Experiments for Characterizing the Fatigue Behavior of an Elastomer

1. Basic Hyperelastic Properties

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

Typical Testing Conditions:
Specimen: simple tension, planar tension (pure shear) and equal biaxial
Peak strain levels: 0.10, 0.20, 0.30, 0.40, 0.5 (for example)
Rate: 0.01 s-1

Output:
Raw Data File: engineering strain, engineering stress, segment, time

2. Volumetric Compression

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

Typical Testing Conditions:
Specimen: Disk cut from sheet

Output:
Raw Data File: hydrostatic strain, hydrostatic pressure, segment, time
Summary File: bulk modulus

3. Elastic, Work and Hysteretic Behavior

Purpose: 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.

Typical Testing Conditions:
Specimen: planar tension (pure shear)
Preconditioning: 10 cycles at 1.1 x upcoming strain level
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)
Frequency: 10 Hz (for example)
Measurement duration: 3000 cycles or steady state temperature, whichever occurs first

Output:
Raw Data File: time, strain, stress, cycle number, surface temperature
Summary File: test condition #, peak strain, peak stress, specific work during loading, specific work recovered on unloading, hysteresis, surface temperature

4. Tear Strength

Purpose: determine the ultimate capacity of the material to support a static load. The strength provides an upper bound useful in planning fatigue experiments.

Typical Testing Conditions:
Specimen: trousers tear
Strain rates: 0.1% / sec, 1% / sec, 10% / sec (for example)

Output:
Raw Data File: time, displacement, force, strain in trouser leg, stress in trouser leg

5. Crack Growth Under Fully Relaxing Conditions

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

Typical Testing Conditions:
Specimen: planar tension (pure shear)
Preconditioning: 10 cycles at 1.1 x upcoming strain level
Peak strain levels: 0.20, 0.22, 0.24, 0.27, 0.30, 0.33, 0.36, 0.40 (for example)
Frequency: 10 Hz (for example)
Max cycles to apply per condition: 36000 cycles (1 hour)

Output:
Summary File: test condition #, peak strain, peak stress, specific work during loading, specific work recovered on unloading, hysteresis, applied cycles, energy release rate, crack growth, crack growth rate

6. Crack Growth Under Non-Relaxing Conditions

Purpose: 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.

Typical Testing Conditions:
Specimen: planar tension (pure shear)
Preconditioning: 10 cycles at 1.1 x upcoming strain level
Peak strain levels: 0.30, 0.40 (for example)
Minimum strain levels: (Peak Strain Level) x [0.0, 0.1, 0.2, 0.3] (for example)
Frequency: 10 Hz (for example)
Max cycles to apply per condition: 36000 cycles (1 hour)

Output:
Summary File: test condition #, peak strain, peak stress, specific work during loading, specific work recovered on unloading, hysteresis, applied cycles, energy release rate, crack growth, crack growth rate

7. Flaw Size and Crack Nucleation

Purpose: 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 (ie S-N curves and Haigh diagram can be computed).

Typical Test Conditions:
Specimen: simple tension
Peak Strain: 100%, 200% strain (on gauge section)
Min Strain: 0% (based on original gauge length)
Frequency: 10 Hz, cycle until break
Measurement interval for recording stress-strain data: cycle # 1, 2, 4, 8, 16…

Output:
Raw Data File: cycle #, min strain, max strain, min stress, max stress, max specific work on loading, and on unloading

General Pricing for Characterizing the Fatigue Behavior of an Elastomer

Prices are shown in US Dollars	Lab Temp. (23C)	-40C to 150C
1. Basic Hyperelastic Properties *(3 tension tests, 3 pure shear tests, 3 equal biaxial tests, all at 0.01 s-1)*	1155	1710
2. Volumetric Compression *(3 tests)*	250	375
***3.* Elastic, Work and Hysteretic Behavior** *(3 tests)*	1700	2550
4. Tear Strength *(9 tests, 3 at each of 3 strain rates)*	945	1350
5. Crack Growth Under Fully Relaxing Conditions *(3 tests, each less than 24 hour duration)*	1015	1015
6. Crack Growth Under Non-Relaxing Conditions *(3 tests, each less than 24 hour duration)*	1015	1015
7. Flaw Size and Crack Nucleation *(6 tests, 3 at each of 2 max strain levels)*	1200	1800

May 2009. 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

Axel Products, Inc. • www.axelproducts.com
2255 S. Industrial Hwy. • Ann Arbor • Michigan • 48104-8106 • USA
P: (+1) 734-994-8308 • F: (+1) 734-994-8309 • E: info@axelproducts.com