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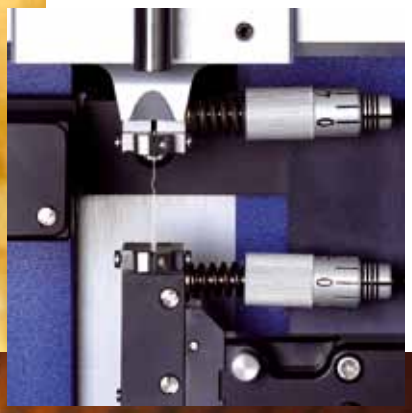
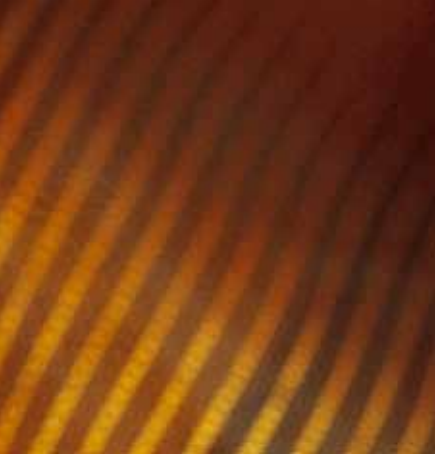


FAVIMAT+ (AI)ROBOT2
FAVIGRAPH
Automatic Single-Fibre Testers



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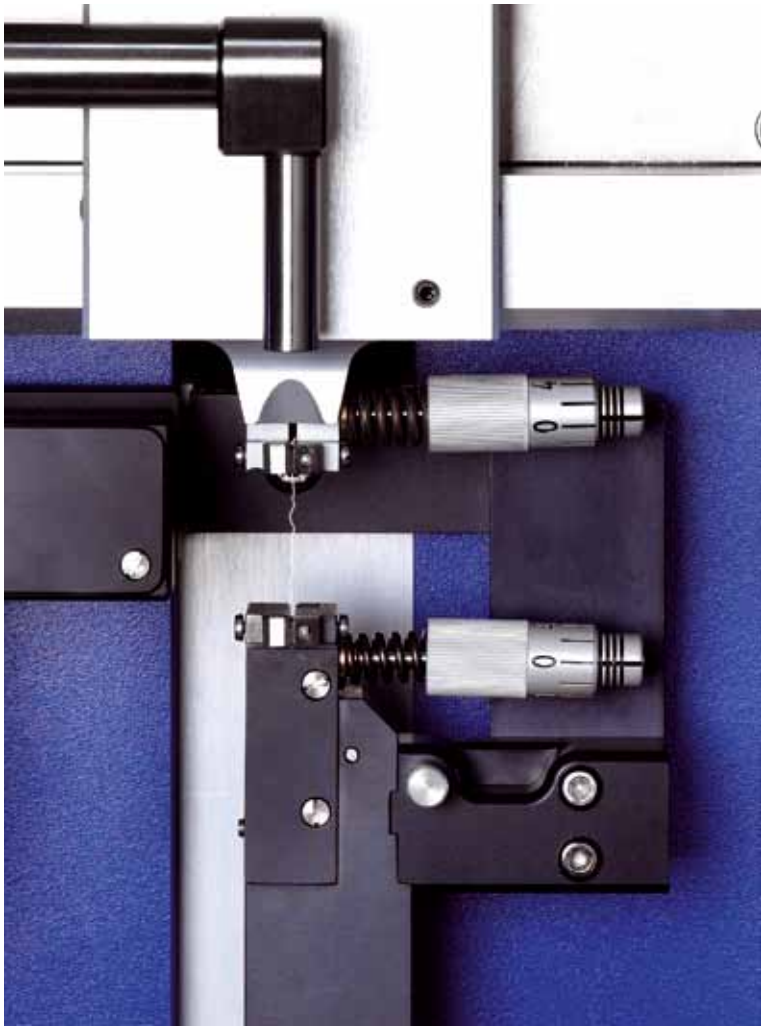
Single-Fibre Testers
FAVIMAT+ and FAVIGRAPH

Testing and evaluation of a wide range of fibre properties are essential for research and quality control purposes in fibre production and for assessing the processability of fibres in carding and spinning. For man-made fibres and in some cases even for natural fibres these tests are carried out on single fibres. Here, typical testing methods are the **static tensile test, linear-density** (fineness) measurement, and measurement of **crimp extension, crimp stability** as well as **number of crimps**.

FAVIMAT+

The design of the FAVIMAT+ takes into account any needs to combine **single-fibre linear-density measurements** and **tensile tests** with different **crimp test methods** into a single testing instrument. All of these tests are carried out on the same fibre section. Transferring the fibre from one testing device to another is, therefore, no longer necessary. This results in a significant reduction in both operator input and expenditure as well as a reduction in possible fibre damage when compared to multiple measurements carried out on alternative independent devices.

The FAVIMAT+ incorporates two additional measuring systems located in the tensile testing section. The high-resolution load cell enables accurate adjustment of specified pre-tensions, as well as the measurement of extremely low tensile forces when determining fibre crimp properties or **testing nano-structures**. To ensure highest measuring accuracy, computer-aided calibration of all measuring systems can be carried out automatically.



Test section FAVIMAT+

The FAVIMAT+ testing methods

Linear-density test

The FAVIMAT+ automatically determines the **linear density** of single fibres using the **vibration method**, e.g. according to ASTM D 1577. With this testing method the resonance frequency of the sample is measured at constant gauge length and known pre-tension; the data obtained is then used for calculating the linear density according to the following formula:

$$T_t = F_V / (4 \cdot f^2 \cdot L^2)$$

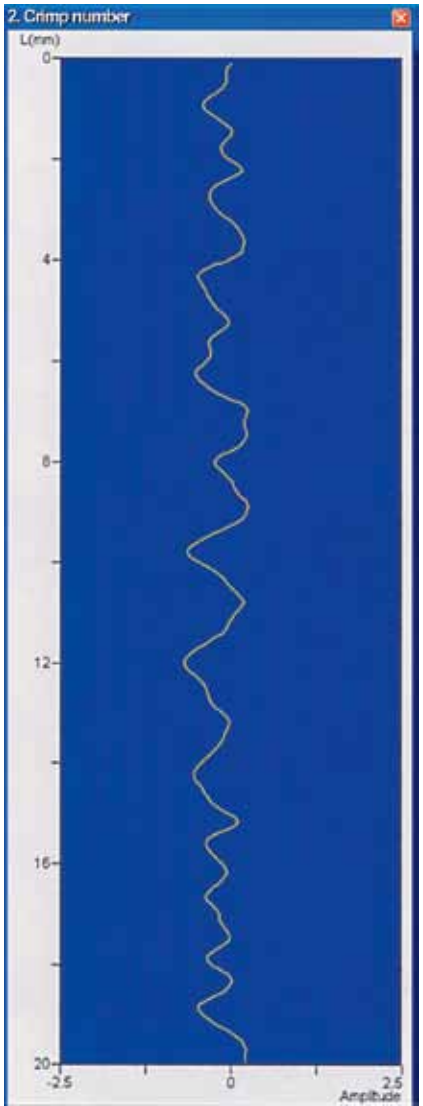
with: T_t = linear density
F_V = pre-tensioning force
f = resonance frequency
L = test section length

A possible influence of bending stiffness and fibre cross-section can be analysed by means of an automated pre-test and can in general be eliminated for series testing.

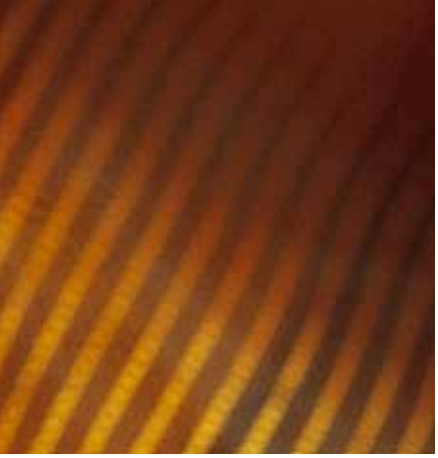
Determination of crimp geometry

A further measuring system with opto-electronic sensor integrated in the FAVIMAT+ enables the creation of a digital image of the crimped fibre, which is held between the two clamps, and the subsequent evaluation of the crimp geometry regarding crimp number and crimp amplitude.

As applicable to mechanical crimp properties, size, shape and regularity of the crimp geometry supply important information regarding the crimping process during fibre production. In addition, these values give information on further processing of the fibres and the properties that can be expected from the intermediate- and finished products.



Test of crimp number



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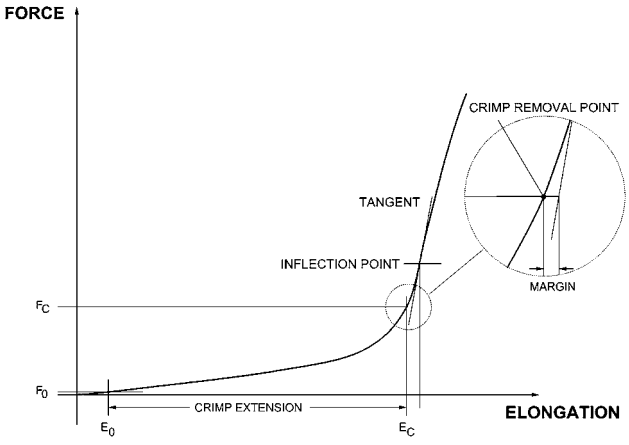
Static tensile test and examination of mechanical crimp properties

Tensile testing of single fibres represents one of the most important quality control testing methods in chemical-fibre production. In addition to the (**linear density-related**) **breaking force** and **breaking elongation**, other parameters such as **modulus, intermediate values of the force/elongation curve**, e.g. force values at specified elongations, **work to rupture** or characteristic values for **elastic- and plastic deformations**, can be obtained.

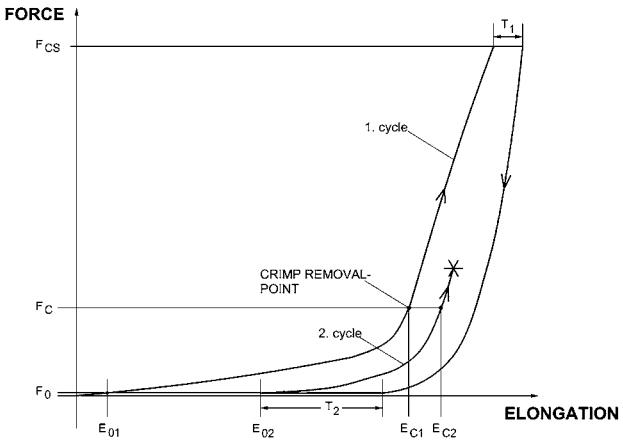
With a known material density the **effective fibre cross-section and breaking stress values**, e.g. in MPa as generally used for reinforcement fibres (carbon, etc.) can directly be determined.

An additional important value determined through tensile tests are the mechanical **crimp properties** of a fibre, which are characterized by the following parameters: crimp elongation, crimp removal force, and crimp stability. Further international accepted crimp measurement methods (e.g. JIS standard, VIBROTEX method) are available as options.

Tensile tests conducted within the range where crimp is removed from the fibre require a **high-resolution force-measuring system** that also enables sufficient measurement accuracy for tensile forces within a range even below 1 mN. The FAVIMAT+, as a consequence, is equipped with a compensating force-measuring system developed by Textechno.



Crimp test



Crimp stability test

In addition, to having an extremely high resolution of 0.0001 cN for a measuring range of 220 cN and fully automatic calibration, the system is characterized by high stability against external vibrations.

For crimp tests, in particular where there is a need to avoid any external influences on the measurement, e.g. breath of the operator, the FAVIMAT+ is equipped with a recessed testing section that is isolated by a motor-driven sliding glass window.

The actual test section comprises the measuring- and draw-off clamps, which open and close automatically. The clamp jaws are tightened by spiral springs, and the clamping force can be steplessly and reproducibly adjusted over a wide range. The gauge length between the clamps can be varied between 0 and 100 mm.

Test sequence

Depending on the task in hand, either one of the four tests or a combination of two, three, or four tests can be carried out on a single clamped fibre.

Cyclic load-, relaxation-, and creep testing

An optional software offers various possibilities for hysteresis- (cyclic load or elongation), relaxation-, and creep testing. These methods can be combined with the linear-density test.

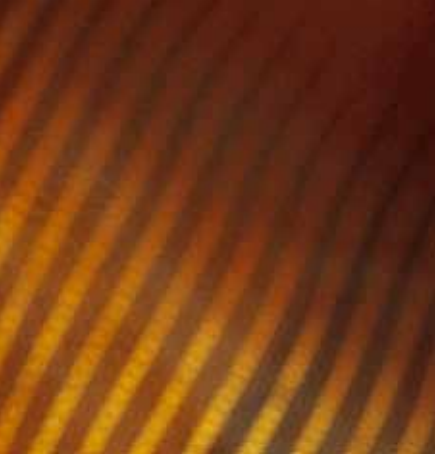
Friction testing

Exchanging the draw-off clamp against the special friction appliance allows tests of friction properties fibre to metal (or other materials). Evaluation includes a graph of friction-force along the fibre and determination of the coefficient of friction.

Clamping systems for different fibre types

The FAVIMAT+ standard clamps are suited for all textile- and most technical fibres including glass, carbon, basalt and Aramid. For very short samples special clamps with jaw faces of only 2 mm height and an innovative short fibre insertion mode enable tensile tests of short cut fibres up to minimum lengths of 3 mm. An optional pressure amplifier is recommended for high-tenacity material like Polyvinyl alcohol (PVA) as used in concrete reenforcement.

A further special clamp for manual sample insertion is equipped with force reduction bollards in order to avoid slippage between the jaw faces or breaks at the clamps on testing very critical material such as ultrahigh molecular weight Polyethylene (e.g. Dyneema, Spectra). For such applications a high-resolution load cell with a force range of 1.200 cN is available.



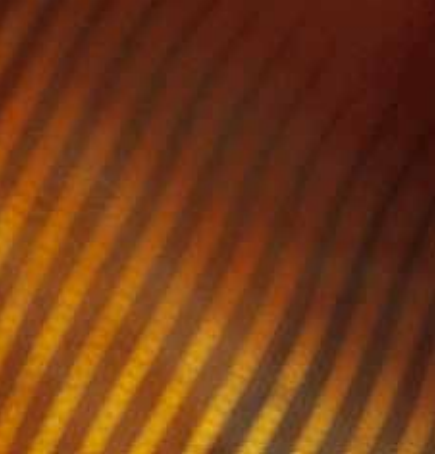
The ROBOT2 and AIROBOT2 automatic fibre feed units

If the crimp stability test is included in a testing cycle, testing of a single fibre may take several minutes, depending on selected loading and relaxation times. As a consequence, the operator has to wait until the next test can be initiated. This clearly demonstrates the advantages of an automatic supply of test specimens.

For this purpose the automatic unit ROBOT2 can be added to the FAVIMAT+. ROBOT2 comprises a **sample storage unit** and a **transfer clamp**, the latter for transferring the single fibre from the storage unit to the test section, and a suction system for removing the waste fibres after each test. The sample storage unit contains up to 20 magazines, each of which can accommodate 25 individual fibres. Therefore, the total capacity of the unit amounts to **500 fibres**. Depending on the test requirements, the fibres are suspended in the magazines using tongs-shaped pre-tensioning weights, e.g. equating to the standard pre-loading for tensile tests, or paperweights for crimp tests. Magazines are equipped with an automatic identification system. They can be removed and reloaded during a running test series.

The AIROBOT2 is a variant of the ROBOT2 automatic fibre feed unit. Here the fibres are loaded pneumatically into the magazine in a semi-automatic loading unit. When being transferred from the sample storage unit into the FAVIMAT+ test section, the fibres are slightly pre-tensioned by a suction device. The AIROBOT2 does not require pre-tensioning weights, resulting in a further substantial increase in test preparation efficiencies.

FAVIMAT+ AIROBOT2



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Efficient testing with FAVIMAT+ (AI)ROBOT2

The time required for testing a single fibre on the FAVIMAT+ including feeding and removal of the fibre amounts to approx. 35 sec (force-elongation test with 20 sec breaking time and linear-density test). The full programme including crimp stability examination has a duration of up to 4 min. Operator time required, therefore, amounts to approx. 4.5 ... 30 hours for 500 fibres when using the FAVIMAT+ without automatic sample feed. During conventional testing with separate testing instruments and visual crimp counting the overall testing time may be even substantially longer.

Transfer clamp and magazine

When FAVIMAT+ and ROBOT2 are combined, the work of the operator is reduced to introducing the fibres into the storage magazine and, where applicable, attaching the pre-tensioning weights. After appropriate operator training it can be assumed that the loading of 500 fibres into the storage magazines will require approx. 80 min. In case of the AIROBOT2 this time is even further reduced to about 45 min. In an extreme case this corresponds to a **reduction** in **working time** of more than **95 %**. When comparing the above figures, the enormous rationalization effect of the FAVIMAT+ (AI)ROBOT2 is evident, which results from the combination of different test methods into a single instrument, together with automated sample feed and -disposal and the large capacity of the sample storage unit.

Testing methods

- Measurement of linear density with the vibration method;
- Static tensile test, cyclic load testing, creep- and relaxation trials;
- Measurement of mechanical crimp properties;
- Crimp number and -geometry measurement;
- Friction testing.

System components

Test section:
- One pair of single-fibre clamps, also suited for other narrow test specimen;
- Continuously adjustable gauge length 0 – 100 mm;
- Draw-off clamp speed 0.1 – 100 mm/min, return speed 300 mm/min, max. travel of draw-off clamp 100 mm;
- Additional vertically movable measuring head that automatically swings into the test section, comprising two measuring systems for the measurement of linear density and the determination of crimp geometry.

Measuring systems:
- Force measuring device, resolution 0.0001 cN, measuring range 220 cN, other ranges available on request;
- Elongation measuring device, resolution 0.1 µm;
- Linear-density measuring system with acoustic initiation of the fibre vibration and opto-electronic recording of the resonance frequency;
- Opto-electronic measuring system for digital recording of the fibre geometry.

(AI)ROBOT2:
- Fibre sample storage unit for a maximum of 20 magazines, each with a capacity of 25 single fibres;
- Transfer clamp (AI)ROBOT2 to FAVIMAT+;
- Loading unit for fibre introduction into the magazine with pre-tensioning weights (ROBOT2) or pneumatics (AIROBOT2).

TESTCONTROL:
- PC system for controlling the test processes and for the evaluation of the measured data, connected via USB interface;
- Input of all parameters for testing and measured-data evaluation on the PC, saving of selected parameter sets of test conditions under code words;
- PC for easy integration within any network type.

Further technical data

Mains supply:
220 V, 50 (60) Hz, current requirement approx. 1.5 A.

Compressed-air supply:
6 bar, 10 l/min., with (AI)ROBOT2 50 l/min.

Lacquer finish:
RAL 9006/5002.

Dimensions, weight:
Height 600 mm, width 600 mm, depth 540 mm, approx. 85 kg (FAVIMAT+);
Height 1125 mm, width 880 mm, depth 600 mm, approx. 90 kg (ROBOT2).

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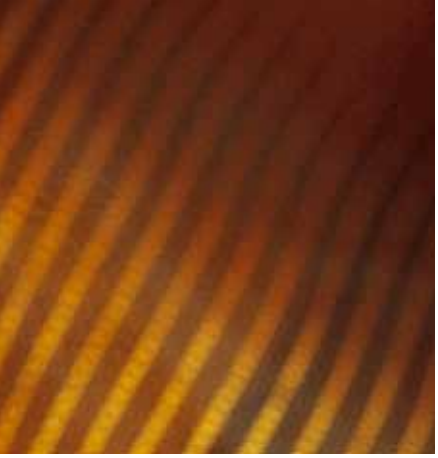


FAVIGRAPH

The FAVIGRAPH combines **linear-density measurements** and **tensile tests** in one test equipment. Here the linear-density measuring head, which is based on the FAVIMAT+ technology, is situated adjacent to the tensile test section.

The innovative characteristic of the FAVIGRAPH is a **transfer clamp** between the two measuring systems, into which the appropriately pre-tensioned fibre is manually loaded. At the start of the test the transfer clamp is positioned above the linear-density measuring head. First, the linear density of the fibre is determined. Thereafter, the transfer clamp turns to the tensile test section and places the fibre into the measuring- and draw-off clamp. During the tensile test it is already possible to insert the next fibre into the linear-density measuring head.

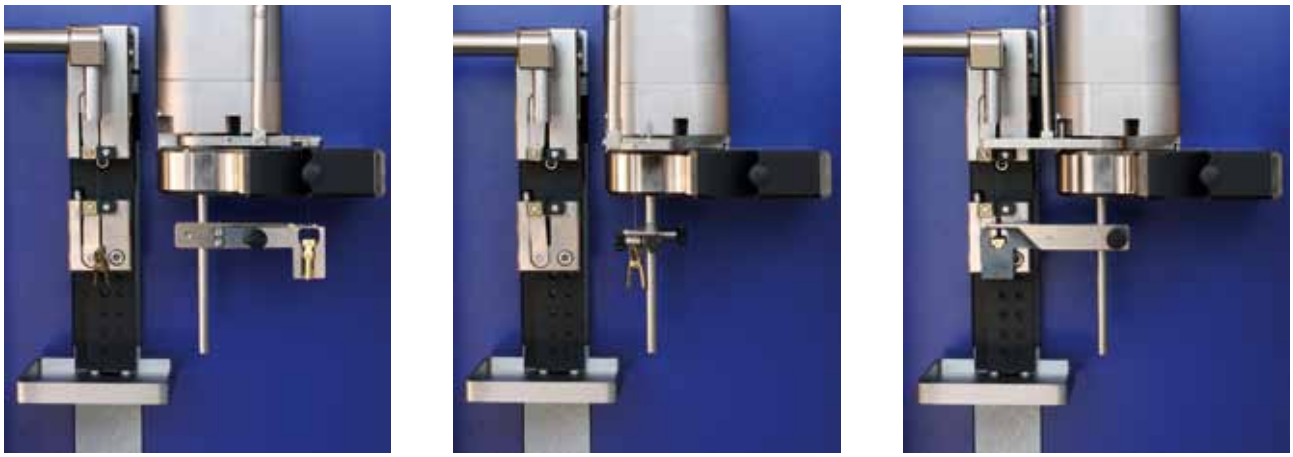
As a consequence, continuous parallel operation of both systems is ensured. With corresponding short fibre breakage times, cycle times of 15 sec are easily achieved resulting in a test output of 240 fibres per hour.

Moreover, a special advantage of the FAVIGRAPH is that the operator handles the fibre only once when introducing it into the transfer clamp at the linear-density measuring head. Compared to conventional systems, where two independent testing instruments necessitate separate introduction of each fibre, the FAVIGRAPH technology signifies a substantial reduction in both work input and possible fibre damage.

Tensile tests in water or other liquid media as well as on fibre bundles are also possible (option).

Special clamps with jaws of only 2 mm height allow tensile tests on samples as short as 4 mm.

FAVIGRAPH



Fibre transfer from the vibroscopic measuring head to the tensile test section

Testing methods

- Measurement of linear density
- Static tensile test, cyclic load testing, creep- and relaxation trials
- Static tensile tests under liquid media
- Fibre bundle testing on natural fibres

System components

Linear-density section
- Vibroscopic linear-density test system
- Pre-tensioning by means of pre-tension weights
- Transfer mechanism capable of transferring the fibre from the linear-density test section to the tensile test section

Tensile test section
- One pair of single-fibre clamps, also suited for other narrow test specimen
- One pair of fibre bundle clamps (optional)
- Continuously adjustable gauge length 0 - 100 mm
- Draw-off clamp speed 0.1 - 100 mm/min, return speed 300 mm/min
  max. travel of draw-off clamp 100 mm
- Available load cell ranges: 20 cN, 100 cN, 10 N, 100 N (other ranges on request)
- Elongation measuring device, resolution 0.1 µm

TESTCONTROL
see FAVIMAT specification page 9

Further technical data

Mains supply:
220V, 50 (60) Hz, approx. 1 A
Compressed-air supply:
6 bar, 25 l/min
Lacquer finish:
RAL 9006/5002
Dimensions, weight:
Height 600 mm, width 450, depth 500 mm, approx. 65 kg

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