

# FATIGUE PROPERTY MAPPING



KNOW YOUR MATERIAL

# MATERIAL CHARACTERIZATION



Endurica's Fatigue Property Mapping™ service provides a comprehensive inventory of the fatigue capabilities of your material.

Get Durability Right® in your development and analysis projects with our uniquely efficient, reliable, and physics-based testing protocols.

## BENEFITS

- Material parameters ready to use with durability simulation codes, including Endurica CL™, Endurica DT™, Endurica EIE™, and fe-safe/Rubber™
- Full support for both nucleation ( $\epsilon$ -N) or ( $\sigma$ -N) and crack propagation (da/dN) analysis methods.
- Accurate and timely results via uniquely reliable and productive test strategies.
- Reduced risk and cost of development iterations when you take your material's fatigue capabilities into account.
- Leverage your material's full potential by properly aligning its capabilities with the application's demands.

<h3>Hyperelastic Module</h3> <p>Simple, planar, and equibiaxial tension, Mullins effect</p>		FPM <b>H</b>
<h3>Core Fatigue Module</h3> <p>Fully relaxing behavior from both nucleation and fracture mechanical perspectives</p>		FPM <b>C</b>
<h4>Intrinsic Strength Module</h4> <p>Quantify endurance limits</p>	FPM <b>IS</b>	<h4>Thermal Modules</h4> <p>Quantify dissipative properties, thermal properties</p>
<h4>Non Relaxing Module</h4> <p>Quantify strain crystallization, minimum and mean strain effects</p>	FPM <b>NR</b>	
<h4>Ageing Module</h4> <p>Quantify endurance limit, estimate ageing rate of stiffness, intrinsic and ultimate strength</p>	FPM <b>AM</b> MASTER CURVE	<p>FPM <b>TB</b> BASIC</p> <p>FPM <b>TA</b> ADVANCED</p> <p>FPM <b>TM</b> WILLIAMS-LANDEL-FERRY</p>
<h4>Creep Module</h4> <p>Creep crack growth rate effects</p>	FPM <b>CR</b>	<h4>Cyclic Softening Module</h4> <p>Quantify cyclic softening effects</p>
		<h4>Reliability Module</h4> <p>Weibull statistics for strength and crack precursor size populations</p>
		<h4>Ozone Module</h4> <p>Quantify ozone attack critical energy and rate</p>

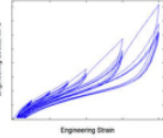


# GET DURABILITY RIGHT<sup>®</sup> WITH ENDURICA'S FATIGUE PROPERTY MAPPING

## Hyperelastic Module

Provides basic information needed for Finite Element Analysis and initial transient softening (Mullins effect)

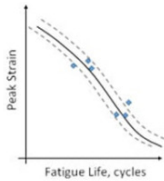
- Simple tension
- Planar tension
- Biaxial tension



## Core Fatigue Module

Pre-requisite for any fatigue analyses

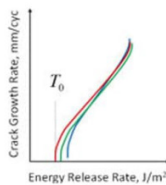
- Provides basic fatigue crack growth rate curve
- Strain-life curve
- Crack precursor size



## Intrinsic Strength Module

Required for safety factor / infinite life / fatigue limit analysis

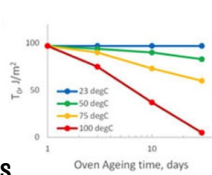
- Recommended for cases with fatigue life longer than  $10^6$  cycles



## Ageing Module

Recommended for cases with fatigue life longer than  $10^6$  cycles, and when ageing must be taken into account

- Quantify evolution of stiffness and crack growth parameters
- Quantify Arrhenius Ageing Law parameters



## Thermal Modules

Quantify dissipative / thermal properties, temperature dependence

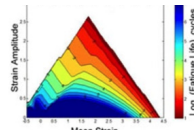
- Basic module for cases involving significant self-heating or thermal gradients
- Advanced module for improved accuracy in structural and heat transfer analyses
- Thermal Effects module (K/WLF) used to determine strain, temperature and frequency dependence of viscoelastic storage and loss modulus



## Non Relaxing Module

Recommended for cases where cyclic minimum loading is greater than zero and material may strain crystallize

- Test is run under range of nonrelaxing ( $R > 0$ ) conditions



## Ozone Module

Quantify ozone attack critical tearing energy and rate

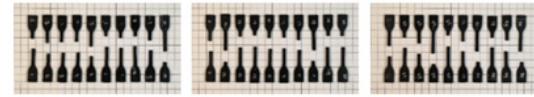
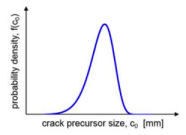
- Required when rubber is susceptible to ozone attack and operating in environment with ozone



## Reliability Module

Recommended when probability of failure needs to be estimated

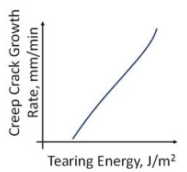
- Weibull analysis parameters relating frequency of occurrence to size of crack precursor



## Creep Module

Recommended for cases involving long periods under static load

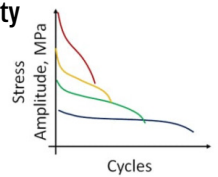
- Time-dependent crack growth is characterized here (rather than cycle-dependent crack growth)



## Cyclic Softening Module

Recommended for cases where stiffness loss limits durability

- Use with Endurica DT cosimulation feature
- Displacement control experiment records the evolution of the peak stress with cycles



## C-SUITE INSIGHTS

### RIGHT-SIZE YOUR TESTING

Use our modular framework to meet your program requirements, from rapid screening to deep characterization.

### LEVERAGE YOUR STRENGTH

Know your material's physics so you can leverage its full capabilities in your application.

### PLUG AND PLAY

Our testing modules deliver compatible results that plug right into our fatigue solvers.

### SCALE UP YOUR CAPACITY

Planning to implement these in your own lab? Use our testing service to keep product development moving while you scale up.

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Learn more



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