

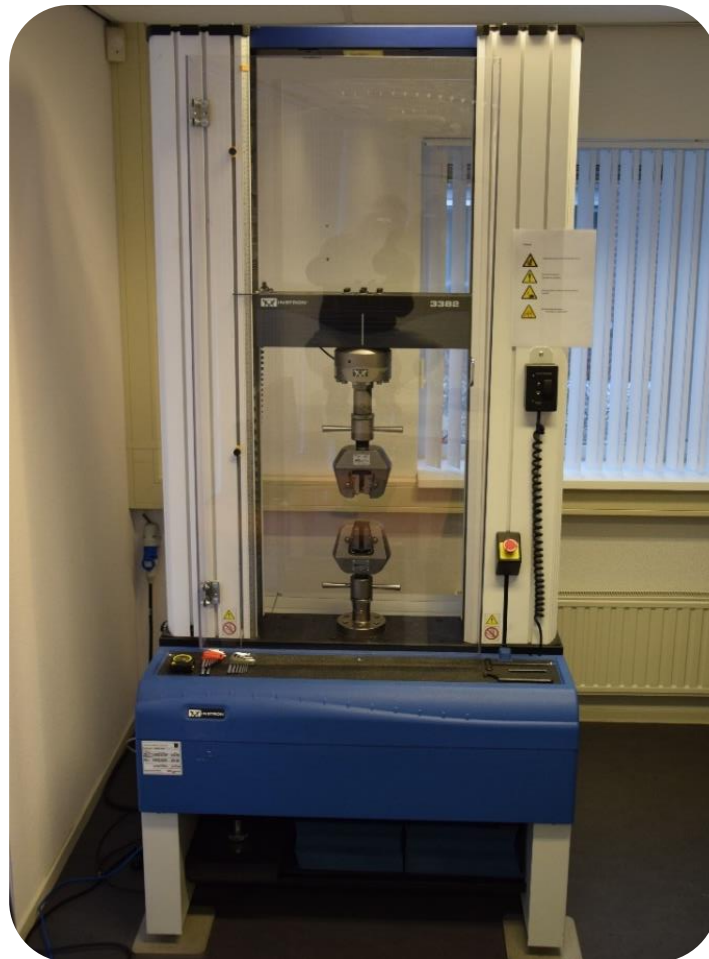
Solico LAB – Testing Capabilities

Solico has its own, fully equipped, test lab which is specialized in the testing of FRP composites. A wide variety of tests can be performed to determine the properties of FRP materials. Examples are mechanical tests such as tensile, compression and shear tests. Furthermore, detailed material compositions can be determined using a DSC and an incineration furnace. Non-destructive test capabilities include an ultrasonic thickness gauge.

The experienced composite engineers at Solico are able to perform, process, analyse and report your testing requirements efficiently and accurately and are able to assist and advise you in your testing needs.

This document provides an overview of the equipment and available testing methods.

Please inform if you are interested or about any methods and specialized tests not listed below to discuss the possibilities by sending an email to: composites@solico.nl



Instron 3382 universal testing machine

Mechanical testing

Instron 3382 Universal testing machine

Most mechanical tests can be performed using the *Instron 3382* universal test machine. This apparatus is equipped with a wide range of grips and gauges. It has a 100 kN capacity.

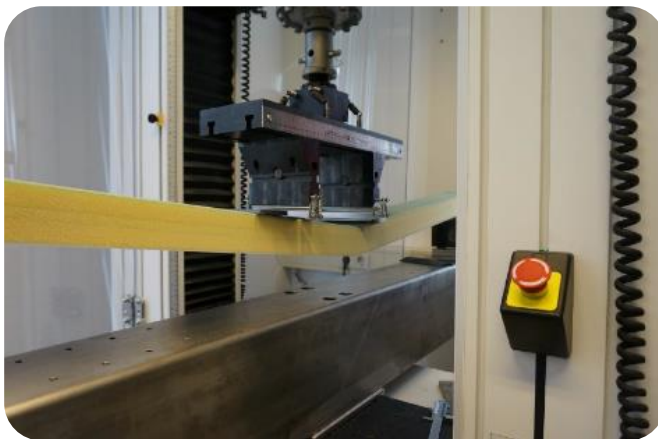
- Speed: 0.005 – 500 mm/min
- 100 kN calibrated load cell
- Strain measurement (clip-on extensometer and strain gauges)
- Wide range of fixtures:
 - Mechanical wedge action grips
 - Compression anvil Ø150 mm
 - 3&4-point flexural/interlaminar shear fixture
 - Combined loading compression test fixture
 - V-notched rail shear test fixture
 - V-notched beam (iosipescu shear) fixture
 - Sandwich flatwise plane shear fixture
 - Sandwich long beam 3&4-point flexure fixture



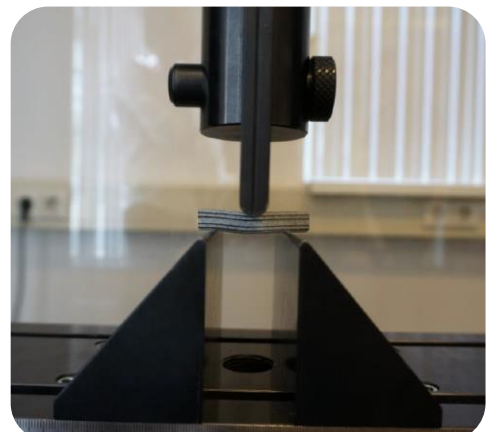
Extensometer on CFRP sample

Examples of applicable testing standards:

ISO 527	Determination of tensile properties
ISO 14126	Determination of compressive properties
ISO 14125	Determination of flexural properties
ASTM C 273	Shear properties of sandwich core materials
ISO 14130	Determination of apparent interlaminar shear strength by short beam method



Sandwich flexural testing



Interlaminar shear testing

Determination of material composition

For the determination of material compositions like fibre fractions, polymer characterization, layup determination, density and hardness a range of machines are available.

Ashing furnace - *Lenton AF 11/6B (1100 °C)*

For the determination of fibre fractions, weights and orientations a *Lenton AF 11/6B* ashing furnace is available. This furnace reaches temperatures up to 1100 °C to burn of resin from laminates in order to analyse the fibres.

Examples of applicable testing standards:

- ASTM D 2584 Ignition loss of reinforced plastics
- ASTM D 2734 Void content of reinforced plastics
- ASTM D 3171 Constituent content of composite materials



Lenton AF 11/6B



Example of layup determination: From composite laminate (left) to ply by ply analyses (right)

Analytical Balance - *Mettler Toledo AB54S*

A high resolution analytical balance for measuring the weight of a sample with an accuracy of 0.1 mg.

Density determination kit - *Mettler Toledo AB-S 33360*

Allows for accurate determination of sample density using the Archimedes principle.

Differential Scanning Calorimetry - *Mettler Toledo DSC12E*

For the determination and characterization of polymers a digital scanning calorimeter is available. Examples of material properties that can be investigated are:

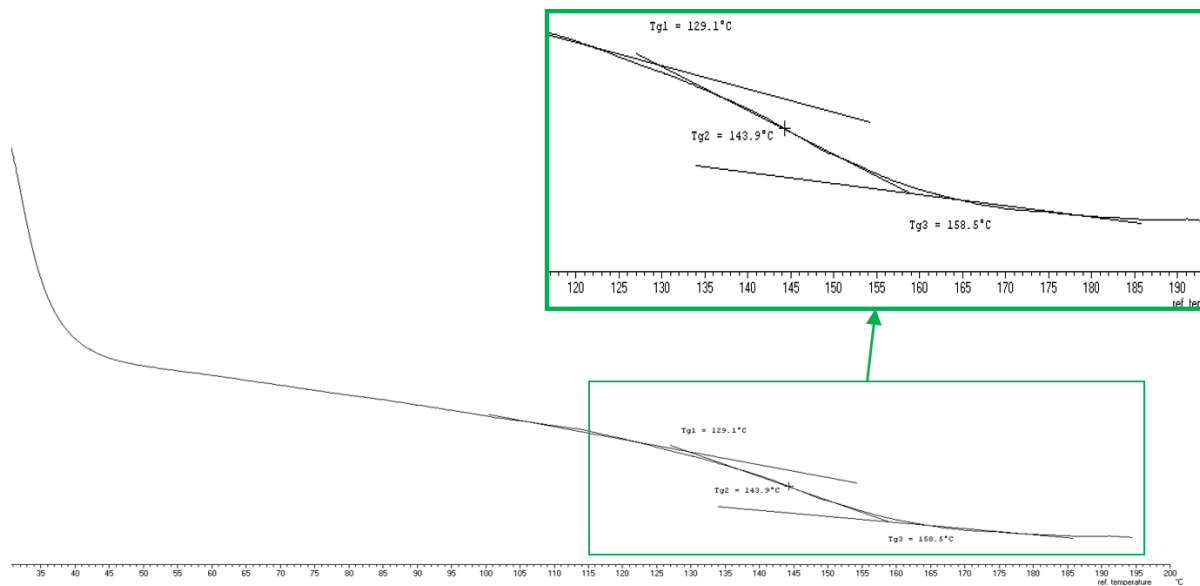
- Glass transition temperature (T_g)
- Melting temperature (T_m)
- Specific heat capacity (C_p)
- Cure kinetics of resin
- Melting/crystallization phenomena
- Heat of reaction



Mettler Toledo DSC12E

Examples of applicable testing standard:

ISO 11357 Analysis of thermal properties of polymers by DSC



Glass transition (T_g) results for a carbon-epoxy sample attained from the DSC

Barcol impressor – *Colman GYZJ-934-1*

For determining the Barcol hardness of materials.

Ultrasonic thickness gage – *Panametrics 25DL Plus*

Non-destructive testing method for the determination of thickness of metals, plastics, glass, rubber and other materials. Measuring range of 0.080 to 500 mm depending on the materials with a 0.001 mm resolution.

Overview of available testing methods

The below mentioned testing methods are available at the Solico lab testing facility. Please inform about any methods or specialized tests not listed below to discuss the possibilities.

Tensile test

- ISO 527-2 Plastics
- ISO 527-4 Isotropic and orthotropic fibre reinforced composites
- ISO 527-5 Unidirectional fibre reinforced composites
- ASTM D638 Plastics
- ASTM D3039 Polymer matrix composites
- ASTM D5083 Reinforced thermosetting plastics straight sided specimens
- ISO 1926 Rigid cellular plastics
- ISO 12815 Fibre reinforced plastics: plain pin bearing strength

Compression test

- ASTM D 6641 Polymer matrix composites using a combined loading compression test fixture
- ASTM C 364 Edgewise compression of sandwich construction
- ASTM C 365 Flatwise compression of sandwich cores
- ASTM D 695 Rigid plastics
- ASTM D 1621 Rigid cellular plastics
- ISO 844 Rigid cellular plastics
- ISO 14126 Fibre reinforced plastic composites

Shear test

- ASTM D 5379 Composites materials by V-notched beam shear method (Iosipescu)
- ASTM D 7078 Composites materials by V-notched rail shear method
- ASTM C 273 Sandwich core materials

Interlaminar shear test

- ASTM D 5379 Composites materials by V-notched beam shear method (Iosipescu)
- ISO 14130 Fibre reinforced composites by short-beam method
- ASTM D2344 Fibre reinforced composites by short-beam method

Adhesive shear test

- ASTM D 1002 Metal to metal, single lap
- ASTM D 3164 Plastics to plastics, plastics to metal, single lap
- ASTM D 3528 Double lap
- ASTM D 5868 Reinforced plastics, single lap
- ISO 4587 Single lap
- ISO 11003 Thick adherents, single lap

Flexural test

- ISO 14125 Fibre reinforced composites by 3&4-point bending
- ISO 178 Plastics by 3-point bending
- ASTM C 393 Sandwich constructions
- ASTM D 790 Unreinforced and reinforced plastics by 3-point bending
- ASTM D 6272 Unreinforced and reinforced plastics by 4-point bending

Density and fibre content test

- ASTM D 792 Density of plastics by displacement
- ISO 1183-1 Density of plastics by displacement
- ASTM D 2584 Ignition loss of reinforced plastics
- ISO 1172 Reinforced plastics by calcination method
- ASTM D 2734 Void content of reinforced plastics
- ASTM D 3171 Constituent content of composite materials

Glass transition temperature test

- ISO 11357 Analysis of thermal properties of polymers by DSC

Hardness test

- ASTM D 2583 Rigid plastics by Barcol impressor

Specimen dimensions

Test specimens are limited to the following dimensions per machine:

Mechanical testing - Instron 3382 Universal test machine

- Mechanical wedge action grips (tensile testing)
Specimen dimensions: up to 12.5 x 50 mm (t x w) for flat specimens
- Compression anvil Ø150 mm
Specimen dimensions: 140 mm (round), 105 mm (rectangular)
- 3&4-point flexural / interlaminar shear fixture
Span: 450 mm (3 pt.), 500 mm (4 pt.)
Specimen dimensions: 125 x 575 mm (w x L)
- Combined loading compression test fixture
Specimen dimensions: 11 x 30 x 140 mm (t x w x L)
- V-notched rail shear test fixture
Specimen dimensions: 12 x 75 mm ($h \times d_1 + 2 \times d_2$)
- V-notched beam (iosipescu shear) fixture
Specimen dimensions: 0.75-12.7 x 19 x 76 mm (t x w x L)
Max capacity: 44 kN
- Sandwich flatwise plane shear fixture
Specimen dimensions: 75 x 250 mm (w x L)
- 24" Span sandwich long beam 3 & 4 point flexure fixture
Span: 500 mm (4 pt.)
Specimen dimensions: 125 x 575 mm (w x L)
- ILTS
Specimen dimension: 150 x 150 mm (w x L)

Differential Scanning Calorimetry - Mettler Toledo DSC 12E

Specimen to fit inside a 6mm diameter crucible. General mass per sample is 5-50mg.

Examples of possible specimen types are:

- Sheet / laminate
- Powder (e.g. scraped of a composite sample)
- Pellets
- Discs/films
- Liquid (resins)

Tip: A standard paper perforator can be used to attain ± 6 mm disc specimen from sheet/laminate/film materials.

Ashing furnace – Lenton AF 11/6B (1100 °C)

Furnace internal dimensions: L x w x h = 300 x 175 x 125 mm

Samples to fit in one of the available crucibles listed below:

1. Ø60 x 44 mm
2. 30 x 45 x 14 mm
3. Ø45 x 14 mm
4. Ø22 x 30 mm

