



2000

Micro-Macro Behavior near the Crack Tip in a Particulate Composite Material

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For Public Release

DUPLICATE INFORMATION 4

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Objectives

- Investigate the Micro-Macro Damage Mechanisms near the Crack tip.
- Determine the Local Strain Fields, Strain Concentrate Factor, and Strain Rate near the Crack Tip.



Local Dewetting About Filler Particles in Propellant

← Direction of Strain →

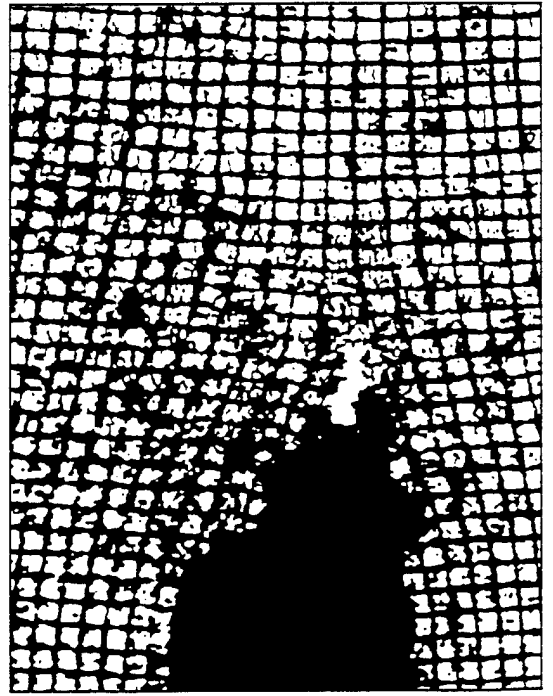
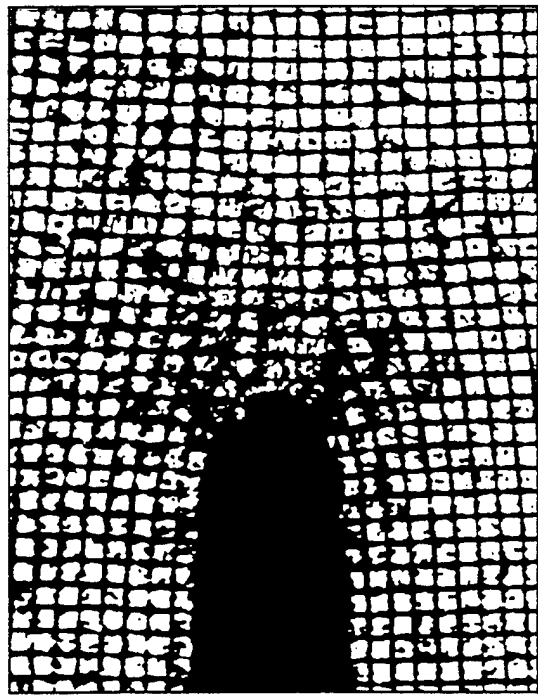
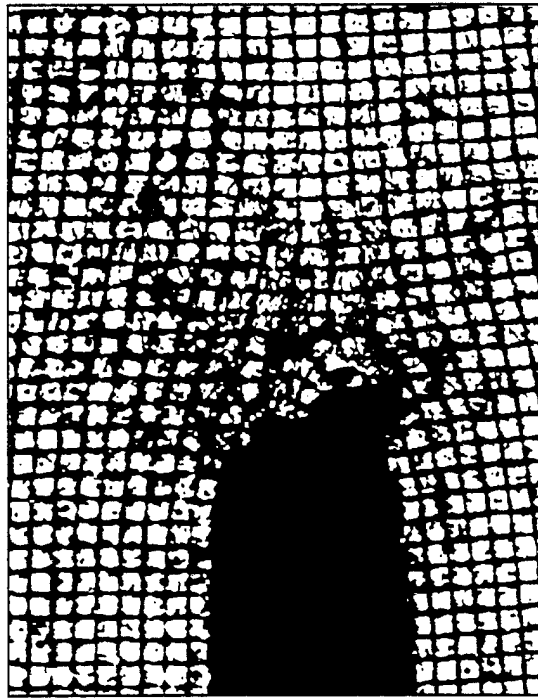


Unstrained

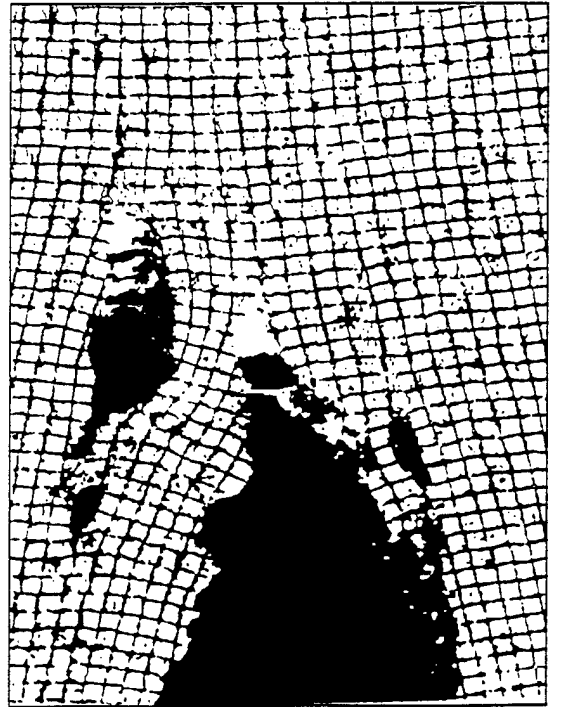
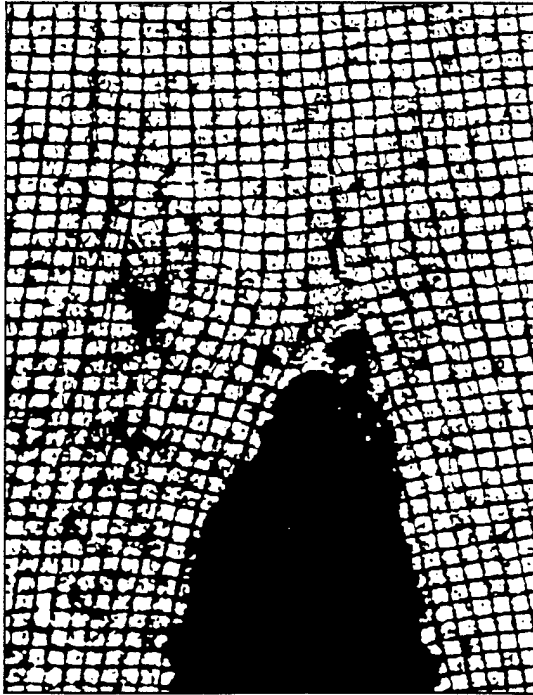
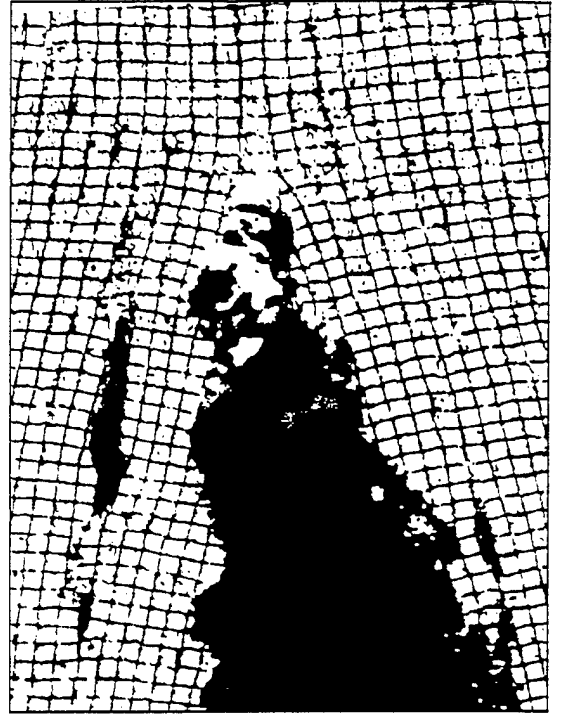
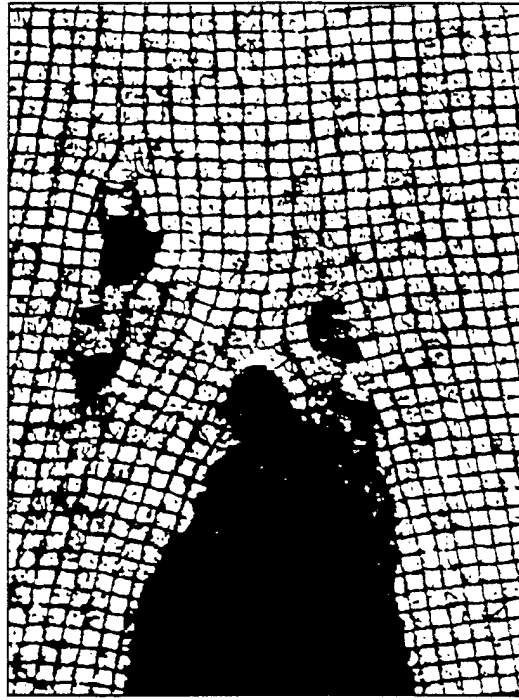


30% Strain

Crack Tip Profiles

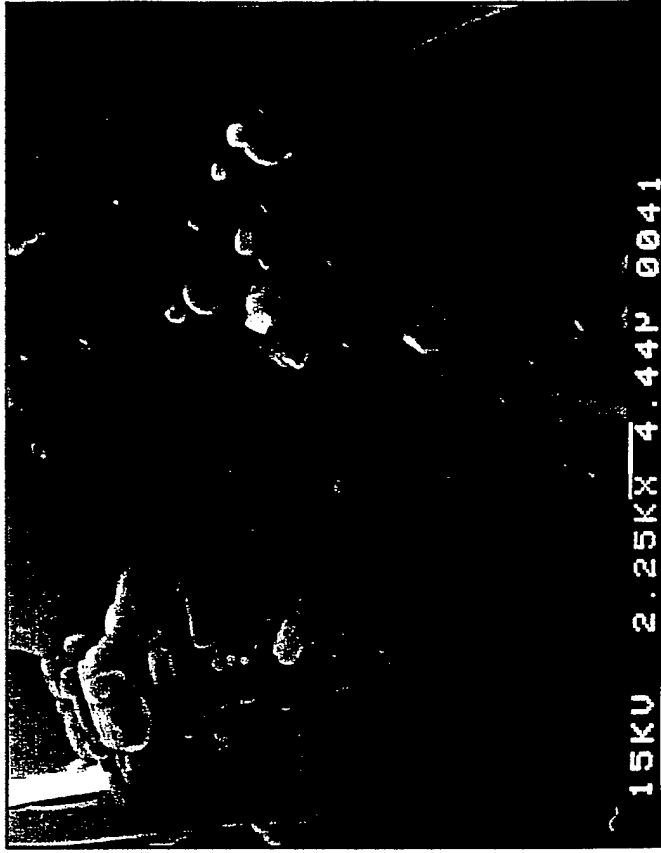
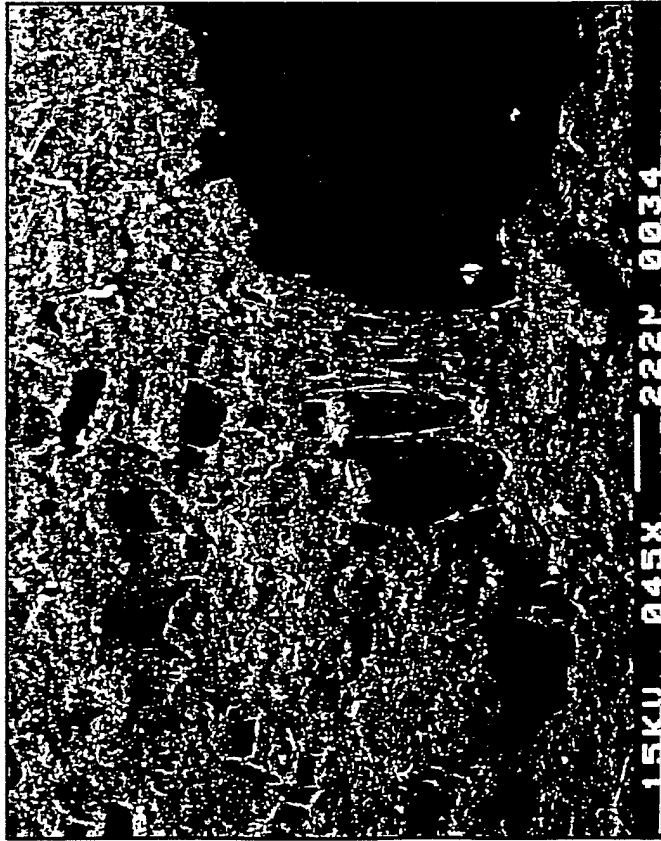


Crack Tip Profiles



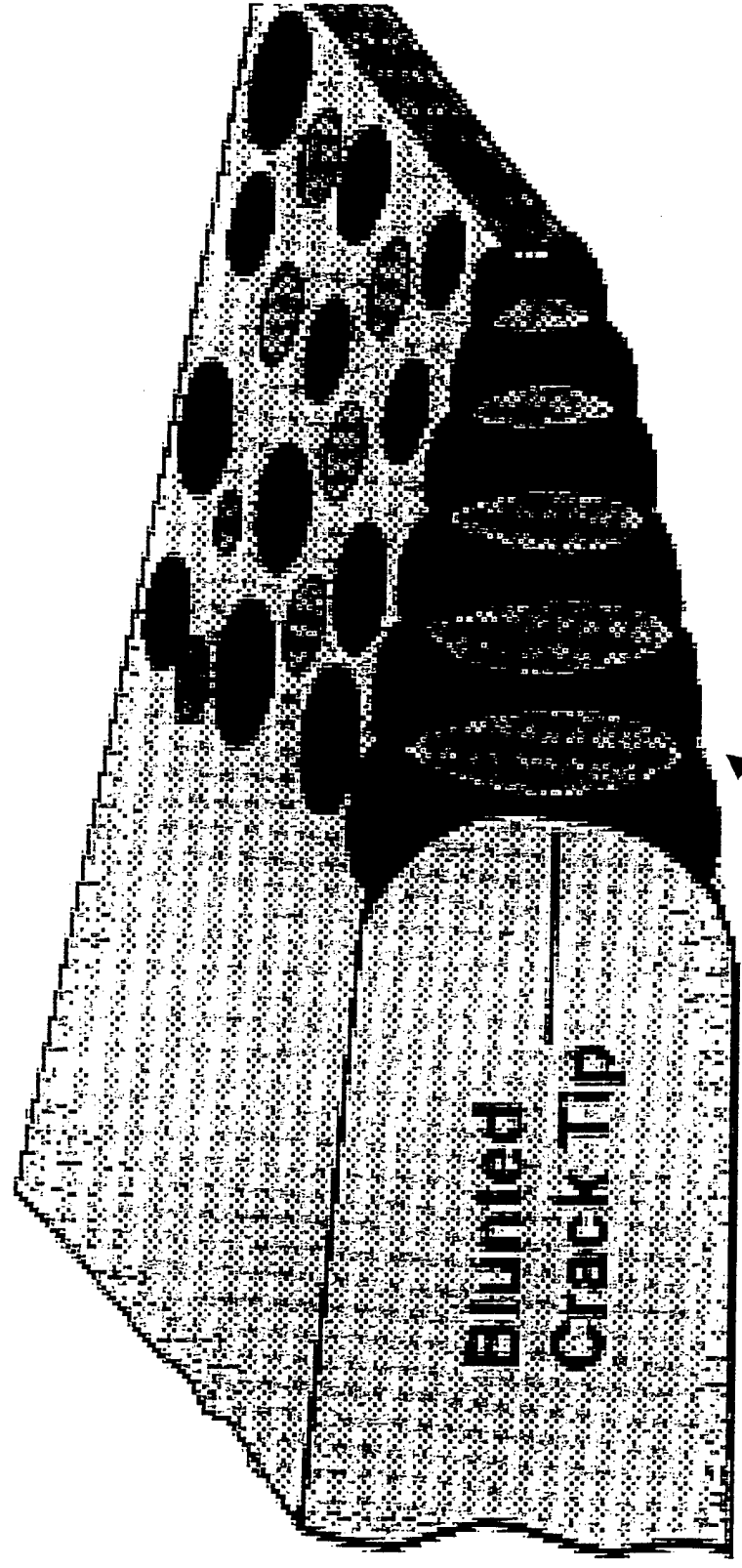


Damage Zone at Crack Tip



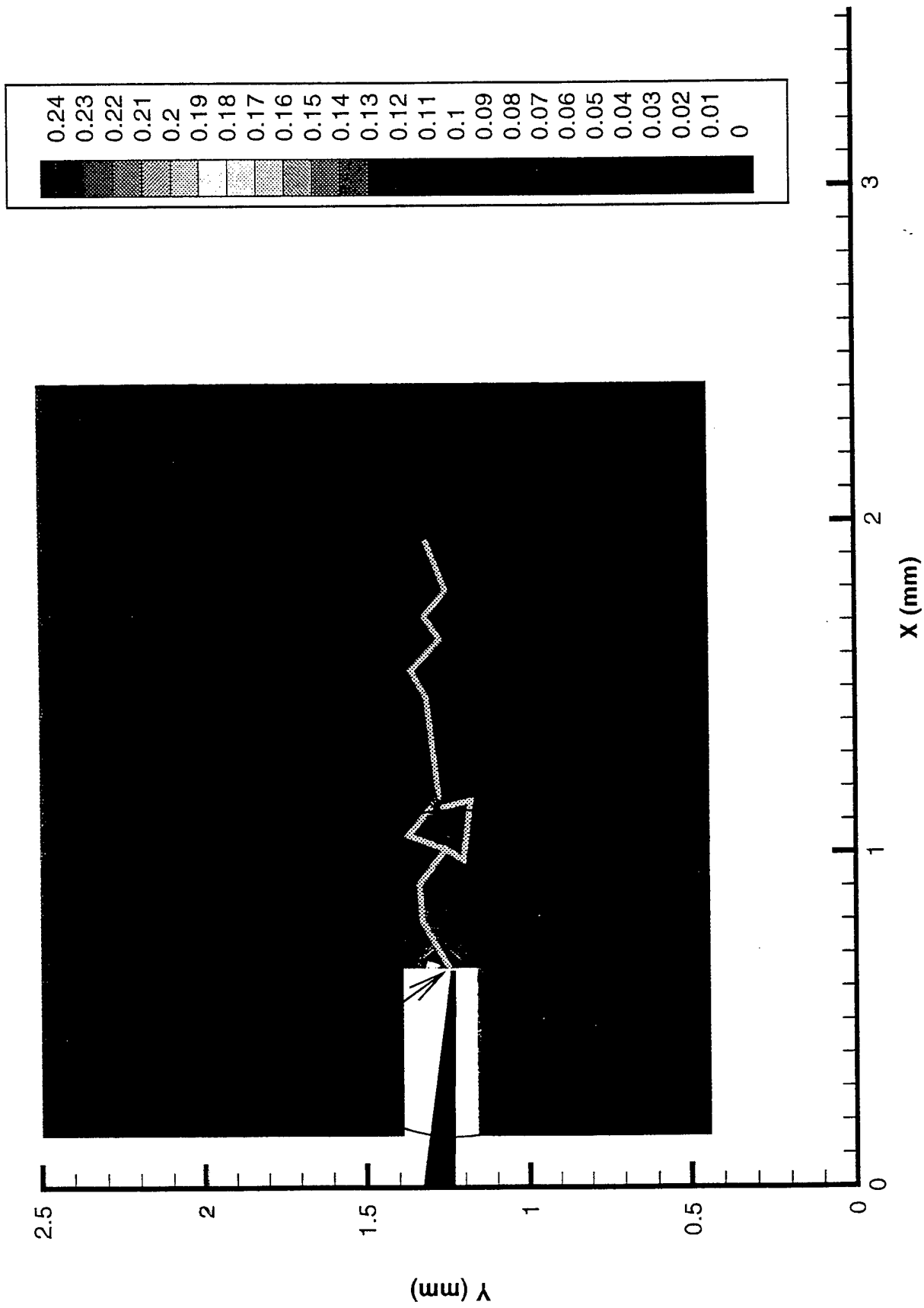


Crack Tip Damage Model

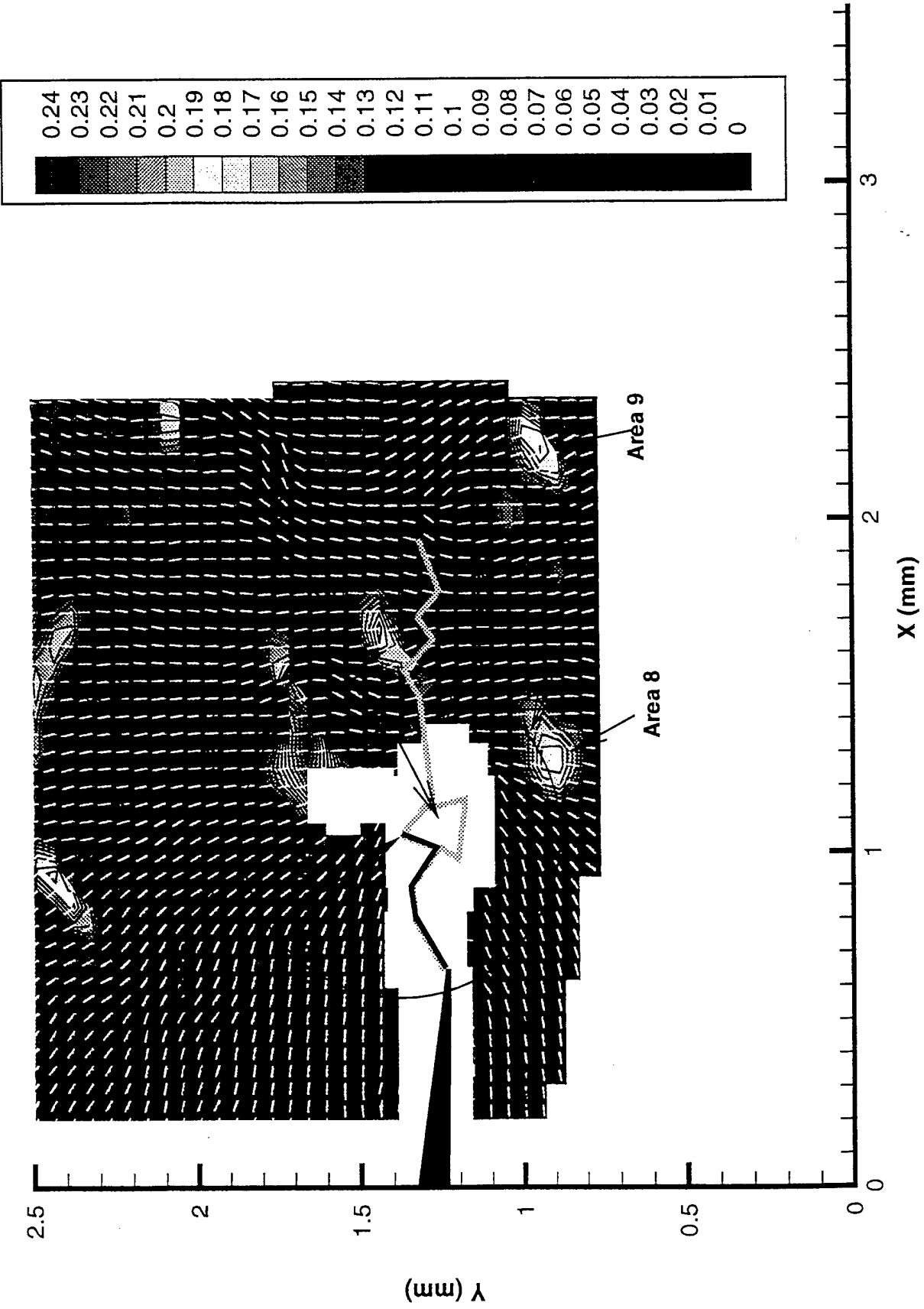


Highly Damaged Zone

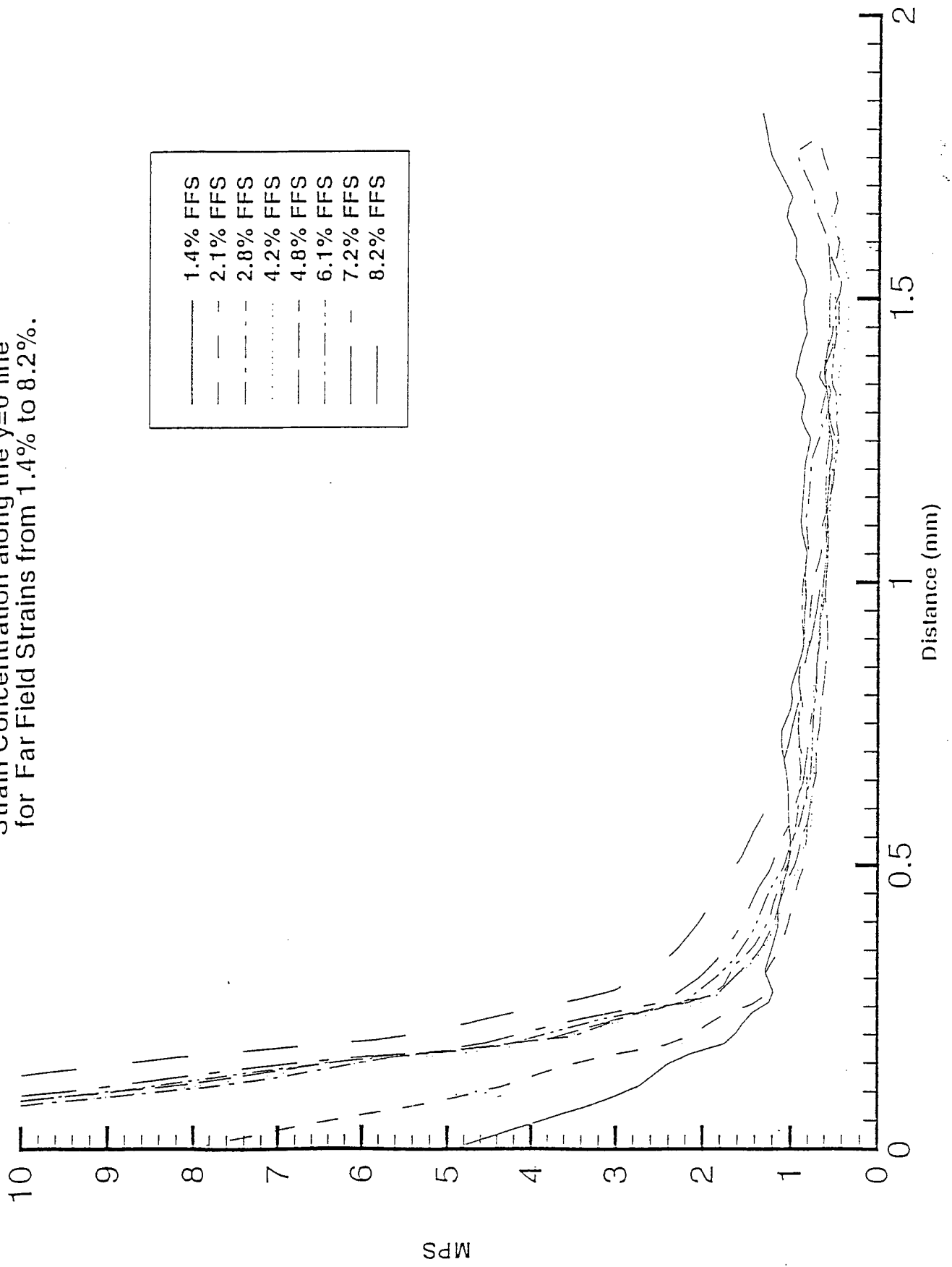
Maximum principal strain for step 2
Far Field Strain 2%



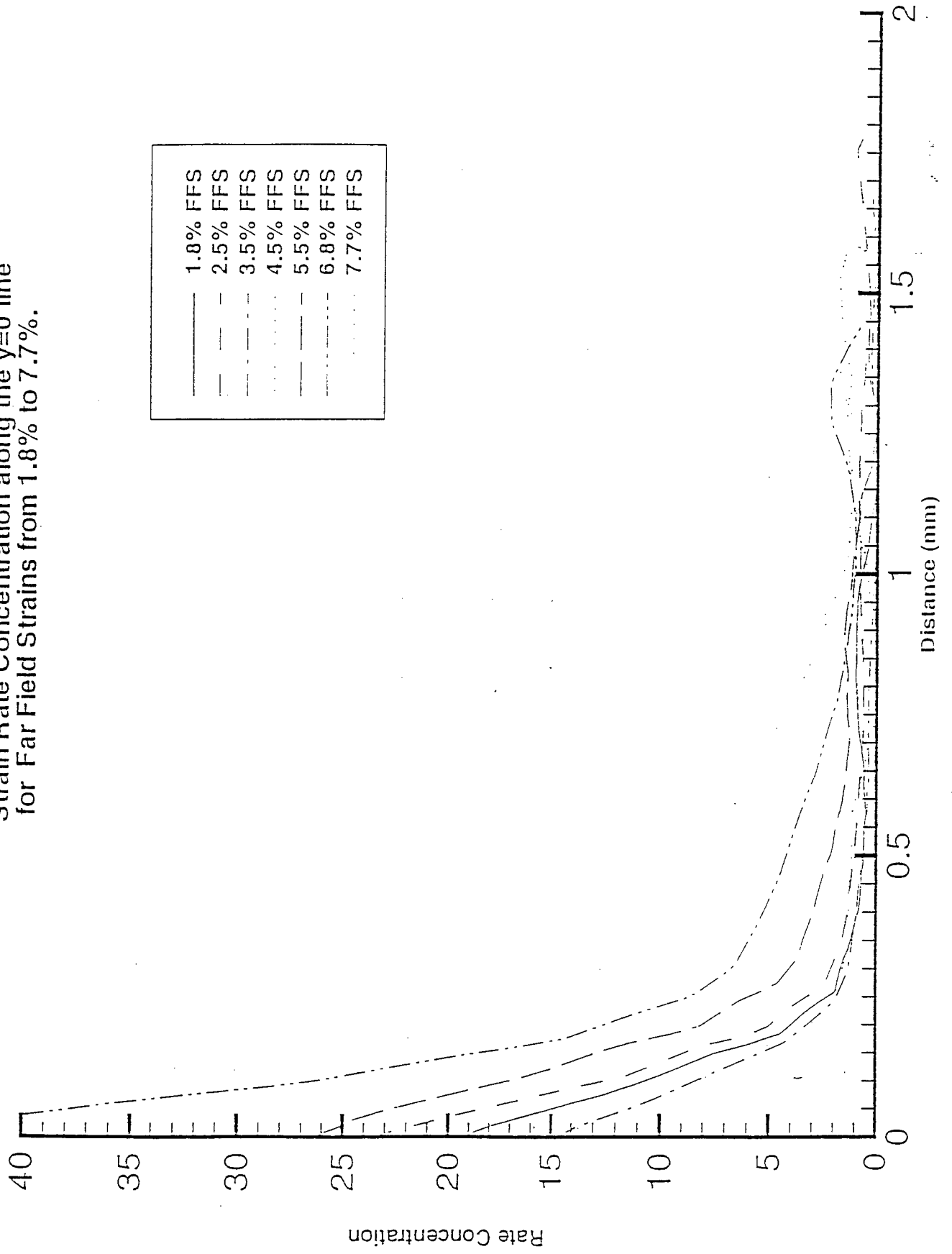
Maximum principal strain for step 5
Far Field Strain 5%



Strain Concentration along the $y=0$ line
for Far Field Strains from 1.4% to 8.2%.

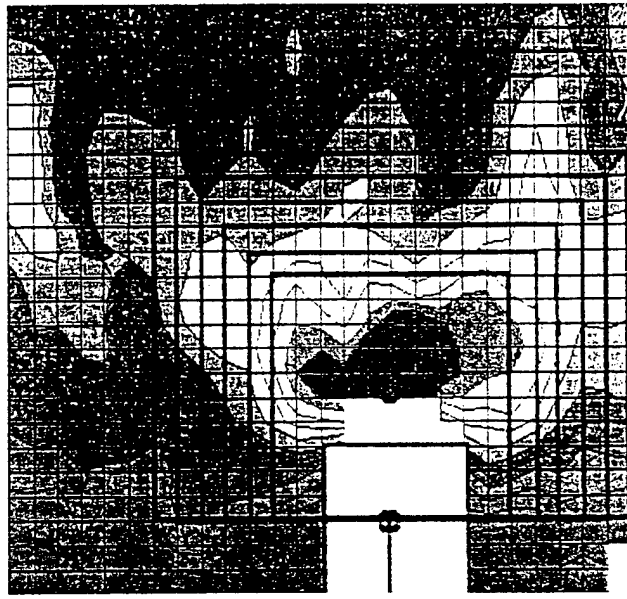
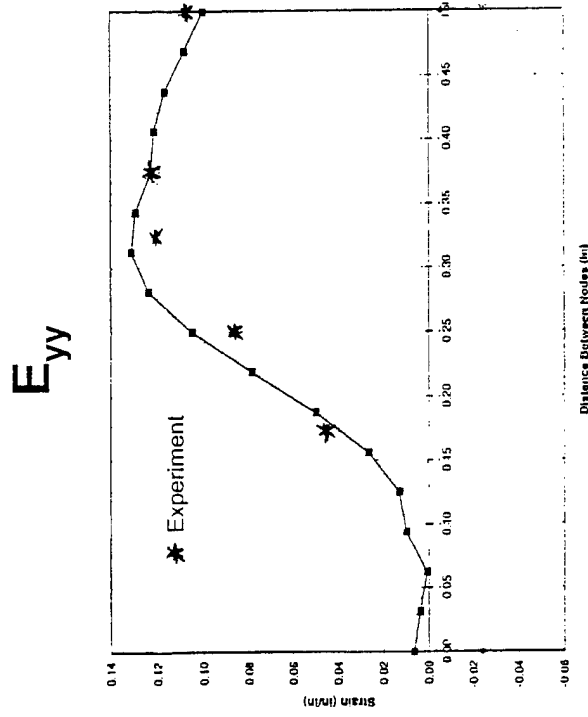


Strain Rate Concentration along the $y=0$ line
for Far Field Strains from 1.8% to 7.7%.





Microstructure has no Significant Effect on the Path-Independent Nature of the J-Integral



- A Good Correlation Exists Between Experimentally Measured and Numerically Calculated E_{yy} Along a Given Path of Integration
- The Mean and the Coefficient of Variation of the J-Integral Along Seven Paths are 633 Pa m and 0.03, Respectively



Conclusions

- **The Heterogeneity of the Microstructure Plays a Key Role for Local Damage and Strain Distributions near the Crack Tip.**
- **The Local Damage Mechanisms Consists of Void Generation and Coalescence.**
- **Local Damage at the Crack Tip Minimized the Transverse Constraint.**
- **The High Strain Field is Localized within 1 mm of the Crack Tip.**
- **On the Macroscopic Scale, the Particulate Composite Material can be Considered as a Continuum**