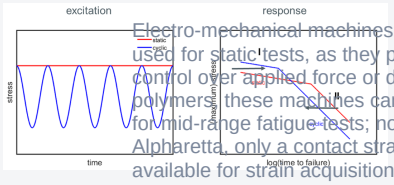
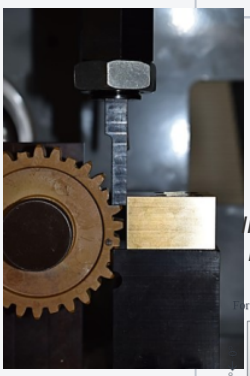
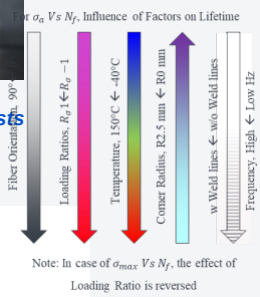
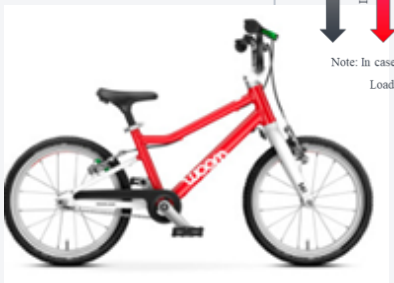
# Fatigue

| APPLICATIONS | | THEORY, KNOWLEDGE, & MODELS | | CAPABILITIES |
|---|---|---|---|---|
| ***Thermal shock (busbars)*** |  ***Thermal Shock on Demonstrator*** ***Grades prioritized for Thermal Shock characterization*** | Introduction to Fatigue (why does material respect SN ?)<br>Difference between Fatigue and Creep<br>CTD presentation - March'26<br>VE presentation (more detailed) - March'26<br>Definition and notations<br>*Physical Background* |  | Basics about Fatigue tests<br>List of Fatigue data available, SSP<br>Upload Fatigue data (systematically linked to material center)<br>• **Core Labs Capabilities**<br>Electro-mechanical machines are generally used for static tests, as they provide better control over applied force or displacement. For polymers, these machines can also be used for mid-range fatigue tests; note that at Alpharetta, only a contact strain gauge is available for strain acquisition.<br>The film folding tester at Bollate is designed to evaluate the lifespan of films, but it is limited to film materials only and can only test thicknesses between 250 and 350 microns. |
| ***Gears*** |  ***Single tooth Bending tests*** | *Influence of Various Factors on Lifetime*<br>  | Effect of Fiber orientation<br>Effect of Temperature<br>Effect of Humidity<br>Effect of Mean Stress / Loading Ratio<br>Effect of Frequency<br>Effect of Weld lines<br>Effect of Sharp Edge / Notch<br>Effect of Over molding<br>Effect of Recycled fibers<br>Effect of ageing<br>Effect of Harsh environments (Chemical, ...)<br>Creep-Fatigue interactions, Self-heating at high frequency<br>Multiaxiality, Triaxiality, Loading Shape<br>Numerical: Effect of Mesh size, Effect of Mesh type<br>Empirical law<br>Stress based approach<br>Energy based approach |
| ***Metal to plastic applications*** |  • *Bikes: Frames, Handle & Fork*<br>• *Coffee machine handles* | | | |
| ***Compressor*** | ***High Frequency Fatigue loadings*** | Life prediction methodologies | | |
| | ***Identified cases for the year 2025*** | | | |
| | | Fatigue modeling of fiber reinforced polymers | | |

| Region | Equipment | Load | | Tem |
|---|---|---|---|---|
| | | max | min | |
| Alpharetta | Instron-ElectroPuls E10000 | 10kN | | ambien |
| Bollate | Film folding endurance tester, MIT, more details | 22Kg | | a |
| Shanghai | Nil | - | | - |
| Tokyo | Nil | - | | - |

*Contacts: Alpharetta: Smith Colter; Bollate: Davide Sutton, Luigi Giraldi ; Shanghai: Li Hanson; Tokyo: Toshio Hatayama*

• **Corporate Capabilities**

Servo-hydraulic machines are well-suited for fatigue testing, with a dynamic testing range equipped with larger load cells. Strain measurements can be performed using **D**igital **I**mage **C**orrelation (DIC), or with contact / non-contact extensometers.

At the Brussels site, in-house developed demonstrator parts and testing setups enable us to conduct fatigue bending tests on L-shaped samples with various radii and on elongated coupons with or without ribs and weld lines.

| Region | Equipment | Load | | Tem |
|---|---|---|---|---|
| | | max | min | |
| *picture* | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Workflow | Life time prediction for cyclic loading | Brussels | 3x Servo-hydraulic machines (DIC, Extenso) | 10kN | -40 |
| | Life time prediction for thermal cyclic loading | | Composite testing | 100kN | -80 |
| Validation | | | | | |

*Contacts: Michel Houba, Dominique Delcourt*

- **ADL Capabilities**

Although tooth bending is not a classic fatigue test, this can be used to validate the FE models, with capacity to test higher frequencies.

*Tips: The current FE model for fiber filled polymers, can be applied only if the failure mode is slow crack growth controlled failure or brittle failure, which typically occurs at the root of the teeth in gear tooth bending.*

| Region | Equipment | Load | Tem |
|---|---|---|---|
| | | max | min |
| Bollate | Gear tooth bending | | a |

*Contacts: Matilde Scurria, Lorenzo Mancin*

- **Potential external partners**

Syensqo has engaged Leartiker to generate fatigue test data (including hysteresis measurements), to support the creation of Digimat fatigue cards across different temperatures. Other capabilities include sample molding, creep analysis, advanced...

| Laboratory | Equipment | Load | T |
|---|---|---|---|
| | | max | |
| Leartiker, Spain | Electro-mechanical<br>MTS Insight 100 (2D & 3D) | 100kN | |
| | Servo-hydraulic machine<br>MTS Bionix, +Torsion | 15kN | |
| | Metravib DMA +300, +2000 | 2kN | |

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