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



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Standard Form 298 (Rev. 8-98) Prescribed by ANSI Std Z39-18







- Investigate the Effect of Loading History on the Damage Characteristics near the Crack Tip.
- Loading Conditions: Constant Strain Rate and Cyclic Loading.







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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





1 Second

4 Seconds



2 Seconds



3 Seconds

7 Seconds



5 Seconds Approved for public release; distribution unlimited.



- (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











0% / applied strain



9.5% / applied strain



Iso-intensity Contour Plots of X-Ray Images





0% / applied strain



9.5% / applied strain





Time = 2 min. 32 sec.



Time = 8 min. 21 sec.

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

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







Time = 8 min. 21 sec.

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





Time = 8 min. 21 sec.



Time = 11 min. 5 sec.

8 min. 21 sec. \leq 9.5% applied strain \leq 11min. 5 sec



Iso-intensity Contour Plots of X-Ray Images



120





Time = 11 min. 5 sec.

8 min. 21 sec. \leq 9.5% applied strain \leq 11min. 5 sec





- 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





Time - 22 min. 8 sec



Time - 22 min. 10 sec





Time - 22 min. 8 sec

Time - 22 min. 10 sec





0% / applied strain

4.55% / applied strain

16