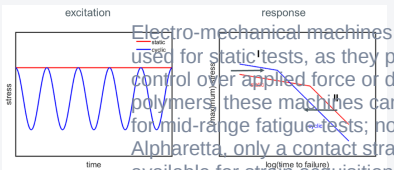
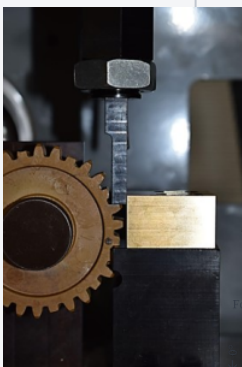
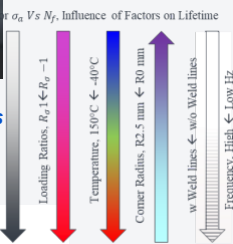


# Fatigue

| APPLICATIONS                      |                                                                                                                | THEORY, KNOWLEDGE, & MODELS                                                                                                                                                                                                      |                                                                                                                                          | CAPABILITIES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |           |           |      |     |  |  |     |     |
|-----------------------------------|----------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|-----------|-----------|------|-----|--|--|-----|-----|
| Thermal shock (busbars)           |                               | <p>Introduction to Fatigue (why does material respect SN ?)</p> <p>Difference between Fatigue and Creep</p> <p>CTD presentation - March'26</p> <p>VE presentation (more detailed) - March'26</p> <p>Definition and notations</p> |                                                                                                                                          | <p>Basics about Fatigue tests</p> <p>List of Fatigue data available, SSP</p> <p>Upload Fatigue data (systematically linked to material center)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |           |           |      |     |  |  |     |     |
|                                   | <p>Thermal Shock on Demonstrator</p> <p>Grades prioritized for Thermal Shock characterization</p>              | <p>Physical Background</p>                                                                                                                                                                                                       |                                                                                                                                          | <p>• Core Labs Capabilities</p> <p>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.</p>                                                                                                                                                   |        |           |           |      |     |  |  |     |     |
| Gears                             |                              | <p>Influence of Various Factors on Lifetime</p> <p>at <math>\sigma_a</math> Vs <math>N_f</math>, Influence of Factors on Lifetime</p>         |                                                                                                                                          | <p>Effect of Fiber orientation</p> <p>Effect of Temperature</p> <p>Effect of Humidity</p> <table><tr><th>Load</th><th>Tem</th></tr><tr><td>max</td><td>min</td></tr></table>                                                                                                                                                                                                                                                                                                                                                                                                        |        | Load      | Tem       | max  | min |  |  |     |     |
|                                   | Load                                                                                                           | Tem                                                                                                                                                                                                                              |                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |           |           |      |     |  |  |     |     |
| max                               | min                                                                                                            |                                                                                                                                                                                                                                  |                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |           |           |      |     |  |  |     |     |
| <p>Single tooth Bending tests</p> | <p>Note: In case of <math>\sigma_{max}</math> Vs <math>N_f</math>, the effect of Loading Ratio is reversed</p> |                                                                                                                                                                                                                                  | <p>Effect of Mean Stress / Equating Ratio</p> <table><tr><th>Region</th><th>Equipment</th></tr><tr><td>max</td><td>min</td></tr></table> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Region | Equipment | max       | min  |     |  |  |     |     |
| Region                            | Equipment                                                                                                      |                                                                                                                                                                                                                                  |                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |           |           |      |     |  |  |     |     |
| max                               | min                                                                                                            |                                                                                                                                                                                                                                  |                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |           |           |      |     |  |  |     |     |
| Metal to plastic applications     |                             | <ul style="list-style-type: none"><li>Bikes: Frames, Handle &amp; Fork</li><li>Coffee machine handles</li></ul>                                                                                                                  |                                                                                                                                          | <p>Effect of Frequency</p> <p>Effect of Weld lines</p> <p>Effect of Sharp Edge</p> <p>Effect of Over molding</p> <p>Effect of Recycled fibers</p> <p>Effect of ageing</p> <p>Effect of Harsh environments (Chemical, ...)</p>                                                                                                                                                                                                                                                                                                                                                       |        |           |           |      |     |  |  |     |     |
|                                   |                                                                                                                |                                                                                                                                                                                                                                  |                                                                                                                                          | <p>Contacts: Alpharetta: Smith Colter; Bollate: Davide Saxon; Luigi Giraldi; Shanghai: Li Hanson; Tokyo: Toshio Hatayama</p> <p>• Corporate Capabilities</p> <p>Creep-Fatigue interactions, Self-heating at high frequency</p> <p>Multiaxiality, Triaxiality, Loading Shape</p> <p>Numerical: Effect of Mesh size, Effect of Mesh type</p> <p>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 different approaches with or without ribs and weld lines.</p> |        |           |           |      |     |  |  |     |     |
| Compressor                        | <p>High Frequency Fatigue loadings</p> <p>Identified cases for the year 2025</p>                               | <p>Life prediction methodologies</p> <p>Fatigue modeling of fiber reinforced polymers</p>                                                                                                                                        |                                                                                                                                          | <p>Stress based approach</p> <p>Energy based approach</p> <table><tr><th>Region</th><th>Equipment</th><th>Load</th><th>Tem</th></tr><tr><td></td><td></td><td>max</td><td>min</td></tr></table>                                                                                                                                                                                                                                                                                                                                                                                     |        | Region    | Equipment | Load | Tem |  |  | max | min |
| Region                            | Equipment                                                                                                      | Load                                                                                                                                                                                                                             | Tem                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |           |           |      |     |  |  |     |     |
|                                   |                                                                                                                | max                                                                                                                                                                                                                              | min                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |           |           |      |     |  |  |     |     |

|            |                                                 |                                            |       |     |
|------------|-------------------------------------------------|--------------------------------------------|-------|-----|
| Workflow   | Life time prediction for cyclic loading         | 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 |      | ai  |

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 [Digi mat fatigue cards](#) across different temperatures. Other capabilities include [sample molding](#), [creep analysis](#), [advanced...](#)

| Laboratory       | Equipment                 | Load  | 1 |
|------------------|---------------------------|-------|---|
|                  |                           | max   |   |
| Leartiker, Spain | Electro-mechanical        | 100kN |   |
|                  | MTS Insight 100 (2D & 3D) |       |   |
|                  | Servo-hydraulic machine   | 15kN  |   |
|                  | MTS Bionix, +Torsion      |       |   |
|                  | Metravib DMA +300, +2000  | 2kN   |   |

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