formation ahead of the crack tip and the coalescence of the main crack tip with the void.