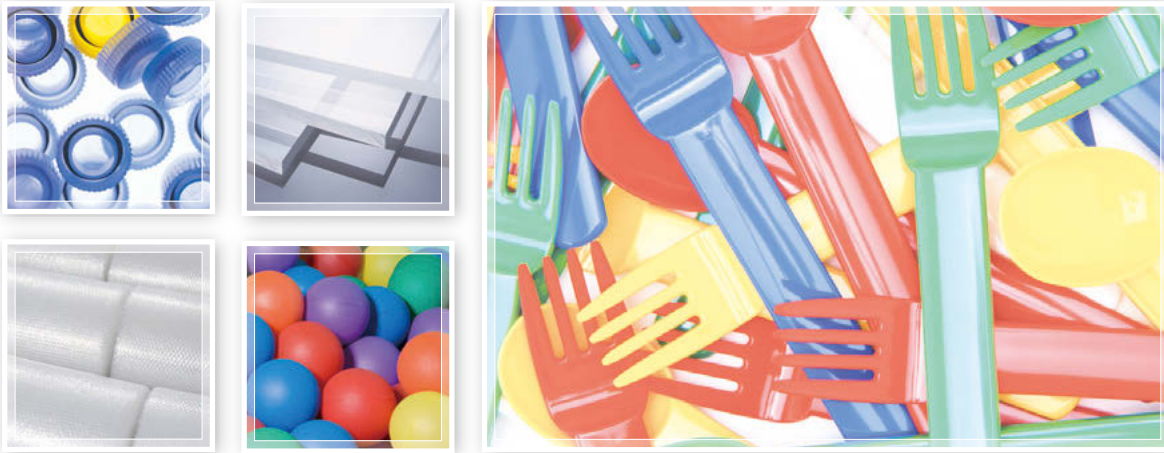


Testing, Weighing and Analytical Instruments for Rubber and Plastics

# Instruments for Evaluations Rubber and Plastics



# Instruments for Evaluations Rubber and Plastics

For the performance evaluation of rubber and plastics...

Rubber and plastic products are used in a wide variety of areas. Evaluations of their basic performance and the components that determine their performance are indispensable for product development and quality control.

Shimadzu not only offers a wide array of evaluation instruments, it also provides comprehensive support from application to after-sales service.

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	P5. Observation and Measurement	P12. Evaluation of Particle and Powder Properties	P16. Global Network
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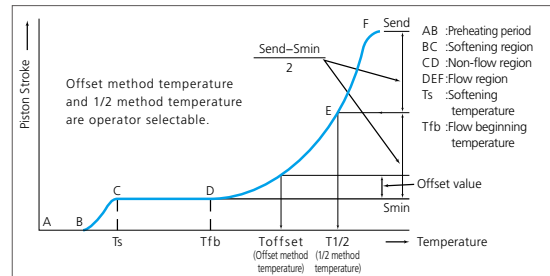


**Testing, Weighing and Analytical Instruments For Rubber and Plastics**

# Evaluation of Rheology Properties

Rheology evaluation instruments provide essential information for research, development, and quality control, including information on the various properties that determine processability, such as viscoelasticity, a property peculiar to polymers, as well as viscosity, fluidity, and rate of volume change.

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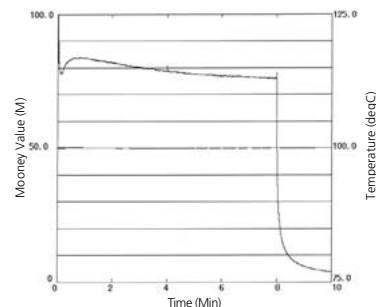
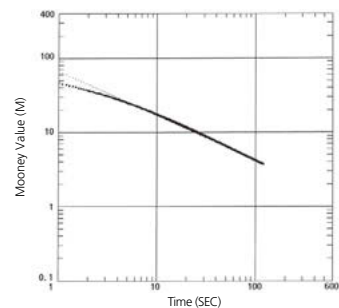


Flow Curve Using Constant Heating Rate Method

## ● CFT-500EX/100EX Capillary Rheometer Flow Tester

This device is used to evaluate the viscosity characteristics of fluid materials such as resin, from the relationship between temperature, pressure, and flowrate. Practical data can be acquired for molding under high pressure, which is not possible by the melt flowrate measurement method. In addition to constant temperature test, constant rate heating test, which tests while increasing temperature at a constant rate, is also possible.

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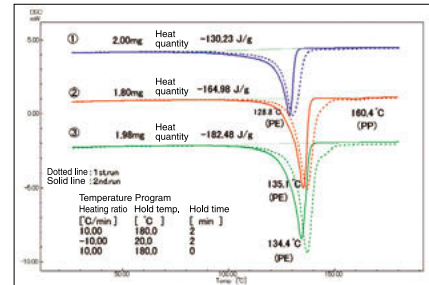


## ● SMV-301/301RT Mooney Viscometer

This device evaluates the Mooney viscosity and vulcanizing characteristics of rubber. The adoption of a color LCD touch panel makes the device easy to operate and basic performance capabilities such as temperature recovery characteristics are also excellent. The device is also equipped with a stress relaxing feature based on the ISO/ASTM standards (SMV-301RT). It can also be operated using PC software.

# Evaluation of Thermal Properties

Plastics are heated up in a variety of ways during formation and processing. This thermal history has a direct influence on product quality and so it is necessary to grasp the thermal properties and perform optimum temperature control in the manufacturing process. Evaluating the thermal properties of a substance involves the evaluation of the dependency of its physical properties on temperature. The physical properties include mass, temperature, enthalpy, dimensions, and strength, and different types of thermal analyzer are used to evaluate different properties.



Measurement of Melting of 3 Types of Separators

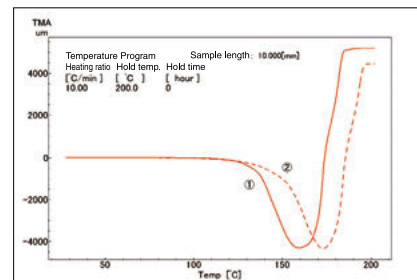
## ● DSC-60 Plus/60A Plus Differential Scanning Calorimeter

This calorimeter is useful for evaluating thermal characteristics such as melting of the separators and transformation/decomposition of electrolytes during heating. Features of this calorimeter include a low noise level of 0.5  $\mu$ W or less, high sensitivity, and high resolution. The cooling process can also be easily measured since the calorimeter has a built-in liquid nitrogen cooling trough.



## ● DTG-60/60H TG/DTA Simultaneous Measuring Instrument

The thermal characteristics and heat resistance of materials can be learned by measuring the weight changes and heat absorbed or generated during heating. This allows the heat resistance of engineering plastic materials and content of reinforcing materials such as carbon black in rubber to be known.



Measurement of Contraction Behavior of Separators by TMA

## ● TMA-60/60H Thermal Analyzer

This instrument is useful for evaluating the expansion/contraction behavior of battery members, especially separators, caused by heating. The newly adopted digital displacement sensor demonstrates little temperature drift, thus assuring stable measurement. High linearity is also achieved in spite of its  $\pm 5$  mm wide measurement range.

# Observation and Measurement

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These instruments allow the non-destructive observation of the interior of products, such as resin products, using X-rays to check for defects, such as voids, and to check the internal state. They are effective for quality control and failure analysis.



- **SMX-100CT**

The inspeXio SMX-100CT is a CT system capable of performing high-magnification 3D observations of resins, medicines, bones, and other soft materials. It is equipped with a sealed tube type microfocus X-ray generator with a maximum output of 100 kV, and a high-sensitivity image intensifier.

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- **SMX-1000plus/ 1000L Plus**

With this special CT system for the SMX-1000 Plus/SMX-1000L Plus microfocus X-ray inspection systems, placing the compact CT unit on the inspection stage and switching to the special CT software enables 3D image analysis, which is not available with conventional inspection functions.

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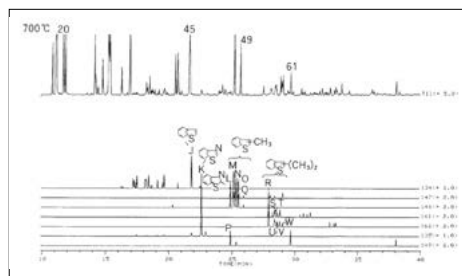
- **SMX-225CT FPD HR**

The inspeXio SMX-225CT FPD HR system features a large high resolution flat panel detector that provides high definition and high contrast CT images, down to the fine details, while still maintaining a large field of view.

# Evaluation of additives and harmful materials

Shimadzu provides a wide variety of evaluation instruments to assist in, for example, the evaluation and management of additives that influence the performance and properties of polymer materials. We also offer instruments for the quantitative analysis of harmful substances, which have become a major point of concern recently because of the effect on public health.

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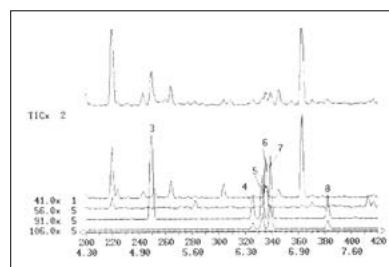


Chromatogram of tire rubber

- GCMS-QP2020 Pyrolysis Measurement System (for testing rubber and plastic additives)

Polymer compounds, such as plastics, rubber, and resin, are thermally decomposed at temperatures greater than 500°C and the products are analyzed using GC-MS. These products reflect the structure of the original polymer compounds and so they can be used to perform polymer identification and high-order structure analysis. Database search software is also available to assist with polymer identification.

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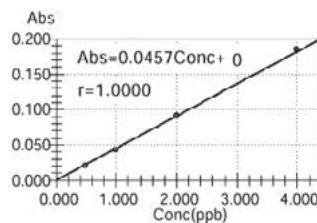


Analysis of components dissolved in polymers

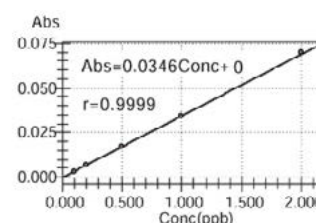
- GCMS-QP2020 Headspace Analysis System (for testing residual solvents in polymers)

The analysis of solvents and volatile components in solids is possible using the headspace. Volatile components, especially those with low boiling points, can be found in the upper region (i.e., the "headspace") of liquids and solids. The headspace sampler is a device that obtains samples of a fixed amount at a fixed temperature and injects them into the GC-MS instrument. This system can be used for the measurement of volatile components in polymers and packing materials and for the qualitative and quantitative analysis of odors given off by chemical products.

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As Calibration Curve  
<Application News No. A302>



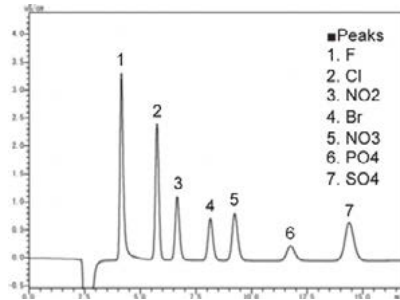
Pb Calibration Curve

- AA-7000 Series Atomic Absorption Spectrophotometers

In addition to high analysis sensitivity for target components, a flexible system configuration, compact installation space, and other user-friendly aspects have been pursued. Attention has also been given to safety, with a vibration sensor included as standard, a world's first.



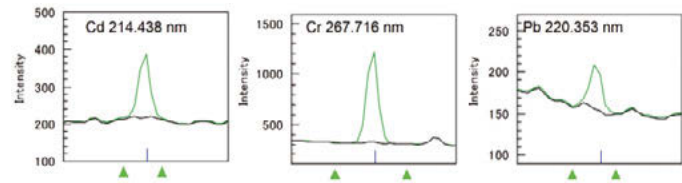
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● Prominence HPLC Ion Analysis System

The modules are centrally controlled by a system controller. Operation is easy, and highly reliable analysis results can be obtained. In terms of data processing, LabSolutions workstation is used, which features excellent security and network compatibility.

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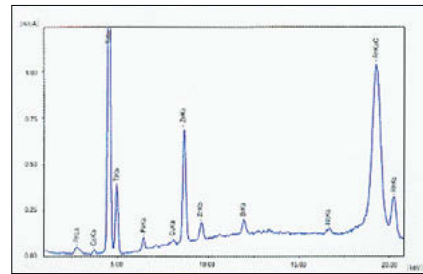


<Application News No. J104>

● ICPE-9800 Series ICP Atomic Emission Spectrometers

In addition to high sensitivity to target components and the capacity for batch analysis of multiple elements, these analysis systems feature a wide analysis concentration range. Wavelength selection for measurement elements as well as spectral interference correction for coexisting elements, which have been highly dependent on the skill of the operator, have been automated.

CE



#### Plastic Material Analysis Example

In the chemistry field, which focuses on samples composed of mainly light elements, this is an effective analytical method that enables sensitivity and accuracy, close to those obtained with wavelength dispersive models, to be obtained even with energy dispersive models. Especially when a liquid sample is frequently measured, measurements are easier than with wavelength dispersive models. Furthermore, this is effective for the analysis of catalysts and organic pellets where pressure forming is difficult.

#### ● EDX-7000/8000 Energy Dispersive X-Ray Fluorescence Spectrometers

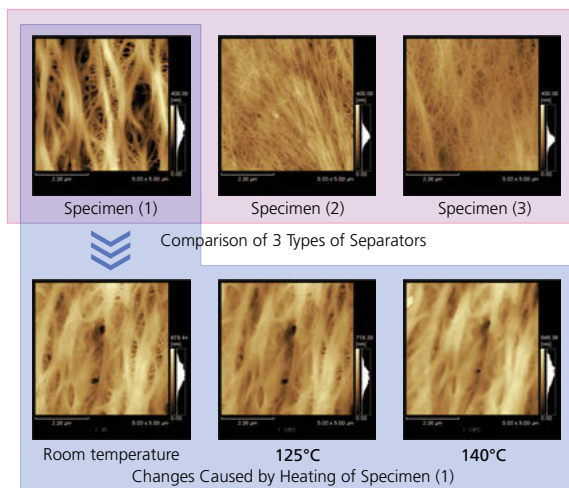
This series of spectrometers is ideal for verifying the composition (i.e. judging contaminants) of materials procured overseas or analyzing toxic elements for compliance with the ELV directive. It can also be used to evaluate the amount of plating attached to bead wire and steel cord used in tires and to measure the weight of zinc phosphate chemical conversion coatings.



#### ● LAB CENTER XRF-1800 Sequential X-Ray Fluorescence Spectrometer

This system can qualitatively and quantitatively analyze a wide range of specimens - solids, powders, liquids, thin films, and other materials. It incorporates the latest functions, such as higher precision qualitative and quantitative functions that use higher-order lines and the world's first 250  $\mu\text{m}$ -compatible mapping, as well as higher operability.





● **SPM-9700 Scanning Probe Microscope**

This microscope supports the surface observation of separators and electrolyte films as well as electrodes and semiconductors, and can easily observe 3D shapes in air or liquid at high magnification. Even nonconductive objects do not need to be coated or pretreated in other ways. Another feature of this microscope is that the electrical characteristics of samples can be measured by a probe tip. It can also be upgraded to an environmentally controlled scanning probe microscope.



EPMA-1720/1720H



EPMA-8050G

● **Development and Evaluation of All Sorts of Automobile Materials EPMA-8050G Electron Probe Microanalyzer**

This state-of-the-art top-of-the-line electron probe microanalyzer is used to develop and evaluate all kinds of materials used in automobiles, such as internal combustion engine components, power train components, brakes, automotive steel panels, films and coatings, wheels, tires, interior parts, lithium-ion rechargeable batteries, fuel cells, catalysts, electronic instrumentation boards, and automotive glasses. The EPMA-8050G features a field emitter (FE) that provides an unprecedentedly large electron beam current, which achieves among the highest resolution and highest sensitivity levels in the world.

# Material Evaluation, Quality Control, Research and Development

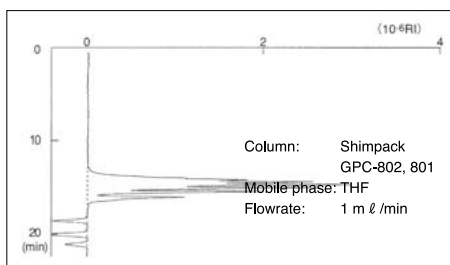
We have a lineup of instruments that can be used for material evaluation, component analysis and color measurement, evaluation for quality control, and research and development work, such as the measurement of molecular weight distributions for polymers.

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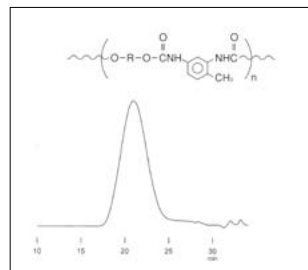


## ● Water Quality Analysis System UV-1280

Due to the simple reagent kits used, this system does not require any complicated pretreatment processes. Because calibration curves are prepared internally by the program, there is no need to prepare calibration curves using standard samples, making it easy to perform measurements. In addition to measuring Cr6+, it can also measure 39 other components in water, such as Cu and cyanide.



Measurement of polyethylene glycol



Analysis of polyurethane resin

## ● High-performance Liquid Chromatograph GPC System

A system for measuring the molecular weight distribution of polymers. It is equipped with visual, easy-to-use calibration curve creation functions, simple graph overwriting functions, and ASCII conversion functions. Also, using features such as time correction based on internal standard peaks, detector delay correction, and sensitivity correction for refractive index detector, it is possible to adjust the whole system and thereby perform accurate molecular weight calculations.

# Mass Evaluation

Mass is one of the most fundamental physical properties of an object. Shimadzu's over eighty years of weighing expertise is integrated with the newest technology to satisfy any requirements of precision weighing.



## ● UniBloc Balances

### Shimadzu's Unique Features

Shimadzu introduced one-piece force cell technology commercially for precision balances in 1989. Today's UniBloc is created by high-precision wire electrical discharge machining applied to a block of aluminum alloy, and replaces the conventional electromagnetic balance sensor assembly. UniBloc's compact, uniform structure ensures stable temperature characteristics, excellent response time and stable corner-load performance. The UniBloc design permits a consistency of production that assures reliability and a long operational life. The updated UniBloc technology expands the UniBloc family balance lineup, which now ranges from semi-micro with a minimum display of 0.01 mg to precision platform balances up to 52 kg in capacity.



## UW Series

Model	Capacity	Minimum display	PSC	Clock-CAL	GLP/GMP/ISO calibration report	Windows Direct
UW220H	220 g	0.001 g	•	•	•	•
UW420H	420 g	0.001 g	•	•	•	•
UW620H	620 g	0.001 g	•	•	•	•
UW820H	820 g	0.001 g	•	•	•	•
UW1020H	1,020 g	0.001 g	•	•	•	•
UW2200H	2,200 g	0.01 g	•	•	•	•
UW4200H	4,200 g	0.01 g	•	•	•	•
UW6200H	6,200 g	0.01 g	•	•	•	•
UW420S	420 g	0.01 g	•	•	•	•
UW820S	820 g	0.01 g	•	•	•	•
UW4200S	4,200 g	0.1 g	•	•	•	•
UW8200S	8,200 g	0.1 g	•	•	•	•

## UX Series

Model	Capacity	Minimum display	PSC	Clock-CAL	GLP/GMP/ISO calibration report	Windows Direct
UX220H	220 g	0.001 g			•	•
UX420H	420 g	0.001 g			•	•
UX620H	620 g	0.001 g			•	•
UX820H	820 g	0.001 g			•	•
UX1020H	1,020 g	0.001 g			•	•
UX2200H	2,200 g	0.01 g			•	•
UX4200H	4,200 g	0.01 g			•	•
UX6200H	6,200 g	0.01 g			•	•
UX420S	420 g	0.01 g			•	•
UX820S	820 g	0.01 g			•	•
UX4200S	4,200 g	0.1 g			•	•
UX8200S	8,200 g	0.1 g			•	•

## ● UW/UX Series Electronic Balances

Shimadzu's newest top-loading balance series provides the supreme combination of performance and innovative features. The weighed result is displayed instantly and stands still. Excellent durability also meets repeated use in production sites. Choice of auto print modes and Shimadzu's unique WindowsDirect function enhance productivity without optional software. Check-weighing modes for quality control purposes and a back light display are also useful features in factory use. Measurement administration is also given good consideration.

A calibration report can be automatically output to meet international standards. The UW is equipped with built-in calibration weight and PSC, and Clock-CAL fully automatic calibration functions as standard.

Specific gravity measurement software is already installed and an optional measurement kit allows more efficient measurements.

# Evaluation of Particle and Powder Properties

Powders are collections of particles distinct from solids and liquids; they have properties and exhibit behaviors that would put them somewhere between solids and liquids. For this reason, measurement of particle size distribution, specific surface area, and pore distribution is usually performed using instruments specifically for the evaluation of the surface properties of powders.

CE



## ● SALD-2300 Laser Diffraction Particle Size Analyzer

SALD Series Standard Model

Measurement range: 17 nm to 2500 mm

Light source: Red semiconductor laser

A new standard models in the SALD series. The analyzer has been equipped with a new function to evaluate changes in particle size distribution with respect to density and time (dispersion, aggregation, and dissolution) while still maintaining data continuity and compatibility with SALD-2000/2100/2200 models that boast the largest number of shipments in Japan. Handling particle concentrations ranging from 0.1 ppm to 20 %, it can now continuously measure up to 200 data points at a minimum of 1-second intervals.

CE



## ● SALD-7500nano Nano Particle Size Analyzer

Ultra-Fine Particle Model

Measurement range: 7 nm to 800 mm

Light source: Blue-violet semiconductor laser (Wavelength 405 nm)

This revolutionary measurement system achieves 10 times the sensitivity of previous models and continuously measures changes in particle size distributions at one-second intervals of particles with diameters in the 7 nm to 800 mm range. In addition, unique options are available to accommodate the measurement of even high-concentration samples (up to 20 wt%) and trace quantity samples (minimum 15 mL).

# Evaluation of Dynamic Strength Properties

Strength is one of the basic properties of material. Shimadzu provides a variety of instruments to measure a wide range of properties, such as basic static strength measurement, fatigue strength with respect to repeated load applications, impact strength with respect to applied shock, and the dynamic behavior of components.

CE



## ● Servopulser E Series Fatigue/Endurance Testing Machines

This standard series, typical of the lineup of Shimadzu electrohydraulic servo-type fatigue testing machines, boasts an extensive track record and consistent performance. It can cover static testing to fatigue tests.

- Maximum Test Force: Dynamic  $\pm 50$ ,  $\pm 100$ ,  $\pm 200$  kN
- Maximum Stroke:  $\pm 25$  mm,  $\pm 50$  mm
- Waveform: Sine, triangular, rectangular, ramp, haversine
- Control: Test force, stroke

CE



## ● MMT Series Electromagnetic Force Micro Material Testing Machines

This series of testing machines adopts an electromagnetic servo actuator to enable fatigue testing of compact parts in the micro test force range. 10 N, 100 N, and 250 N models are available.

# Evaluation of Static Strength Properties

A variety of tests are carried out to test material strength properties. For example, tensile tests, compression tests, and bending tests are used as basic static strength tests to obtain the relationship between the external force and deformation, dynamic fatigue tests are used to obtain information on the durability, and rheology tests are used to obtain processability properties. From high-performance measurement to automatic labor-saving measurement, Shimadzu provides a wide variety of products to meet testing requirements.



Table-top Model

Floor Model

## ● AG-X plus Series Autograph

Designed for reliability and ease-of-use, these precision universal testers provide high control and measurement performance. For the three most important functions of a testing machine - setting, measurement, and inspection - enjoy the highest level of performance available. TRAPEZIUM X PC software uses newly designed, state-of-the-art. NET technology that ensures operation is easier than ever. Additionally, perform tests without a computer via a color TFT touch panel, use the USB memory function to directly set test parameters created previously on a PC, and then easily transfer result data to a USB device. Choose from several floor-type and tabletop models to fit your application needs.

• Capacity : 10 N to 2000 kN (16 models)

## Major Applicable Standards

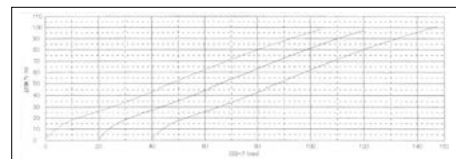
### Plastics

- JIS K 7161 Plastics—Determination of tensile properties Part 1: General principles (ISO 527-1, ASTM D5938)
- JIS K 7162 Plastics—Determination of tensile properties Part 2: Test conditions for moulding and extrusion plastics (ISO 527-2, ASTM D5937)
- JIS K 7171 Plastics—Determination of flexural properties (ISO 178, ASTM D5943)
- JIS K 7127 Plastics—Determination of tensile properties—Part 3: Test conditions for films and sheets (ISO 527-3)
- JIS K 7181 Plastics—Determination of compressive properties (ISO 604)

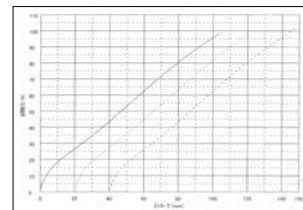
### Rubber

- JIS K 6251 Tensile testing methods for vulcanized rubber (ISO 037)
- JIS K 6252 Rubber, vulcanized or thermoplastics—Determination of tear strength (ISO 34-1, -2)
- JIS K 6254 Vulcanized rubber—Determination of stress-strain properties at low deformation
- JIS K 6256 Adhesion testing methods for rubber, vulcanized or thermoplastic
- JIS K 6257 Accelerated aging test methods for vulcanized rubber

## Examples of Data Created with an Autograph

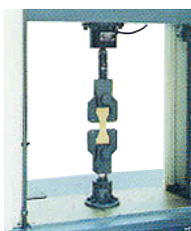


Display during testing



Graph of test force against stroke

## Tensile, Compression, Bending, and Environmental Tests



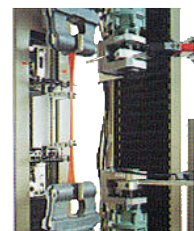
Tensile test for plastics



Compression test for foam rubber



Bending test



Gauged extension measurement



Environmental test



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EZ-SX	EZ-LX	EZ-LX HS
Max. 500 N	Max. 5 kN	Max. 2 kN
0.001 to 1000 mm/min.		0.001 to 2000 mm/min.
500 mm	920 mm	

● **EZ Test Compact Table-top Material Tester**

This compact, slim instrument is equipped with advanced functions to support highly efficient tests.

**NEW DESIGN**

- The compact size fits easily on tables.
- Lower table height (20% lower) and larger work space
- This makes it easier to exchange jigs and samples and to perform a wide variety of operations.

**HIGH PERFORMANCE**

- EZ Test uses a high-precision load cell that guarantees accuracy to within  $\pm 0.5\%$  of the indicted value over a wide range from 1/500 to 1/1 of the load cell capacity.
- Tests can be performed at up to maximum load capacity levels across the entire test speed range from 0.001 to 2000 mm/min (HS model).
- Maximum test speed: 2000 mm/min, Return speed: 3000 mm/min (HS model) The high return speed significantly reduces the wait time between tests, even for those with long displacements.
- EZ Test can measure 1000 data per sec, enabling accurate detection of peak force.

**IMPROVED USABILITY**

- Enhanced usability by the adjustable controller  
This allows for adjusting the control panel position and angle to match the posture of the operator.
- Visual, user-friendly TRAPEZIUMX software  
4 software platforms-Single, Cycle, Control, and Texture-enable various types of evaluation.
- Power-saving function reduces power consumption by over 55% compared to previous models.

CE



● **HMV-G Series Micro Hardness Testers**

This series of testers is widely used for measuring the hardness of quenched parts and testing the hardness of welded parts. It automatically reads the distance across opposite corners of indents at a resolution of  $0.09 \mu\text{m}$  (when a 40x objective lens is used).

Test Force: 98.07 mN to 19.61 N

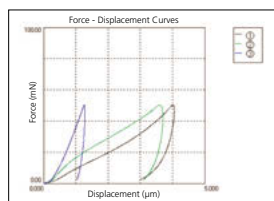
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● **DUH-211/2115 Dynamic Ultra Micro Hardness Tester**

This system is for evaluating the strength of materials, such as semiconductors, LSIs, ceramics, hard disks, evaporated thin films, and coating layers, in the micro region, that cannot be handled on conventional testing machines. It can also be used for the hardness evaluation of plastics and rubber.

CE



Compression Test Results of 3 Types of Separators

● **MCT Series Micro Compression Testing Machines**

This series of testing machines measures the pressure crack strength of individual particulates (with a diameter  $1 \mu\text{m}$  or more). As a result, the compression characteristics of anode active material particles can be evaluated. Also, by adding on the side observation kit (option), the fracture process of anode powders can be observed and compression characteristics data can be linked with images.

# Global Network

Shimadzu maintains a network of sales, service, technical support and application centers around the world. This network is based on our overseas business structure that designates five major target areas; North America, Central and South America, Europe, China, and Asia-Oceania.

Our sales and service operations are designated to meet the unique requirements of local markets.

## Global Activity

<p>Shimadzu Europa GmbH</p> 	<p>Shimadzu (Suzhou) Instruments Manufacturing Co., Ltd</p> 	<p>Shimadzu Head Office Kyoto Japan</p> 	<p>Shimadzu Scientific Instruments, Inc.</p> 
 <ul style="list-style-type: none"> <li>● Overseas offices</li> <li>▲ Production bases</li> <li>● Distributors</li> </ul>			
<p>Shimadzu (China) Co., Ltd</p> 	<p>Shimadzu (Asia Pacific) Pte., Ltd</p> 	<p>Shimadzu Murasaki Factory Kyoto Japan</p> 	<p>Shimadzu do Brasil Comercio Ltda.</p> 



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