Monitoring Damage Characteristics in a Filled Elastomer Under Cyclic Loads Using X-Ray Techniques

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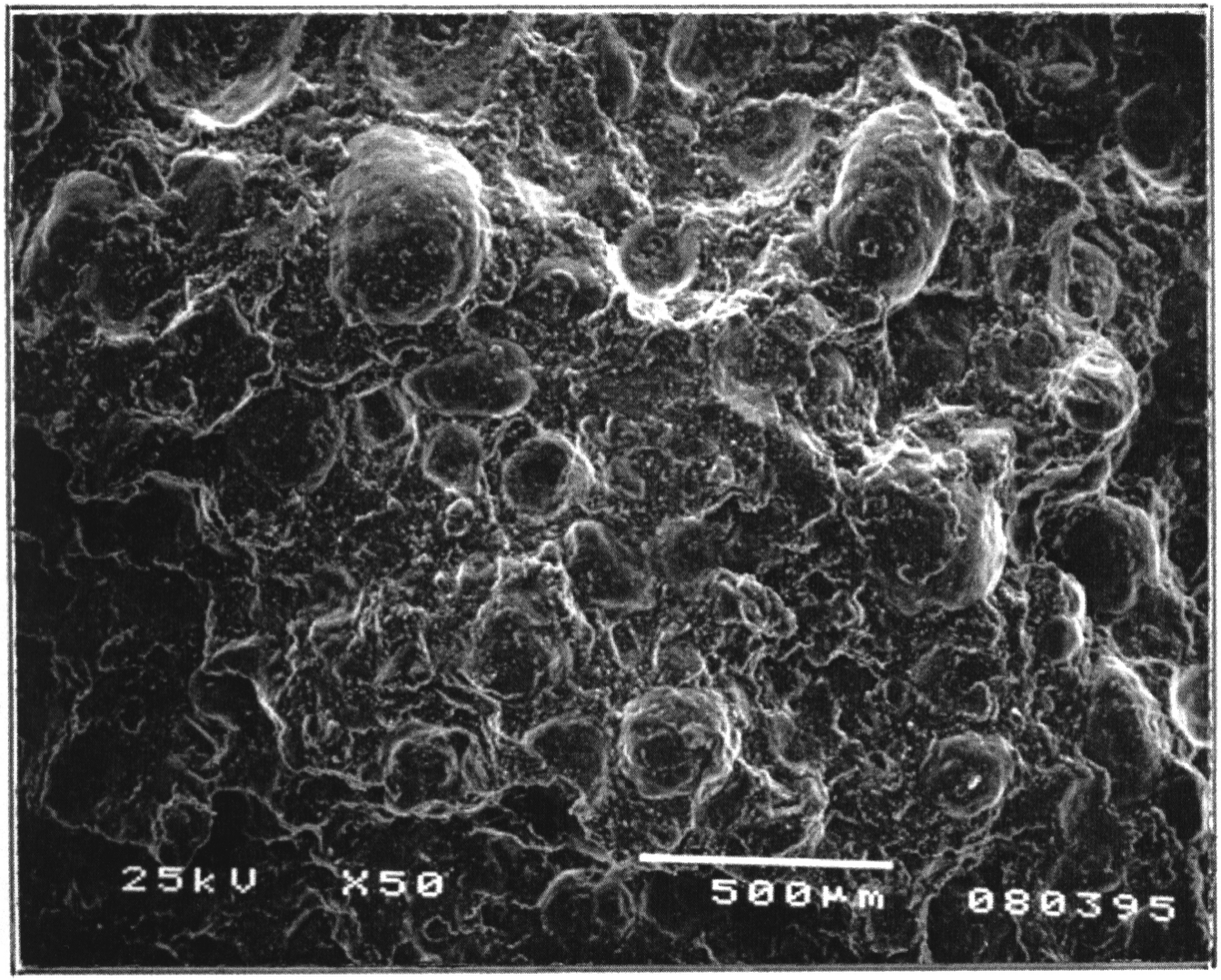
Objectives

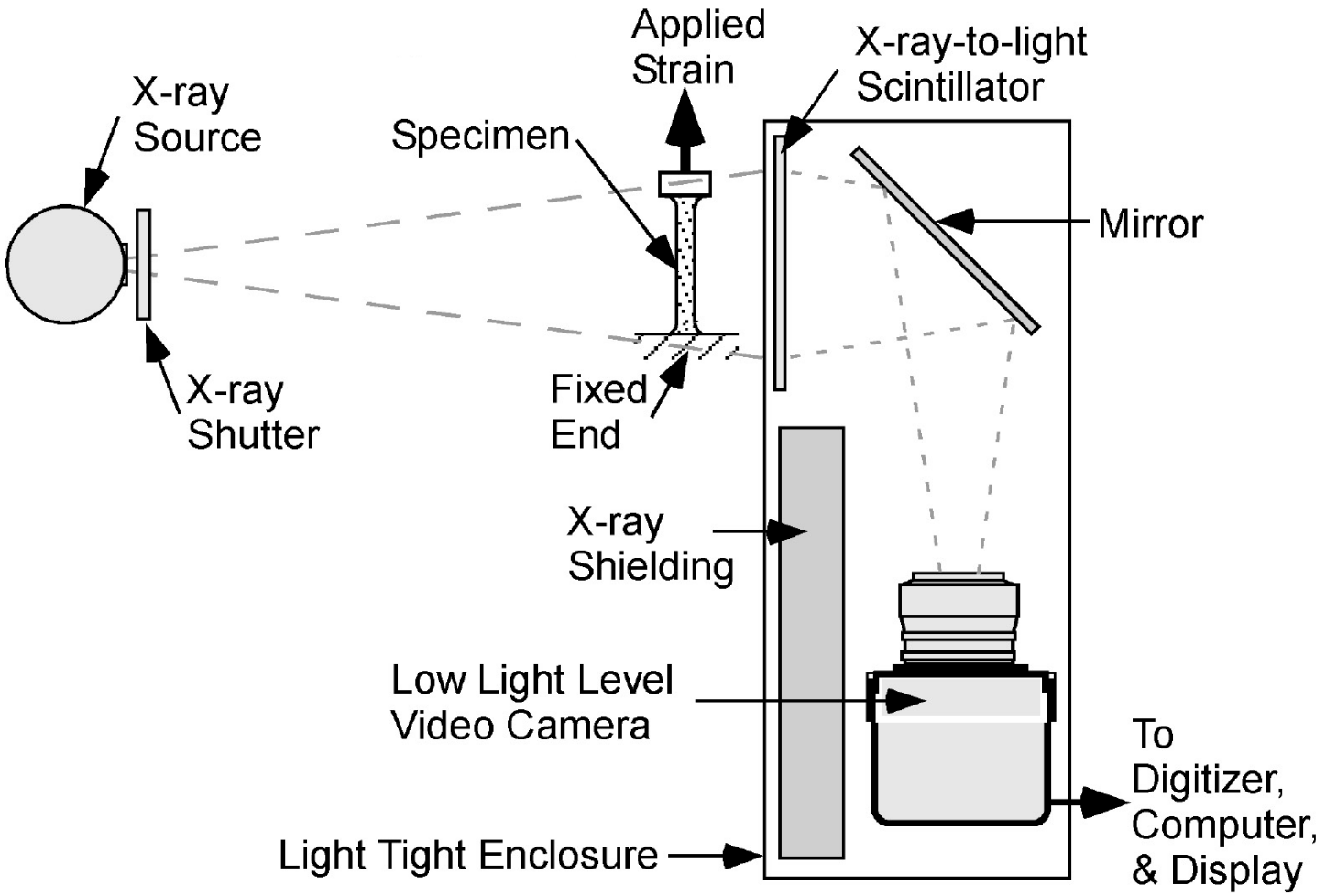
- **Investigate the Effect of Loading History on the Damage Characteristics near the Crack Tip.**

- **Loading Conditions: Constant Strain Rate and Cyclic Loading.**

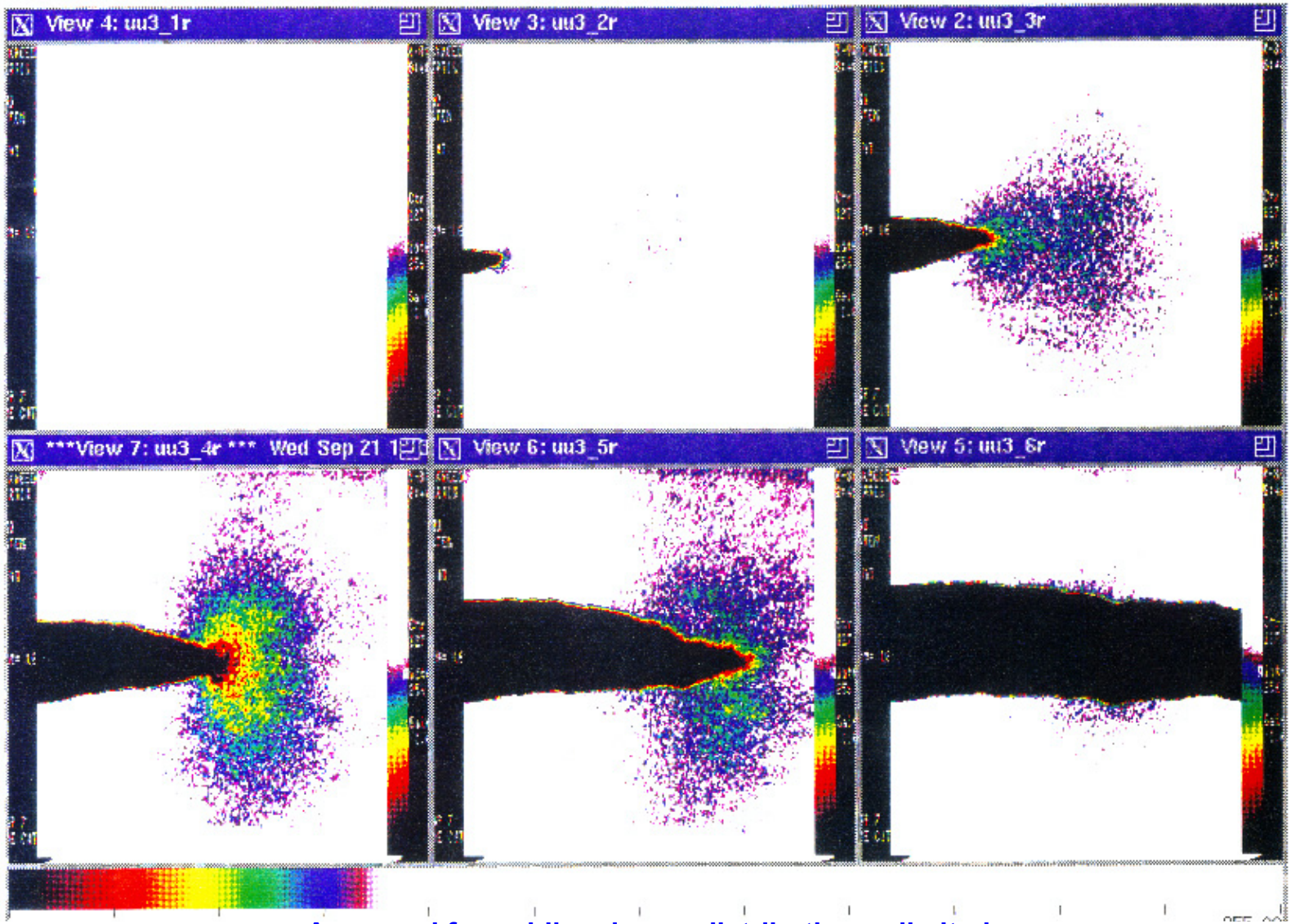
Particulate Composite Material



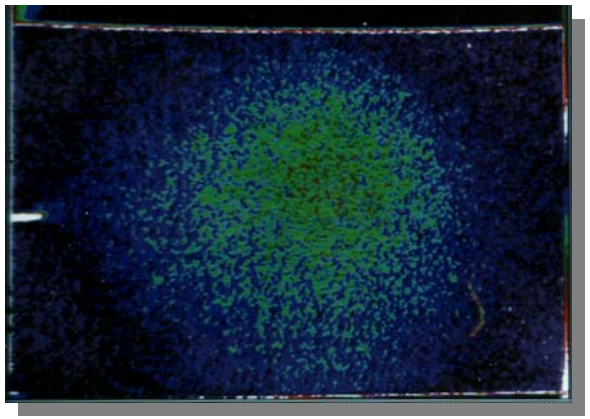
X-Ray Testing Setup



Monitoring Damage Characteristics During Crack Growth in a Specimen Without Pre-Damage



Monitoring Damage Characteristics During Crack Growth in a Specimen With Pre-Damage



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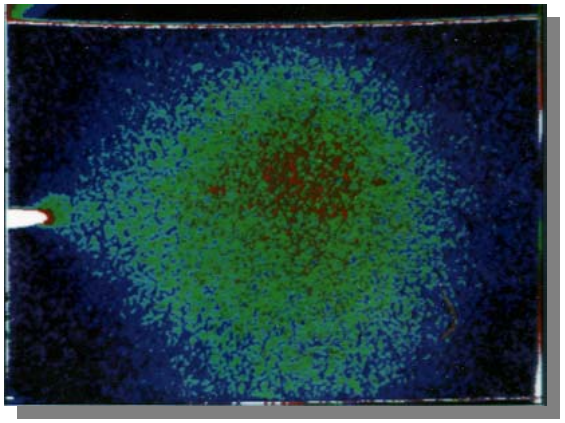

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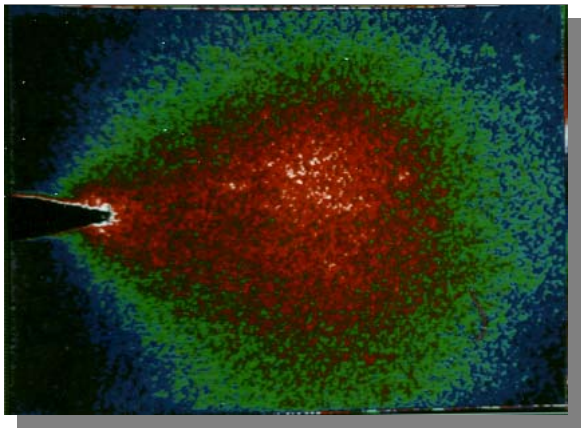

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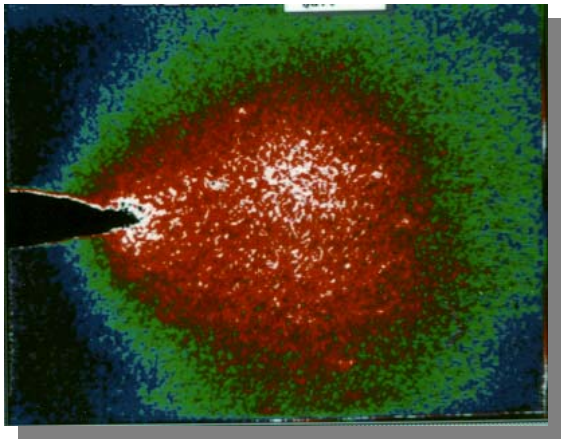

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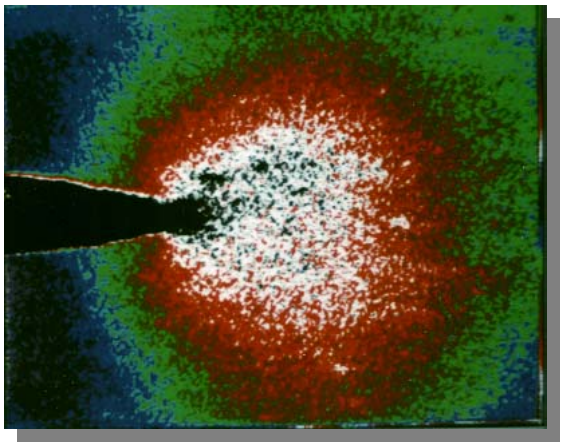

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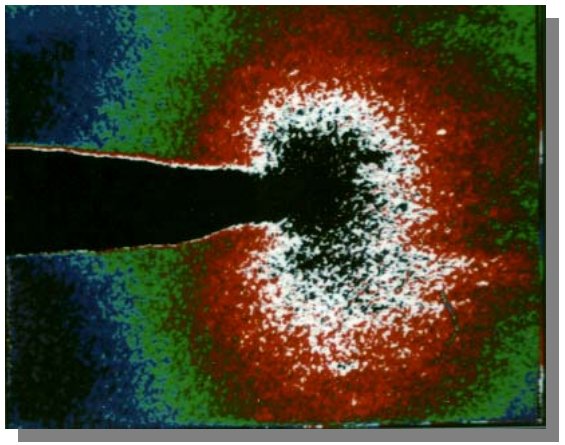


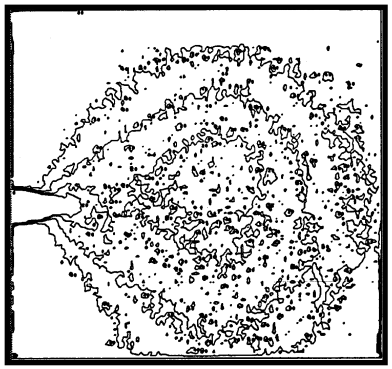
7 Seconds

Monitoring Damage Characteristics During Crack Growth in a Specimen With Pre-Damage

(A) Crack Growth Velocity Decreases When the Crack Enters the Damaged Region

(B) A Severely Damaged Region has no Significant Effect on Crack Growth Behavior

(C) The Preexisting Damage May Change the Criticality of the Crack



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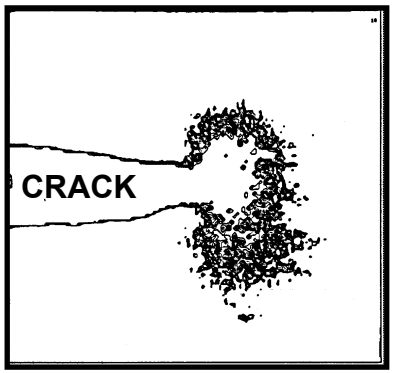

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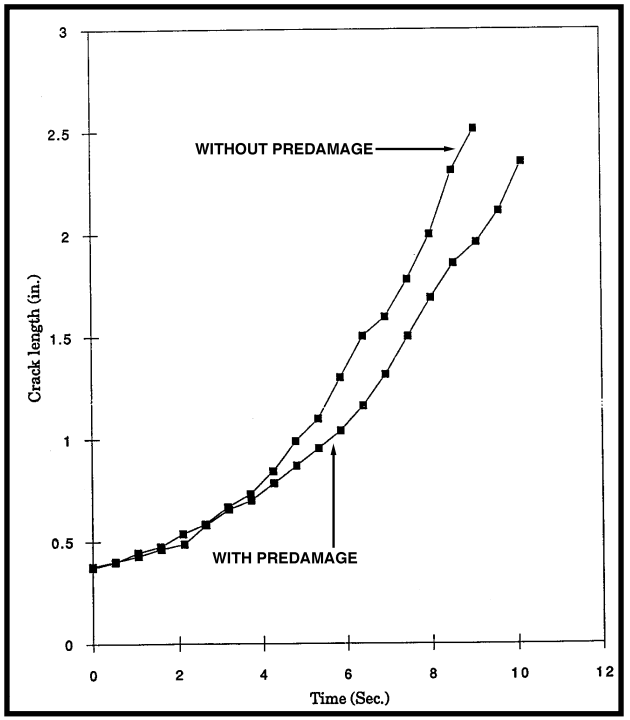
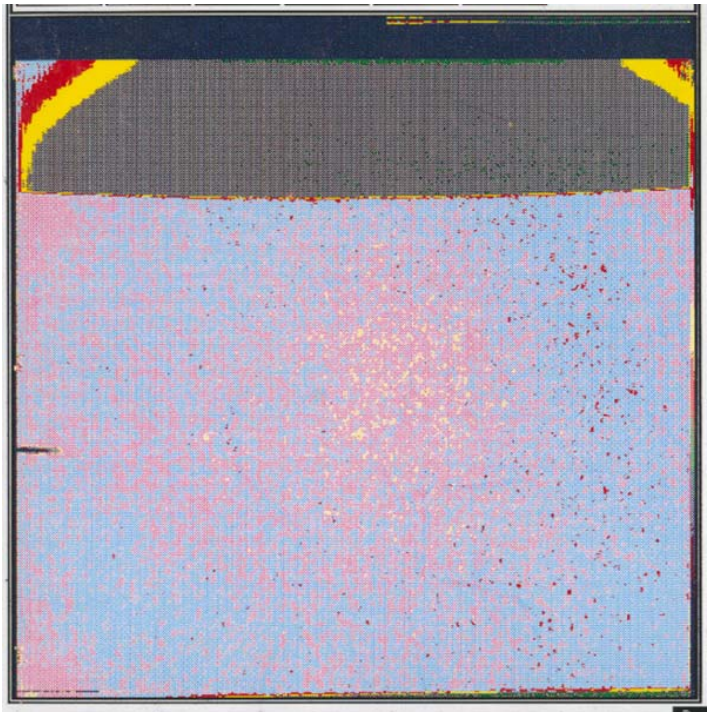
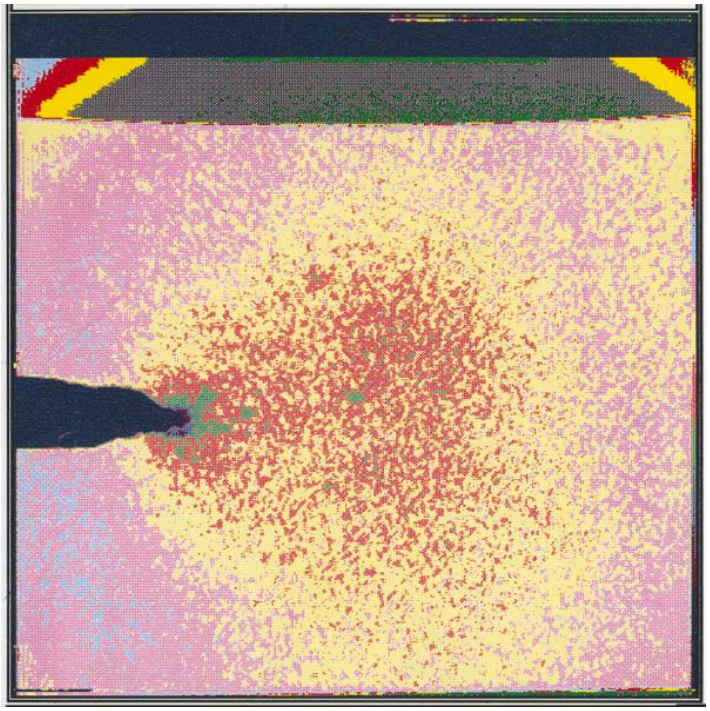


X-Ray Images

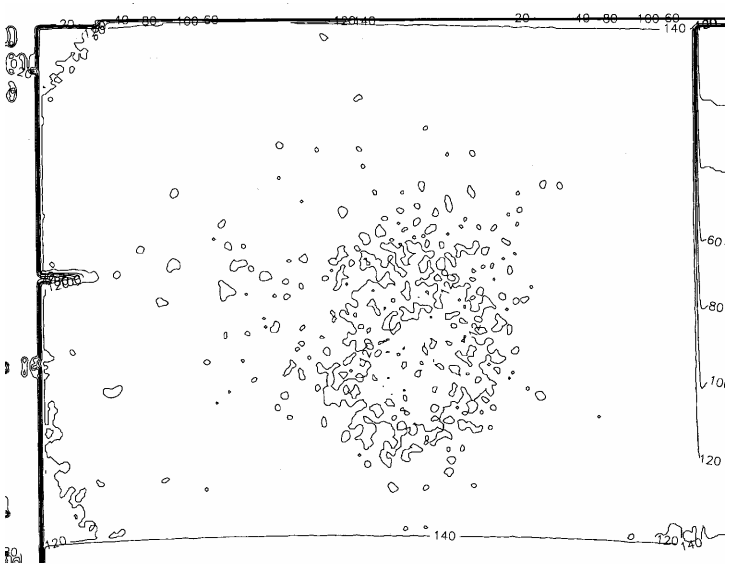


0% / applied strain

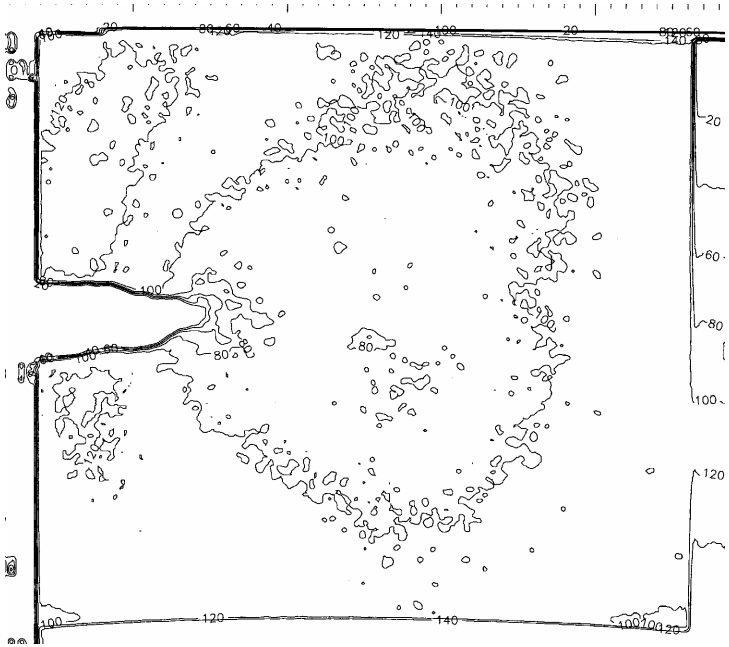


9.5% / applied strain

Iso-intensity Contour Plots of X-Ray Images

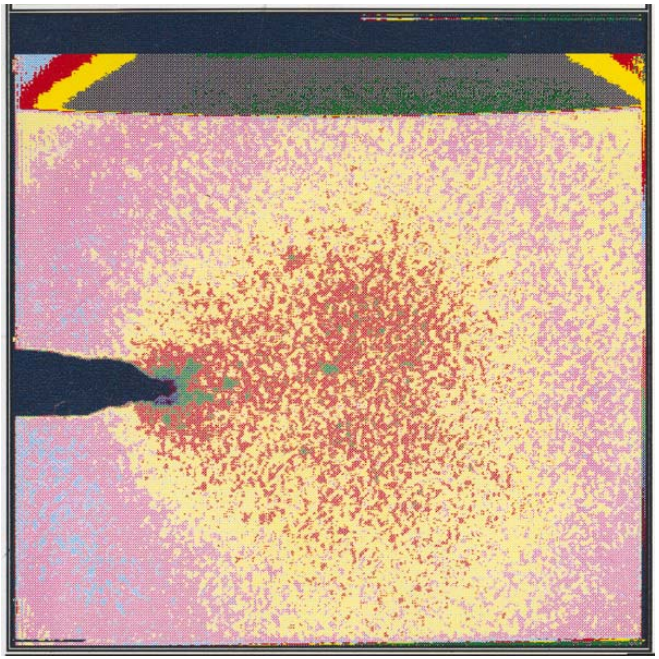


0% / applied strain



9.5% / applied strain

X-Ray Images (9.5% Applied Strain)



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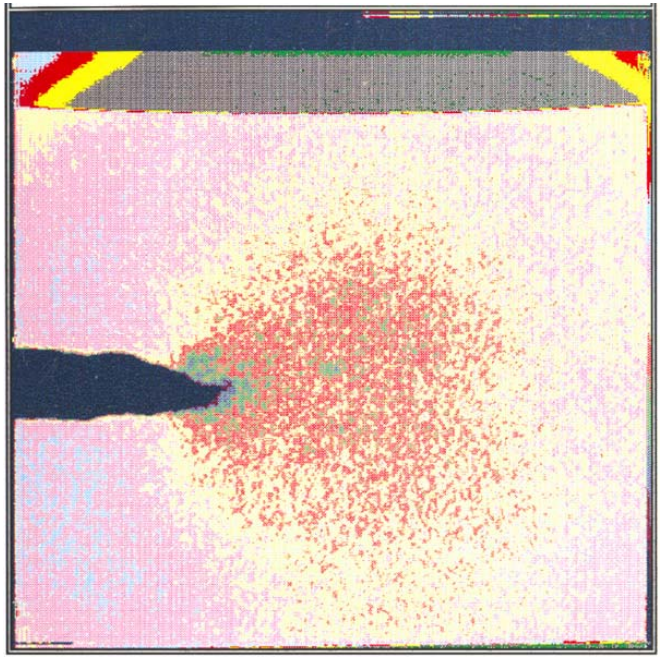

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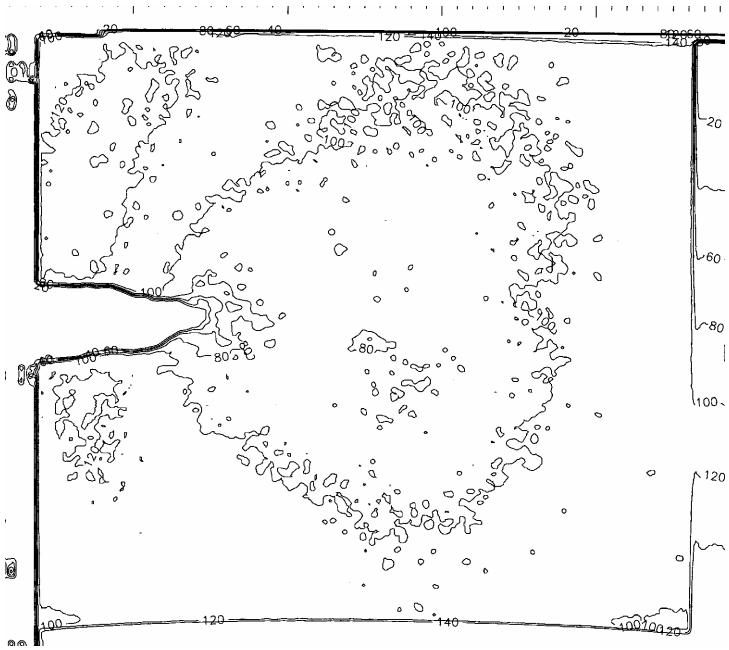
2 min. 32 sec. < 0% applied strain < 8 min. 21 sec

Iso-Intensity Contour Plots of X-Ray Images (9.5% applied strain)



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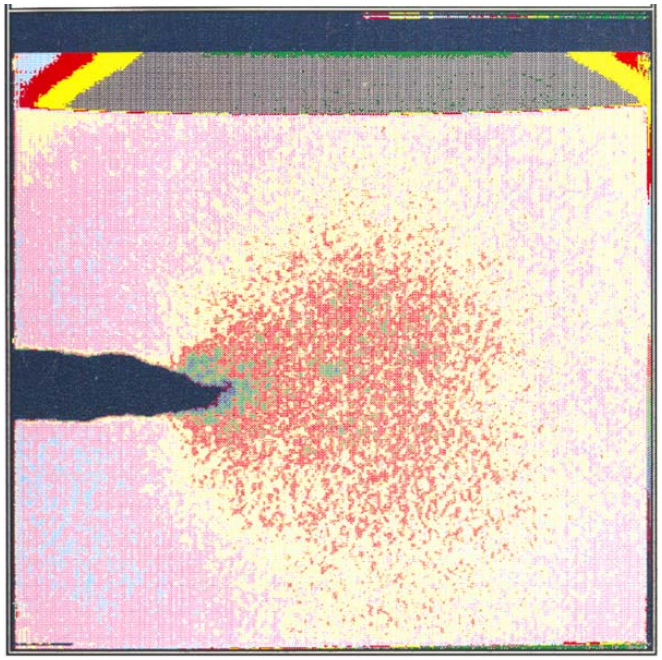
Time = 8 min. 21 sec.

2 min. 32 sec. < 0% applied strain < 8 min. 21 sec

X-Ray Images (9.5% Applied Strain)



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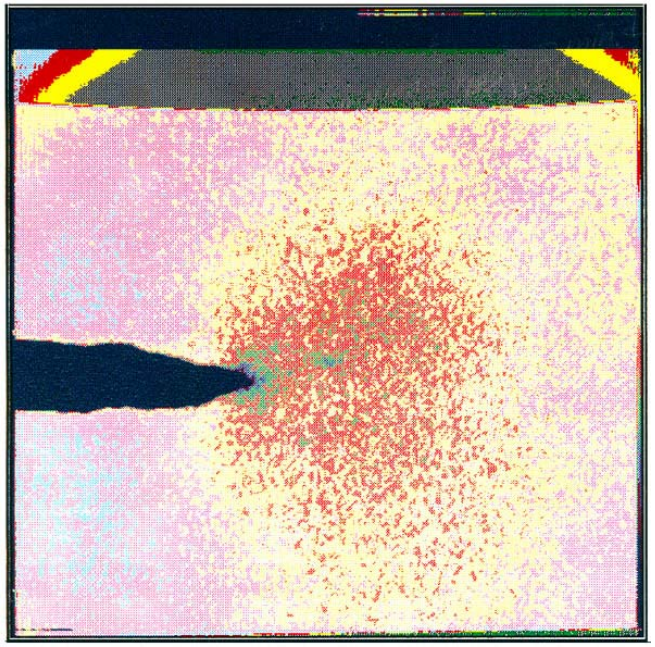
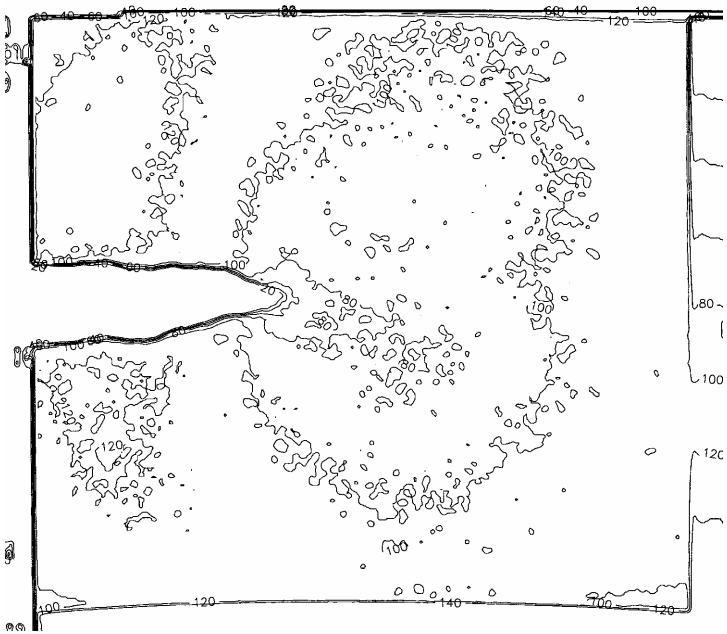


Time = 11 min. 5 sec.

8 min. 21 sec. ≤ 9.5% applied strain ≤ 11min. 5 sec

Iso-intensity Contour Plots of X-Ray Images

Time = 8 min. 21 sec.



Time = 11 min. 5 sec.

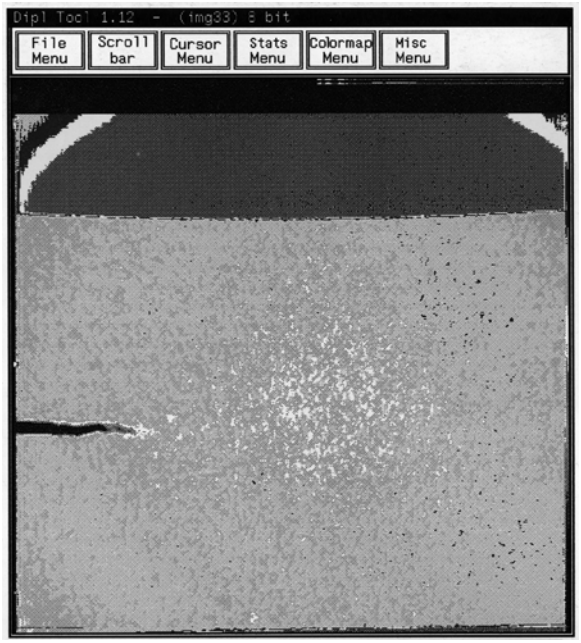
8 min. 21 sec. ≤ 9.5% applied strain ≤ 11min. 5 sec

Conclusions

1. The damage zone size and the damage intensity in the damage zone are highly dependent on the loading history.
2. Under the constant strain condition the crack propagates.
3. As the applied strain is increased, the damage gradient is decreased and the size of the highly damaged region is increased.
4. The x-ray technique is a promising technique to monitor damage evolution during crack propagation.

X-Ray Images (second loading cycle)

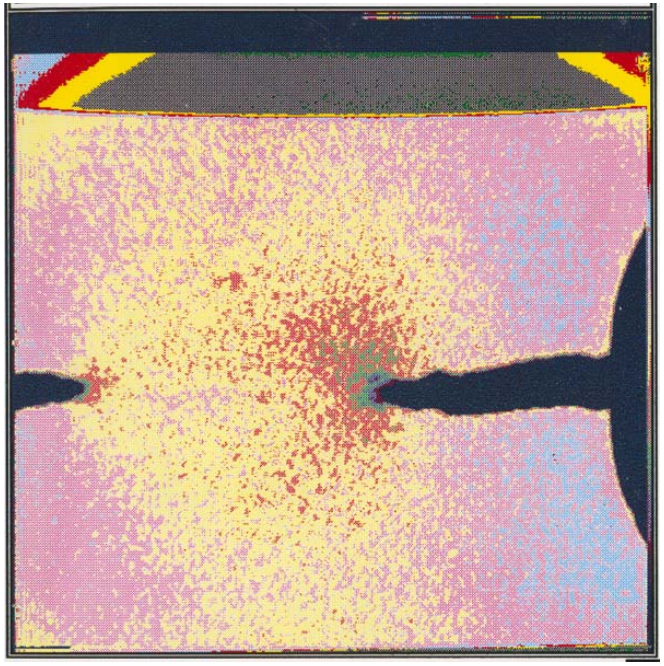
REPLACE IMAGES W/COLOR



0% / applied strain

4.55% / applied strain

X-Ray Images (constant strain rate)



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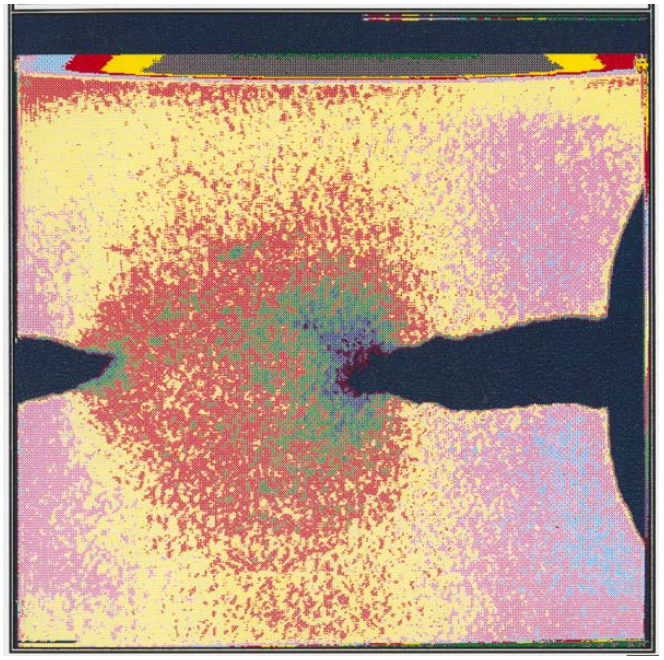
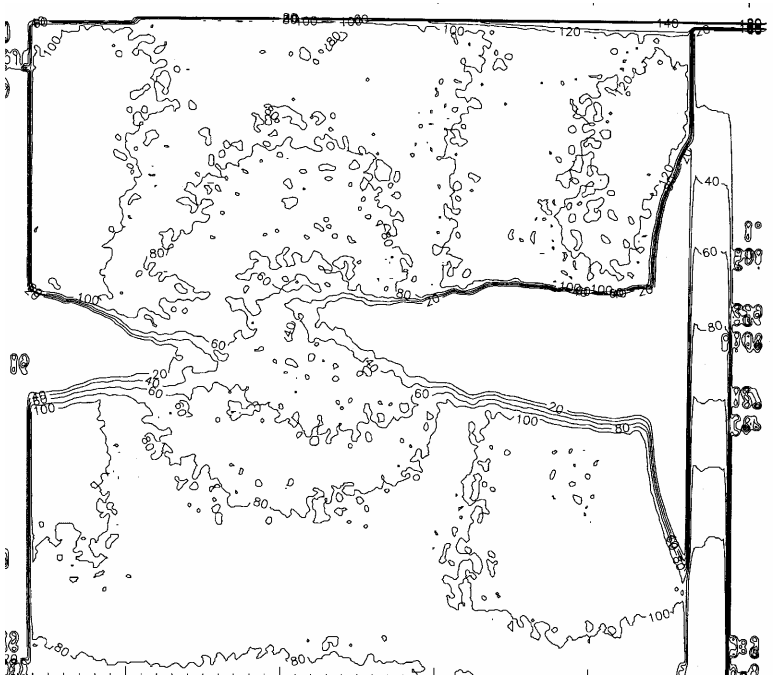


Time - 22 min. 10 sec

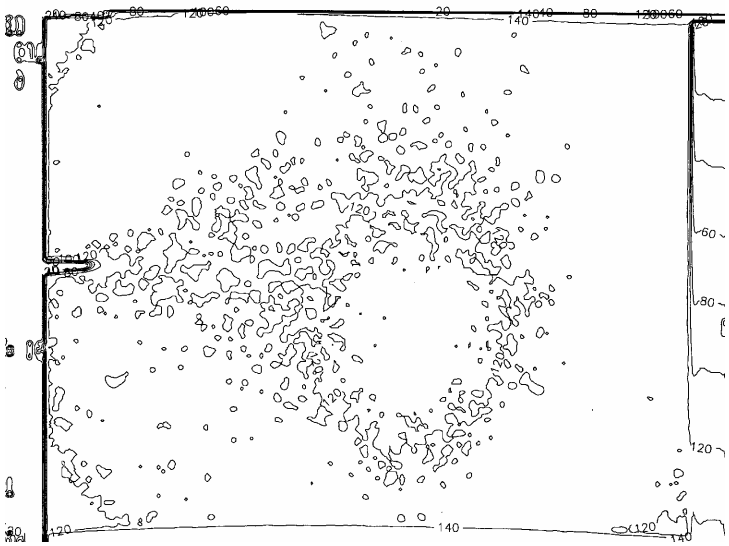
Iso-Intensity Contour Plots of X-Ray Images (constant strain rate)

Time - 22 min. 8 sec

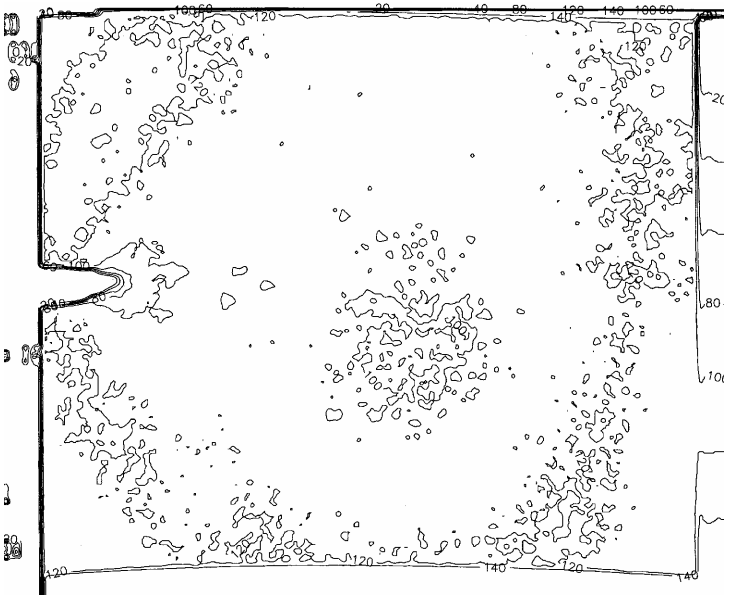


Time - 22 min. 10 sec

Iso-Intensity Contour Plots of X-Ray Images (second loading cycle)



0% / applied strain



4.55% / applied strain