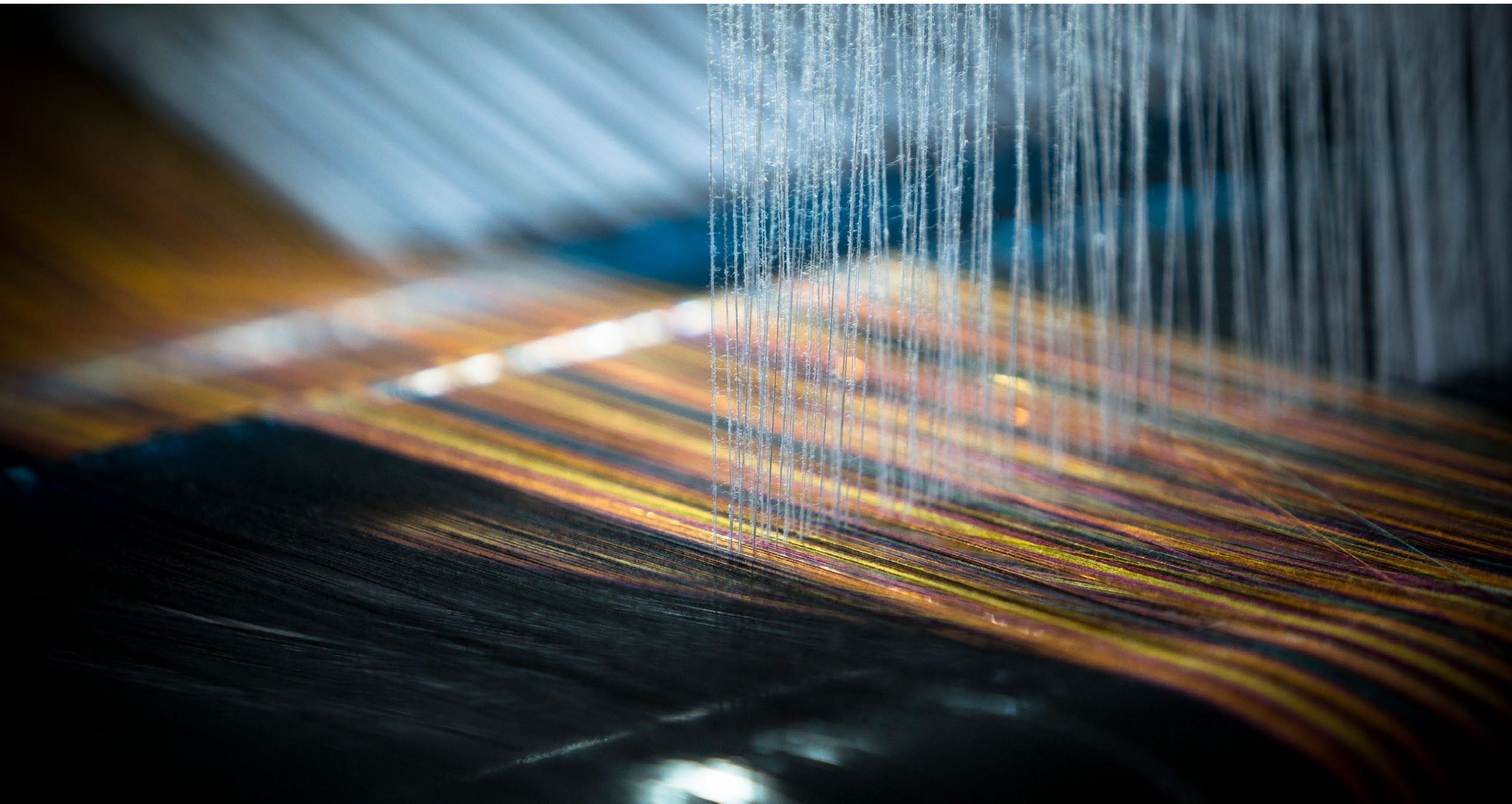
KLA INSTRUMENTS

T150 UTM

Nanomechanical Tester



Features

- Nanomechanical actuating transducer delivers high sensitivity over a large range of strain
- Dynamic characterization mode captures evolution of mechanical properties with strain
- Flexible, upgradeable system can be configured for a variety of applications
- Easy test protocol development includes real-time experimental control
- Testing complies with ASTM standards

Applications (Materials)

- Thin individual polymer, metal or ceramic fibers
- Electrospun polymer nanofibers
- Polymer films
- Spider silk
- Biomaterials (e.g., soft tissue scaffold)
- Textiles
- MEMS

T150 UTM

OVERVIEW

The T150 UTM offers researchers a comprehensive means of nanomechanical characterization. With its high resolution and large dynamic range, spanning five orders of magnitude of storage and loss modulus, the T150 UTM offers researchers the ability to understand dynamic properties of compliant fibers and strain rate sensitive materials. It produces tensile force (load on the sample) using electromagnetic actuation combined with a precise capacitive gauge to deliver high sensitivity over a large range of strain. It also lets researchers investigate tension/compression properties of biological materials using a dynamic characterization mode that permits accurate measurement at each point during testing.

The user-friendly design simplifies training—standard tests can be run the same day the instrument is installed. Accurate, real-time test results are quickly generated and automatically reported in Microsoft Word and Excel. Every T150 UTM is supported by knowledgeable, experienced regional applications and customer service engineers, who are available to provide technical support and guide users through more advanced testing.

Advanced Design

During tensile elongation, the T150 UTM holds the nanomechanical actuating transducer head stationary while moving the crosshead, providing a stable system with a low noise floor. The system allows accurate identification of the critical tension point during specimen elongation. Data collected before the onset of tension on the sample is used to accurately identify the start of tension.

The T150 UTM features high lateral stiffness, attributable to a two-spring design that restricts the indenter transducer to one degree of freedom, the axis of indentation. The restriction of movement enables the instrument behavior to closely follow the dynamic model.

Loads are applied in the micro-Newton range and strain measurements correspond to nanoscale extensions of the sample material. The nanomechanical actuating transducer head functions as a load cell by sending a precise amount of current to the actuator coil so that the lower grip on the specimen remains centered. Measurement error is reduced by decoupling load application from displacement sensing, so that the measured material response and loading mechanisms are independent.

System Components

The T150 UTM includes a nanomechanical actuating transducer head as well as a fully automated data acquisition and control system with PC, monitor and keyboard. NanoSuite® Professional software enables easy use of standard test methods and creation of unique solutions for automated, consistent results. The T150 UTM is equipped with a micropositioner stage, a sample guide that holds the sample orthogonal to the direction of applied tension and aids in the positioning of the upper sample grip. In addition, an indentation kit including an inversion footer is available, allowing the system to be used as an indenter.

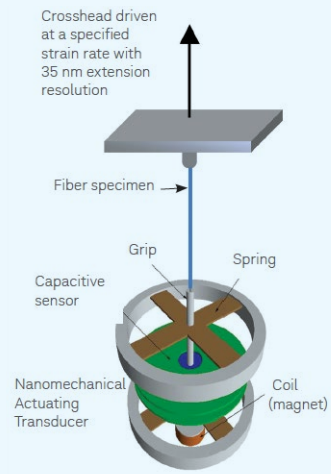


Figure 1. The sensitivity of the T150 nanomechanical actuating transducer (NMAT) enables detection of small loads required for deformation of small diameter individual fibers.

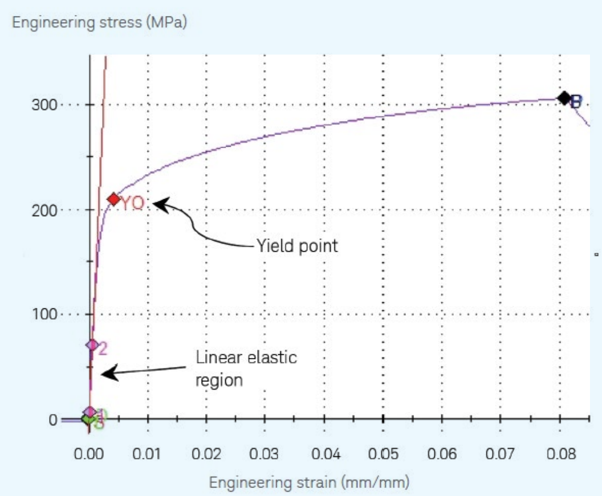


Figure 2. The engineering stress-strain curve demonstrates the tensile test results from a test on single Cu wire of 29µm diameter.

Continuous Dynamic Analysis (CDA) Option

The Continuous Dynamic Analysis (CDA) option offers a direct, accurate measurement of the specimen's stiffness at each point in the experiment, enabling mechanical properties to be determined continuously as the specimen is strained. By measuring both the amplitude and phase relationships between the load and displacement oscillations, CDA can determine storage and loss modulus.

The CDA option enables T150 UTM users to gain access to dynamic properties information continuously throughout the force curve, providing a wealth of information on the material's response. The option also offers the advantage of measuring complex moduli over a range of oscillation force frequencies.

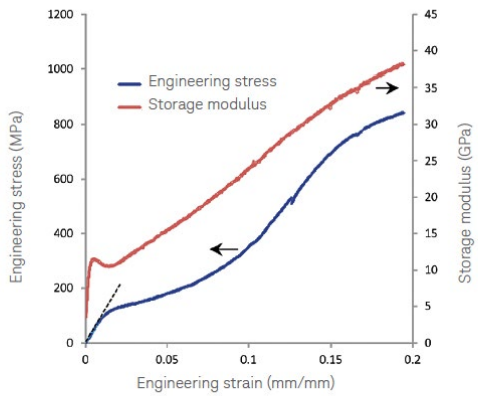
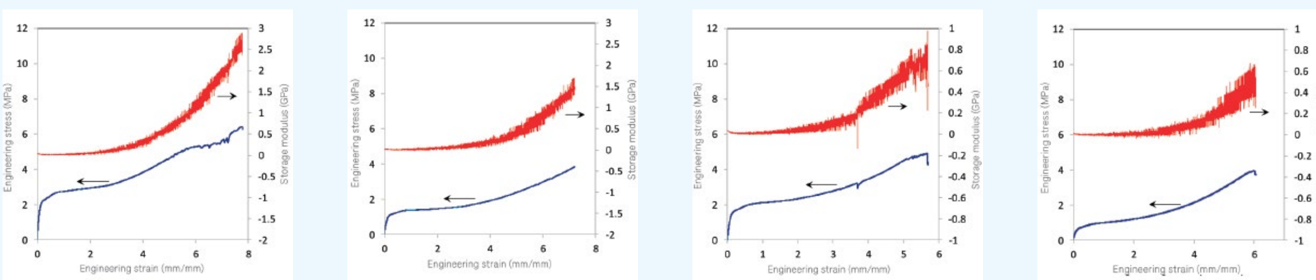


Figure 3. Variation of dynamic storage modulus with increasing strain in a single PET fiber. The continuous dynamic analysis (CDA) option allows the T150 to measure the dynamic mechanical properties continuously during a tensile test.



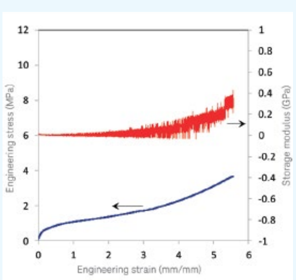


Figure 4. The test method named "UTM T150 Standard Toecomp CDA" was used to show the quasi-static engineering stress-strain curves, along with the dynamic storage modulus measurements, for 80%, 60%, 50%, 40% and 20% sheath bicomponent fibers with different volume fractions of the sheath. Note the decrease in the magnitude. By comparing the curves, it is evident that the sheath are the load bearing component in these fibers. The initial dynamic storage modulus values for each of these fibers are similar to the quasi-static Young's modulus measurements.

Specifications

- Maximum load: 500mN (50.8g)
- Load resolution: 50nN (5.1µg)
- Maximum actuating transducer displacement: ±1mm
- Displacement resolution: < 0.1nm
- Dynamic displacement resolution: < 0.001nm
- Maximum crosshead extension: 200mm
- Extension resolution: 35nm
- Extension rate: 0.5µm/s to 5mm/s
- Dynamic frequency range (sample dependent): 0.1Hz to 2.5kHz

CDA Option

- Force amplitude range: 0.1µN to 4.5mN
- Frequency range characterization of instrument dynamic response (sample dependent): 0.01Hz to 200Hz

KLA SUPPORT

Maintaining system productivity is an integral part of KLA's yield optimization solution. Efforts in this area include system maintenance, global supply chain management, cost reduction and obsolescence mitigation, system relocation, performance and productivity enhancements, and certified tool resale.

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