Dynamic Ultra Micro Hardness Testers

DUH-211/211S
System for Evaluating Thin Films, Surface-Treated Layers, and Microelectronic Parts
Dynamic Ultra Micro Hardness Testers
DUH-211/211S
Building on our experience with hardness evaluation technology for the micro range, we have taken our quest for greater precision and ease of use to the next level. Our hardness tester can measure the strength properties of material surfaces and microscopic materials using new evaluation methods specified in ISO standards.

Perform evaluation using the hardness and materials parameters specified in ISO 14577-1 (Annex A) *1).

Evaluates hardness of a wide range of materials

- Thin films
- Plastics
- Rubbers and elastomers
- Metallic materials
- Fibers
- Brittle materials
- Microscopic electronic components

Test the surface strength of thin films, surface-treated layers such as ion-implanted layers and nitride layers, as well as nonmetallic materials such as plastics, rubbers, and ceramics.

*1 ISO 14577-1 Metallic materials - Instrumented indentation test for hardness and materials parameters Part 1: Test method
Annex A Materials parameters determined from the force/indentation depth date set
Standard used for new evaluation methods that continuously measure changes in test force and indentation depth which occur when an indenter is pressed into a material, and for the evaluation of material hardness and strength properties such as Young's modulus and creep deformation.
Materials and Applications

Thin Films Such as Vapor-Deposited Films and Semiconductor Materials, and Surface-Treated Layers Such as Ion- Implanted Layers and Nitride Layers

As film production technology improves and diversifies, it is becoming increasingly important to evaluate the hardness of thin films and coatings on the surface of materials. These include ion-implanted layers, DLC (diamond-like carbon) films, and vapor-deposited films produced by CVD (chemical vapor deposition) and PVD (physical vapor deposition). By using an ultra micro test force to measure depths of less than one tenth of a film's thickness, the DUH tester makes it easy to evaluate the hardness of only the film, without influence from underlying materials.

DLC Films

DLC films offer properties such as high hardness, low friction coefficients, wear resistance, electrical insulation, chemical resistance, and infrared light permeability, and are widely used in tools, automotive parts, semiconductor manufacturing equipment parts, and household goods. Measuring the hardness of such films is necessary for determining the optimal film manufacturing parameters and for monitoring their quality, but creating large indentations is not possible. The DUH is perfect for these types of application, because it can evaluate hardness based on the indentation depth using only a small test force.

Plastics

An important feature of engineering plastics is hardness. The DUH can measure the hardness of even highly light-absorbent materials, which are difficult to measure using conventional testers. Engineering plastics offer high strength, heat resistance, and other properties while still providing the advantages of plastics in general such as superior plasticity and ease of processing. As a result, they are commonly used for internal mechanical parts (such as gears and bearings) in consumer electronic products. They provide higher wear resistance, lighter weight, and lower cost than metal parts, and can be mass produced, where hardness is used to improve performance and control quality. However, the low reflectivity of plastics makes it difficult to measure the size of indentations when using conventional hardness testers. In contrast, the DUH is perfect for these applications, because it evaluates hardness based on the test force applied and the resulting indentation depth.

Rubbers and Elastomers

Because indentation depth is used to determine hardness, hardness can be measured using a variety of test forces and the tester can even be used to evaluate deterioration in material surfaces of materials. Rubber provides a low elastic modulus, high elongation in response to small forces, and high repulsion. Consequently, its raw materials are often mixed with various chemical ingredients to make a variety of products, such as tires, vibration absorbing rubber, and O-rings. Due to the harsh environments where such products are typically used, in addition to evaluating durability, hardness is used to also evaluate surface deterioration. However, conventional hardness testers cannot evaluate the elastic characteristics of rubber because of the indentation after testing. In contrast, the DUH measures both the test force and indentation depth, which makes it the perfect method for evaluating rubber, including its elasticity.
Metallic Materials

Perform micro-region hardness measurement, which has become increasingly difficult as feature sizes have become ever smaller.

Brittle Materials Such as Glass and Ceramics

Use a small test force to evaluate the hardness of brittle materials without generating cracks. Measure the test force required to generate cracks. Because glass is clear, hard, highly resistant to thermal deformation, and a good electrical insulator, it is used for a wide range of applications, from window glazing and display screens to various substrate materials, such as for CDs. On the other hand, glass also tends to be brittle and thus requires various material and processing method modifications for it to be used in, for example, large thin display applications. Hardness is used to evaluate glass, but large test forces cause cracks and the indentations are not clearly visible. Therefore, the DUH is ideal for evaluating glass, because it determines hardness based on the indentation depth using a small test force.

Ultra-Fine Fibers Such as Optical Fibers and Carbon Fibers

Evaluate the strength of specimens taken from composite fiber materials and obtain important information. Measure the hardness of fibers.

Micro Powders

Advances are being made to create ever finer micro powders in an effort to increase their surface area-to-volume ratios. The strength of powders is evaluated using compression testing, but due to the size of the particles, the DUH is ideal for measuring their hardness in more detail.
**Features**

1. **Evaluation of Hardness and Material Parameters in Accordance with Standards (ISO 14577-1 Annex A)**
   Measure the behavior of a specimen as an indenter is pressed into it and evaluate the hardness, elastic modulus, and amount of work done during indentation, in compliance with ISO 14577-1 (instrumented indentation test for hardness) Annex A.

2. **Highly Precise Evaluation of Elastic Modulus**
   Perform highly precise evaluation of the elastic modulus, using correction based on instrument rigidity and the shape of the indenter tip.

3. **Low Test Force with Measurement Resolution of 0.196 µN**
   Control the test force using a high resolution of 0.196 µN. This allows measurement of material strength properties in micro regions and in the outermost surfaces of specimens.

4. **Ultra-Wide Test Force Range of 0.1 to 1,961 mN**
   Use a wide test range of 0.1 to 1,961 mN for measurement, and test a variety of industrial materials, including rubber, plastics, and ceramics.

5. **High-Precision Measurement of Indentation Depth**
   No need to measure the actual indentation. Specimen indentation depth can be measured in units of 0.0001 µm for depths up to 10 µm.

6. **Supports a Wide Range of Testing Methods**
   Record the relationship between the test force and the indentation depth. Test both the unload and load processes. Use the DUH-211S to perform cyclic load-unload tests and step load-unload tests.

7. **Supports Vickers Hardness Test**
   A function to measure the length of diagonals is provided as a standard feature. This function allows you to measure the hardness that corresponds only to plastic deformation, Vickers hardness, and Knoop hardness. (A Vickers indenter and Knoop indenter are available as options.) Maximum microscope magnification is 500× (1000× is available as an option).

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### Measurement Principle

Electromagnetic force is used to press an indenter (standard type: 115° triangular pyramid) against a specimen. Pressing force is increased at a constant rate, from 0 to the preset test force. Indentation depth is automatically measured as the indenter is pressed against the specimen. This allows dynamic measurement of changes that occur in the specimen’s resistance to deformation during the indentation process, and obtains a wide variety of data. During indentation the DUH-211S measures dynamic hardness and evaluates the hardness that corresponds to both plastic and elastic deformation. Also, if the indentation size is large enough to be observed with a microscope, hardness can be calculated using just the plastic deformation, by measuring the diagonal length of the indentation.

#### Expressions for Dynamic Hardness

1. **115° triangular pyramid indenter (standard)**
   \[ D_{HT115} = \frac{3.8584 \times F}{h^2} \]  
2. **100° triangular pyramid indenter (option)**
   \[ D_{HT100} = \frac{15.018 \times F}{h^2} \]  
3. **Vickers indenter (option)**
   \[ DHV = \frac{3.8584 \times F}{h^2} \]  
4. **Knoop indenter (option)**
   \[ DHK = \frac{1.5583 \times F}{h^2} \]  

Even though the theoretical unit for these hardness expressions is kgf/mm², it is normally not used.

#### Expressions for Martens Hardness (ISO 14577-1 Annex A)

1. **115° triangular pyramid indenter (standard)**
   \[ HM_{115} = \frac{1000 \times F}{26.43 \times h^2} \]  
2. **Vickers indenter (option)**
   \[ HMV = \frac{1000 \times F}{26.43 \times h^2} \]  

#### Hardness Expressions Based on Diagonal Length

1. **115° triangular pyramid indenter (standard)**
   \[ HT_{115} = \frac{160.07 \times F}{d^2} \]  
2. **100° triangular pyramid indenter (option)**
   \[ HT_{100} = \frac{121.53 \times F}{d^2} \]  
3. **Vickers indenter (option)**
   \[ HV = \frac{189.10 \times F}{d^2} \]  
4. **Knoop indenter (option)**
   \[ HK = \frac{1451.1 \times F}{d^2} \]
Functions

Combines Easy Operability and High-Level Data Processing Functions

Model used to perform three basic tests: DUH-211
Advanced model provides seven test modes: DUH-211S

Parameters required for each type of test can be viewed at a glance.

Test Types

<table>
<thead>
<tr>
<th>Item</th>
<th>DUH-211</th>
<th>DUH-211S</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Load–Hold Test</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>2. Load–Unload Test</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>3. Cyclic Test</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>4. Depth Setting Test</td>
<td>—</td>
<td>○</td>
</tr>
<tr>
<td>5. Depth Setting Load–Unload Test</td>
<td>—</td>
<td>○</td>
</tr>
<tr>
<td>6. Step Load Test</td>
<td>—</td>
<td>○</td>
</tr>
<tr>
<td>7. Step Load–Unload Test</td>
<td>—</td>
<td>○</td>
</tr>
</tbody>
</table>

Indentation size can be measured in tests 1, 2, 4, and 5.

DUH-211/211S Dynamic Ultra Micro Hardness Testers
Data Processing

Simply set the required items to obtain the desired information.

Data Processing Items
- Results display
- Data output for test force and depth
- Graph output for test force and depth
- Graph output for hardness and depth
- Graph output for hardness between 2 points and depth
- Graph output for depth and time
- Graph output for hardness and test force
- Graph output for depth squared and test force
- Hardness calculation based on preliminary test force
- Graph output for hardness and parameters
- Calculation of converted hardness values
- Repeated changes of surface detection points
- Calculation of elastic modulus
- ASCII file output

Example of test results display (load–unload test)

Graph of depth squared against test force

Calculation of elastic modulus
ISO 14577-1 (Annex A) Compliant Evaluation
(Instrumented Indentation Test for Hardness)

Relationship between test force and indentation depth during indentation process can, in accordance with ISO 14577-1 (Annex A), be used to evaluate hardness, elastic modulus, and amount of work done.

- **HM**: Martens hardness
- **HM**: Martens hardness obtained from gradient of graph of test force versus depth
- **H**: Indentation hardness
- **E**: Indentation elastic modulus

### 1. Indentation Elastic Modulus (E)

Definition of indentation elastic modulus (E) states that E is obtained from the inclination of the tangent used to calculate the indentation hardness (H), and is equivalent to Young’s modulus.

\[
1 = \frac{1 - \nu_i^2}{E_i} + \frac{1 - \nu_s^2}{E_s}
\]

\[S = \frac{dP}{dh} = 2 \cdot E_r \cdot A_p \cdot 0.5 / \pi 0.5
\]

\[A_p = 23.96 \cdot h_c^2
\]

\[h_i = h_{\text{max}} - 0.75(h_{\text{max}} - h_r)
\]

If Poisson’s ratio for the specimen is set in the test parameters, the DUH-211/211S calculates E. Otherwise, the DUH-211/211S calculates \((1 - \nu_s^2) / E_s\).

### 2. Plastic and Elastic Portions of Indentation Work (\(\eta\))

A portion of the total mechanical work performed by indentation, \(W_{\text{total}}\), is consumed due to plastic deformation, \(W_{\text{plast}}\). The remaining portion of the total mechanical work corresponds to elastic deformation, \(W_{\text{elast}}\), which is released when the test force is unloaded. This work is defined by \(W = \int Fdh\).

\[
\eta_{it} = \frac{W_{\text{elast}}}{W_{\text{total}}} \times 100\%
\]

\[W_{\text{total}} = W_{\text{elast}} + W_{\text{plast}}
\]

Test Examples

- **Specimen**: Fused silica
  - Test force: 1 mN

- **Specimen**: Copper alloy
  - Test force: 1 mN
### Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>DUH-211</th>
<th>DUH-211S</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Loading Unit</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loading Method</td>
<td>Electromagnetic coil</td>
<td></td>
</tr>
<tr>
<td>Test Force Range</td>
<td>Full scale of 0.1 to 1,961 mN</td>
<td></td>
</tr>
<tr>
<td>Test Force Accuracy</td>
<td>±19.6 µN or ±1% of displayed test force, whichever is greater</td>
<td></td>
</tr>
<tr>
<td>Minimum Measurement Increment</td>
<td>0.196 µN (for a test force not exceeding 1.96 mN)</td>
<td></td>
</tr>
<tr>
<td><strong>Displacement Measurement Unit</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measurement Method</td>
<td>Differential transformer</td>
<td></td>
</tr>
<tr>
<td>Measurement Range</td>
<td>0 to 10 µm</td>
<td></td>
</tr>
<tr>
<td>Minimum Measurement Increment</td>
<td>0.0001 µm</td>
<td></td>
</tr>
<tr>
<td>Linearity</td>
<td>±2% of full scale (20 µm)</td>
<td></td>
</tr>
<tr>
<td><strong>Indenter</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td>Triangular pyramid indenter with tip angle of 115° (Vickers indenter and Knoop indenter are available as options.)</td>
<td></td>
</tr>
<tr>
<td>Tip Radius</td>
<td>0.1 µm max.</td>
<td></td>
</tr>
<tr>
<td><strong>Optical Monitor</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Magnification (microscope)</td>
<td>x500</td>
<td></td>
</tr>
<tr>
<td>Objective Lens</td>
<td>x50 (Up to 2 lenses can be attached)</td>
<td></td>
</tr>
<tr>
<td>Eyepiece</td>
<td>x10</td>
<td></td>
</tr>
<tr>
<td>Lighting Method</td>
<td>Reflected illumination</td>
<td></td>
</tr>
<tr>
<td>Light Source (lamp)</td>
<td>LED: 3 W, 3 V</td>
<td></td>
</tr>
<tr>
<td>Light-Path Switching</td>
<td>Observation or photograph (selectable)</td>
<td></td>
</tr>
<tr>
<td><strong>Micrometer</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collimation Method</td>
<td>Direct connection between encoder and control handle; synchronized movement of two indexes</td>
<td></td>
</tr>
<tr>
<td>Detector</td>
<td>Optical encoder</td>
<td></td>
</tr>
<tr>
<td>Effective Measurement Range</td>
<td>200 µm (with x50 objective lens)</td>
<td></td>
</tr>
<tr>
<td>Minimum Measurement Increment</td>
<td>0.01 µm/pulse</td>
<td></td>
</tr>
<tr>
<td><strong>Specimen Stage</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical Distance</td>
<td>Approx. 60 mm</td>
<td></td>
</tr>
<tr>
<td>Area</td>
<td>Approx. 125 (W) × 125 (L) mm</td>
<td></td>
</tr>
<tr>
<td>Stage Movement Range</td>
<td>25 mm in both X and Y directions</td>
<td></td>
</tr>
<tr>
<td>Specimen Holder</td>
<td>Specimen dimensions (i.e., 8 (thickness) × 30 (width) mm) when thin-type attachment (type 3) is used</td>
<td></td>
</tr>
<tr>
<td><strong>Test Modes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Load–Hold Test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Load–Unload Test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyclic Test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depth Setting Test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depth Setting Load–Unload Test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step Load Test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step Load–Unload Test</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Required PC Specifications</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OS</td>
<td>Windows® 7 (32/64 bit edition)</td>
<td></td>
</tr>
<tr>
<td>CPU</td>
<td>1 GHz min.</td>
<td></td>
</tr>
<tr>
<td>Disk Drives</td>
<td>CD-ROM drive</td>
<td></td>
</tr>
<tr>
<td>Display Resolution</td>
<td>1024 × 768 min.</td>
<td></td>
</tr>
<tr>
<td>Expansion Bus</td>
<td>PCI Express ×1, 2 slots min. more than one ×1 slot is required (or slot size ×2 or more)</td>
<td></td>
</tr>
<tr>
<td><strong>Utilities</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power Supply</td>
<td>Single phase, AC 100–115 V ± 10%, AC 230 V ± 10% (Ground resistance 100 Ω max.).</td>
<td></td>
</tr>
<tr>
<td>Power Consumption</td>
<td>Approx. 100 W (not including power consumption of PC)</td>
<td></td>
</tr>
<tr>
<td>Grounding</td>
<td>The ground terminal on 3-prong connectors must be properly grounded with grounding resistance at 100 Ω or less.</td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>Recommended temperature: 23±1°C. Allowable range: 10°C to 35°C</td>
<td></td>
</tr>
<tr>
<td>Vibration</td>
<td>Horizontal vibration: 0.017 Gα max. (at 10 Hz or more) 0.01 µm max. (at less than 10 Hz)  Vertical vibration: 0.010 Gα max. (at 10 Hz or more) 0.005 µm max. (at less than 10 Hz)</td>
<td></td>
</tr>
<tr>
<td>Humidity</td>
<td>80% max. (no condensation)</td>
<td></td>
</tr>
<tr>
<td><strong>Dimensions and Weight</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>External Dimensions</td>
<td>Tester: Approx. 355 (W) × 405 (D) × 530 (H) mm Control unit: Approx. 315 (W) × 375 (D) × 110 (H) mm</td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>Tester: Approx. 60 kg Control unit: Approx. 5 kg</td>
<td></td>
</tr>
</tbody>
</table>

*Windows 7 is registered trademark of Microsoft Corporation in the US and other countries.

### Standard Configuration

<table>
<thead>
<tr>
<th>Name</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardness Tester (main unit)</td>
<td>1</td>
</tr>
<tr>
<td>Objective Lens (x50)</td>
<td>P/N 344-89964-40 1</td>
</tr>
<tr>
<td>Triangular Pyramid Indenter (tip angle: 115°)</td>
<td>P/N 340-47013 1</td>
</tr>
<tr>
<td>Specimen Stage (XY stage)</td>
<td>P/N 347-24205-41 1</td>
</tr>
<tr>
<td>Micrometer Head</td>
<td>P/N 344-17737-40 2</td>
</tr>
<tr>
<td>Specimen Holder</td>
<td>1</td>
</tr>
<tr>
<td>Control Unit</td>
<td>1</td>
</tr>
<tr>
<td>Accessories (Cords, AC adapters, tools, instruction manual, installation disk)</td>
<td>1 set</td>
</tr>
</tbody>
</table>

PC and Printer are not included.

### External Dimensions

![External Dimensions Diagram]

- Hardness tester (main unit).Unit: mm
- Control unit.

**Note:** The original text also includes a table for **Dimensions and Weight**, a list of **Accessories**, and additional specifications for the **PC and Printer**.
Optional Accessories

Length Measurement Kit (Color or Monochrome)
- Length measurement kit, color: P/N 347-24778-44
- Length measurement kit, monochrome: P/N 347-24778-43

Microscope images of the specimen surface can be displayed on the PC screen. Measure the size of indentations on the screen and save the images.

Objective Lens
- x100 objective lens P/N 344-89977-40
- x40 objective lens P/N 347-25400
- x20 objective lens P/N 344-89924-40
- x10 objective lens P/N 344-89941-40
- x40 objective lens with ultra-long operating distance P/N 344-89300-41
- 40x objective lens with ultra-long operating distance

Vickers Hardness Standard Block
- P/N 340-06619-07

BK7 (Glass Test Piece)
- P/N 339-89207-14

Used to obtain the correction factors required for the indenter when measuring the elastic modulus.

Triangular Pyramid Indenter with 100° Tip Angle
- P/N 340-47011

This indenter, with a tip angle of 100°, has a smaller tip radius and makes smaller indentations than an indenter with a tip angle of 115°. Used for testing small-size specimens.

Measurement Kit for Vickers Hardness
- P/N 347-24449-01

The verification in according with standard (ISO 6507-2) is done at the factory. Factory verified for compliance with Vickers hardness test standards. Please order simultaneously with the DUH.

Measurement Kit for Knoop Hardness
- P/N 347-24449-11

The verification in accordance with standard (ISO 4545-2) is done at the factory. Factory verified for compliance with Vickers hardness test standards. Please order simultaneously with the DUH.

Windbreak
- P/N 347-24400-01

This case minimizes the influence of air disturbances, such as due to DUH tester exposure to air flow or sound. W700 x D650 x H750 (mm)

Windbreak (Large type)
- P/N 347-24400-02

In the case that Active Vibration-Absorbing Bench is used this is select. W700 x D650 x H950 (mm)

Vickers Hardness Standard Block
- P/N 340-06619-07

Used for measuring hardness with the 700HMV micro Vickers. Used as a rough guide for Vickers hardness measurement.

Slender Specimen Holder
- P/N 344-82943-40

This attachment is used to firmly hold thin specimens with an outer diameter of 0.15 mm to 1.6 mm, such as sewing machine needles, watch shafts, thin-shaped medical equipment, wires, sintered wires, and nonferrous wires.

Disk-Type Vacuum Suction Unit
- P/N 344-86201-42

Used for 5”, 6”, and 8” wafers. (Air supply for suction must be separately prepared.)

Micrometer Head (Digital Display)
- P/N 347-25447-12 (2 unit)

Used to digitally display the amount of stage movement (up to a maximum of 25 mm) in the front/back or left/right directions in 1 µm increments. (Photo shows this head attached to a stage.)

Objective Micrometer
- P/N 046-60201-02

Used to adjust the microscope’s magnification factor. Marked with scale graduations at 10 µm intervals.

Installation Precautions

Consider the following points when deciding on the installation location of the tester.

1. To minimize vibration:
   1) Install the tester in a location where floor vibration is minimal. Normally, place the tester on a vibration-absorbing bench.
   2) Do not install the tester in a location where people frequently walk by.
   3) Do not install the tester near equipment that generates vibrations.
   4) If possible, install the tester on the first floor of a building.
   5) Install the tester as far away as possible from streets, roads and railway tracks.
   6) Do not perform testing if vibration-generating equipment (e.g., a crane) is being used nearby.

2. To minimize air drafts and sounds:
   1) Do not install the tester in locations that are directly or indirectly subject to streams of air from air-conditioning equipment.
   2) Do not install the tester near a water system. Do not install the tester near sound-generating equipment (e.g., telephones).
   3) Do not install or close nearby doors during testing.
   4) Do not install the tester near sound-generating equipment. (Photo shows this head attached to a stage.)

3. To ensure testing accuracy:
   These points are especially important when performing the following types of tests:
   - Tests involving force of 1 mN or less
   - Tests involving the measurement of changes for indentation depths of 0.05 µm or less

   In these cases, be sure to maintain the following conditions:
   - Temperature: No fluctuations greater than ±1°C
   - Vibration: Refer to specification table.
Example of Dynamic Ultra Micro Handness Tester DUH-211/211S Systems

**Electric X-Y Stage System**
- **Stroke**: X-axis, Y-axis ±25 mm (There is the function that the slides 50 mm toward the X-axis. All stroke of X-axis are 100 mm)
- **Resolution**: 0.001 mm
- **Drive method**: Ball screw actuated by stepping motor

* Compatible to electric Z system.

**High-Temperature Unit System**
- **Temperature Setting Range**: From 30°C above room temperature to 250°C (temperature control is possible at 50°C or higher)
- **Accuracy**: Within ±2°C of set temperature
- **Total Magnification of Microscope**: ×400 (objective lens: ×40; eyepiece: ×10)
- **Utilities**: 100V 50/60 Hz

* High-temperature systems are only available when ordering the main unit.

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**Micro Compression Testing Machine**
**MCT Series**
This machine is used to measure the compressive strength of single particles (of diameter 1 µm or greater). The compressive strength of ceramics, plastics, pigments, food products, and pharmaceuticals can be measured at a particulate matter stage, providing data that is closely related to the final application of these substances.

- **Loading Method**: Electromagnetic force 9.807 mN to 1.961 N or 9.807 mN to 4.903 N
- **Indenter**: Diamond, cone-shaped, 50-µmø diameter
- **Displacement Measurement**: Differential transformer 0 µm to 10 µm or 0 µm to 100 µm
- **Optical Monitor**: Equipped with ×500 microscope

**Micro Hardness Tester**
**HMV-G21**
This type of hardness tester automatically measures length using a built-in CCD camera. The automatic measurement function provides easy and worry-free measurements without human error. The innovative G-frame provides a broad work area, dramatically improves operability, and easily accommodates long samples or other samples with a large area.

- **Test Force Range**: 98.07 mN to 19.61 N (Optionally from 9.807 m)
- **Indentation Measurement Time**: Approx. 0.3 sec.
- **Test Force Range**: 98.07 mN to 19.61 N (Optionally from 9.807 m)
- **Indentation Measurement Time**: Approx. 0.3 sec.
- **Electric XY Stage**: Stroke: ±25 mm
- **Autofocus**: Resolution: 0.001 mm

**Fully Automatic Micro Hardness Tester**
**HMV-G-FA**
By including an automatic measurement function, an electric XYZ stage function, and an auto-focus function to a micro Vickers hardness tester used for evaluating the hardness of paint or plating coatings or surface-hardened layers, this automatic hardness tester is able to perform a continuous series of highly precise measurements automatically.

- **Test Force Range**: 98.07 mN to 19.61 N (Optionally from 9.807 m)
- **Electric XY Stage**: Stroke: ±25 mm
- **Autofocus**: Resolution: 0.001 mm

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