Experiments for Characterizing the Fatigue Behavior of Elastomers

1. Basic Hyperelastic Properties

Purpose: to determine the basic properties for the development of a hyperelastic material model.

1.1. Typical Testing Conditions

1.1.1. Specimen: simple tension, planar tension (pure shear) and equal biaxial

1.1.2. Peak strain levels: 0.10, 0.20, 0.30, 0.40, 0.5 (for example)

1.1.3. Rate: 0.01 s^{-1}

1.2. Output

1.2.1. Raw Data File: Engineering Strain, Engineering Stress, Segment Number, Time

2. Volumetric Compression

Purpose: to determine the confined (bulk) stiffness of the elastomer to additionally define the hyperelastic material model.

2.1. Typical Testing Conditions

2.1.1. Specimen: Disk cut from sheet

2.2. Output

2.2.1. Raw Data File: Hydrostatic Strain, Hydrostatic Pressure, Segment Number, Time

2.2.2. Summary File: Bulk Modulus

3. Elastic, Work and Hysteretic Behavior

Purpose: to determine the relations between strain, stress, stored and dissipated energy. These relations provide the basis for FE Analyses to determine the history of loading, for estimating crack driving forces, and for estimating self-heating effects.

3.1. Typical Testing Conditions

3.1.1. Specimen: planar tension (pure shear)

3.1.2. Preconditioning: 10 cycles at 1.1x upcoming strain level

3.1.3. Peak strain levels: 0.05, 0.10, 0.15, 0.20, 0.25, 0.30, 0.35, 0.40, 0.45, 0.50 (for example)

3.1.4. Frequency: 10 Hz (for example)

3.1.5. Measurement duration: 3000 cycles or steady state temperature, whichever occurs first

3.2. Output

3.2.1. Raw Data File: Engineering Strain, Engineering Stress, Cycles at current strain level, Time (s), Surface Temperature

3.2.2. Summary File: Cycles at current strain level, Maximum Strain, Minimum Strain, Maximum Stress (MPa), Minimum Stress (MPa), Loading Energy (N-mm), Unloading Energy (N-mm), Hysteretic Energy (N-mm), Surface Temperature

4. Tear Strength

Purpose: to determine the ultimate capacity of the material to support a static load. The strength provides an upper bound useful in planning fatigue experiments. The critical tearing energy may be determined from this experiment.

4.1. Typical Testing Conditions

4.1.1. Specimen: planar tension (pure shear)

4.1.2. Strain rates: 0.01 s^{-1}

4.2. Output

4.2.1. Raw Data File: Engineering Strain, Engineering Stress, Segment Number, Time

4.2.2. Critical Tearing Energy

5. Fatigue Crack Growth Under Fully Relaxing Conditions

Purpose: to determine the rate of crack growth as a function of crack driving force, under conditions where the load is fully removed during each cycle.

5.1. Typical Testing Conditions

5.1.1. Specimen: planar tension (pure shear)

5.1.2. Frequency: 10 Hz (for example)

5.1.3. Test duration: 20 hours

5.2. Output

5.2.1. Summary File: Peak Strain, Peak stress, specific work during loading, specific work recovered on unloading, hysteresis, energy release rate, crack growth

6. Fatigue Crack Growth Under Non-Relaxing Conditions

Purpose: to determine the effect of nonrelaxing cycles on the rate of crack growth. When these results are combined with results from fully relaxing conditions, it becomes possible to estimate fatigue performance over a wide range of conditions.

6.1. Typical Testing Conditions

6.1.1. Specimen: planar tension (pure shear)

6.1.2. Frequency: 10 Hz (for example)

6.1.3. Test duration: 20 hours

6.2. Output

6.2.1. Summary File: Peak Strain, Peak stress, specific work during loading, specific work recovered on unloading, hysteresis, energy release rate, crack growth

7. Creep Crack Growth

Purpose: to determine the rate of crack growth under a near constant strain condition. The specimen is subject to a very slowly increasing strain.

7.1. Typical Testing Conditions

- 7.1.1. Specimen: planar tension (pure shear)
- 7.1.2. Ramp: from 0.03 to 0.50
- 7.1.3. Test duration: 20 hours

7.2. Output

- 7.2.1. Summary File: Time, Strain, Stress, crack width

8. Flaw Size and Crack Nucleation

Purpose: to determine the fatigue crack nucleation life at a benchmark operating condition, and the associated naturally occurring flaw size. Once the flaw size has been determined, crack growth rate measurement results can be used to efficiently estimate fatigue crack nucleation life over a wide range of conditions.

8.1. Typical Test Conditions

- 8.1.1. Specimen: simple tension
- 8.1.2. Peak Strain: 100%, 200% strain (on gauge section)
- 8.1.3. Min Strain: 0% (based on original gauge length)
- 8.1.4. Frequency: 10 Hz, cycle until break

8.2. Output

- 8.2.1. Raw Data File: cycles to failure for each experiment.

9. Cutting Resistance

Purpose: to determine the resistance of rubber to cutting under pre-strain.

9.1. Typical Testing Conditions

- 9.1.1. Specimen: planar tension (pure shear)
- 9.1.2. Pre-strain Levels: 5%, 10%, 15% (for example)

9.2. Output

- 9.2.1. Summary File: Strain, Cutting Resistance Force

10. Tensile Test to Failure

Purpose: determine the rubber failure in uniaxial tension

10.1. Typical Testing Conditions

- 10.1.1. Specimen: simple tension (ASTM D412 Die D)

10.2. Output

- 10.2.1. Summary File: Strain, Stress, Time

General Pricing for Characterizing the Fatigue Behavior of Elastomers

Prices are shown in US Dollars	Lab Temp (23°C)	23°C to 150°C	-40°C to 23°C	-40°C to 200°C
1. Basic Hyperelastic Properties *3 tension tests, 3 pure shear tests, 3 equal biaxial tests, all at 0.01/s*	1450	2151	2151	2151
2. Volumetric Compression *(3 tests)*	395	565	565	565
3. Elastic, Work and Hysteretic Behavior *(3 tests)*	2125	3187	3187	3187
4. Tear Strength, Critical Tearing Energy *(3 tests)*	450	675	675	675
5. Fatigue Crack Growth Under Fully Relaxing Conditions *3 tests, each less than 20-hour duration*	1510	1920	2540	—
6. Fatigue Crack Growth Under Non-Relaxing Conditions *3 tests, each less than 20-hour duration*	1510	1920	2540	—
7. Creep Crack Growth *3 tests, each less than 20-hour duration*	1510	1920	2540	—
8. Flaw Size and Crack Nucleation *6 tests, 3 at each peak strain level*	1200	1800	1800	—
9. Cutting Resistance *3 tests, each less than 20-hour duration*	1575	2365	2365	—
10. Uniaxial Tensile Test to Failure *(3 tests)*	265	396	396	396

November 2026. Pricing subject to change.

Notes:
a. These are typical durability and crack growth tests. Feel free to request a proposal for other interests or specifications.
b. The data is delivered via e-mail in an ASCII format.
c. Customer data and materials will be retained for 1 year after initial data delivery.

Purchase Order, VISA, MasterCard, AMEX, and Discover Card are accepted methods of payment.
Terms: NET 30 Days after Delivery of Data.