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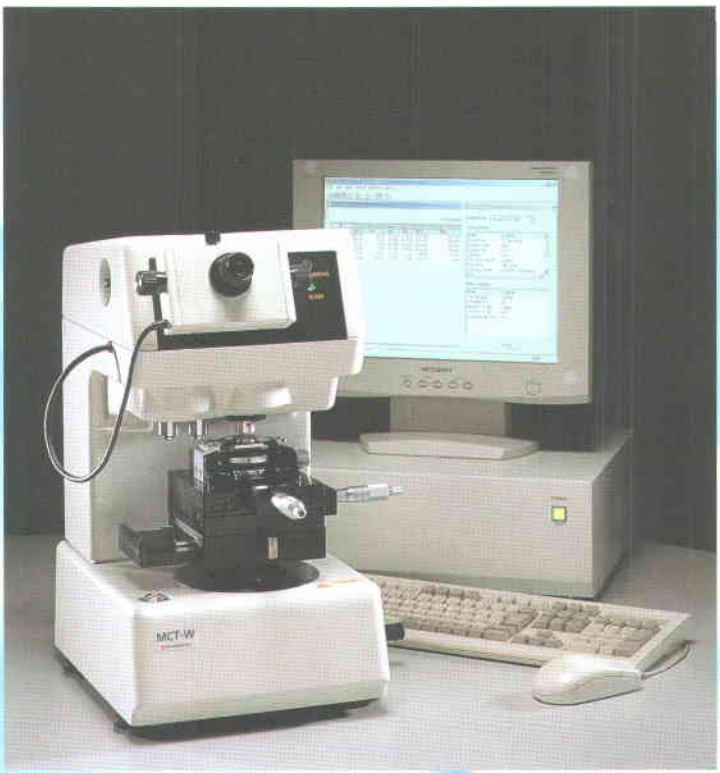
C227-E020

Compression Testing for Powders, Fibers and Micro Materials

Shimadzu Micro Compression Testing Machine

MCT-W

Series



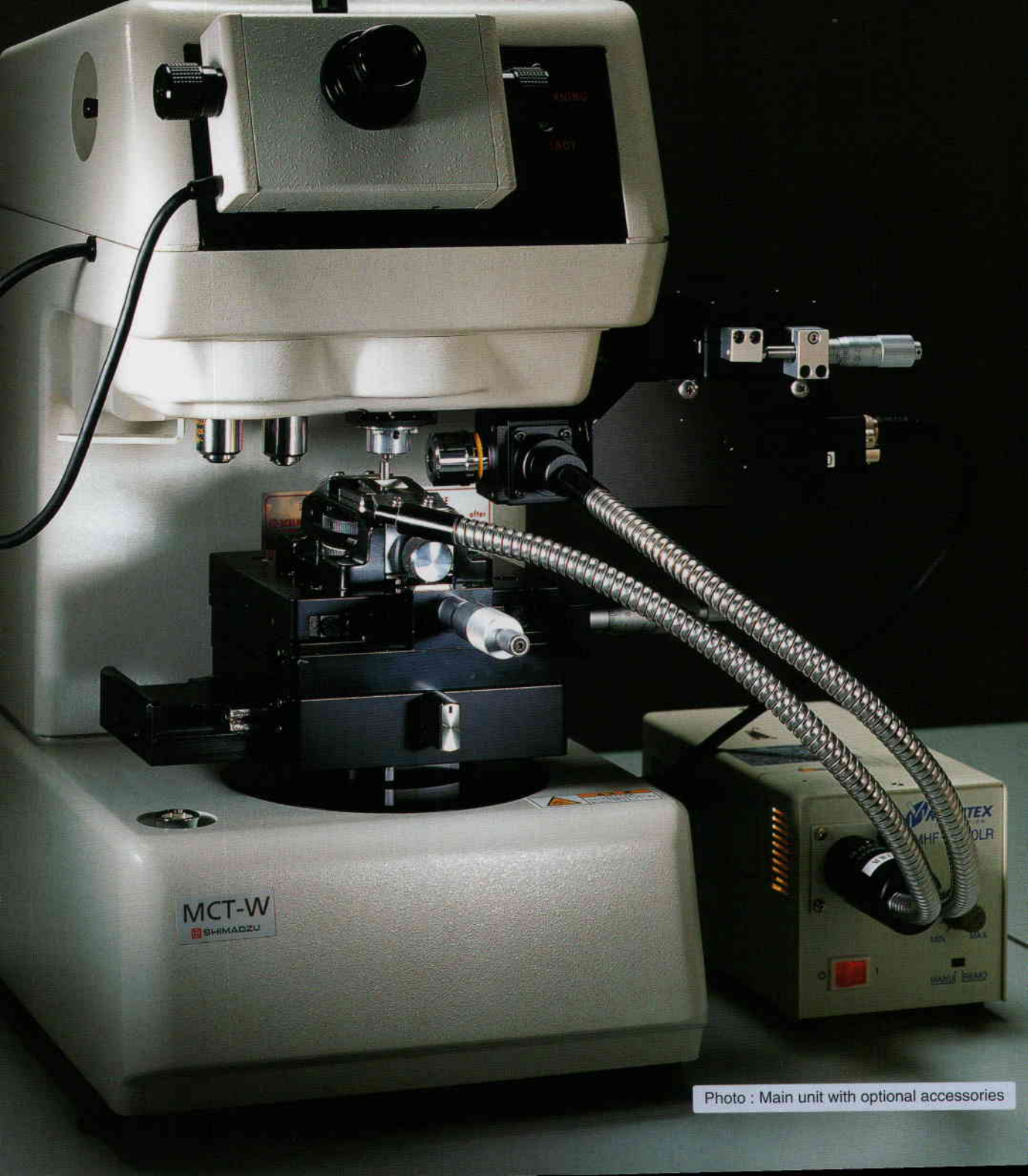


Photo : Main unit with optional accessories

Shimadzu Micro Compression Testing Machine

MCT-W Series

Evaluates Compression Strength of Various of Micro Specimens

The Shimadzu micro compression testers MCT-W Series evaluate the strength of micro components, micro particles generated in powder processing and fine fibers used in new materials.

As production of spherical micro powder particles with diameters from several microns to several 100μm becomes possible with the advancements in metal and ceramic powder manufacturing technologies, it has become necessary to evaluate their characteristics. Fine fibers used in composite materials, as well as various other micro materials, also need to be evaluated for their compression characteristics.

The Shimadzu MCT-W Series is just the right micro compression tester to meet strength-evaluation needs in the fields of micro particles and fine fibers.

Evaluates the compression strength of micro substances.

- **Variety of micro components**
- **Ceramic particles**
- **Fine metallic powder**
- **Resin particles**
- **Pigments**
- **Food source powders**
- **Pharmaceuticals (micro capsules)**
- **Fine fibers**

- Powders, which easily condense and lose fluidity due to their lack of momentum and also disperse easily, are extremely difficult to handle. Particle size enlargement to increase the apparent momentum is a common method to combat this problem. The enlarged particles should not break apart during transportation but have to be easily decomposed to the original particles when, for example, mixed into polymer materials. In other words, they have to be processed to break under a specific load.
- The MCT-W Series, capable of compression characteristics evaluation for each particle, is also ideal for the evaluation of enlarged particles.

A New-Concept Compression Testing Machine for Evaluating the Strength of Micro Materials

1 Micro Compression Displacement Measurement

To enable evaluation of compression characteristics of various micro materials, the MCT-W series provides models with two different resolution and measurement ranges:
- measurement range up to 100μm and resolution of 0.01μm.
- measurement range up to 10μm and resolution of 0.001μm.

2 Wide Load Range

The MCT-W series is available in two different test forces: maximum test forces of 4900mN and 1960mN.

3 Highly Accurate Measurement

Test force are applied at an accuracy of less than ±1% of the set or displayed test force (whichever is greater).

Main Testing Sequence

1. Setting test parameters
2. Specimen observation with a microscope and dimensional measurement (when necessary)
3. Loading
4. Analysis

4 Measurement of Specimen Dimension Provided as Standard

The specimen dimension measurement function that uses an overhead image (provided as standard) enables determination of the geometrical mean diameter and length of the specimen.

5 Length Measurement on PC Screen and Saving of Images (optional)

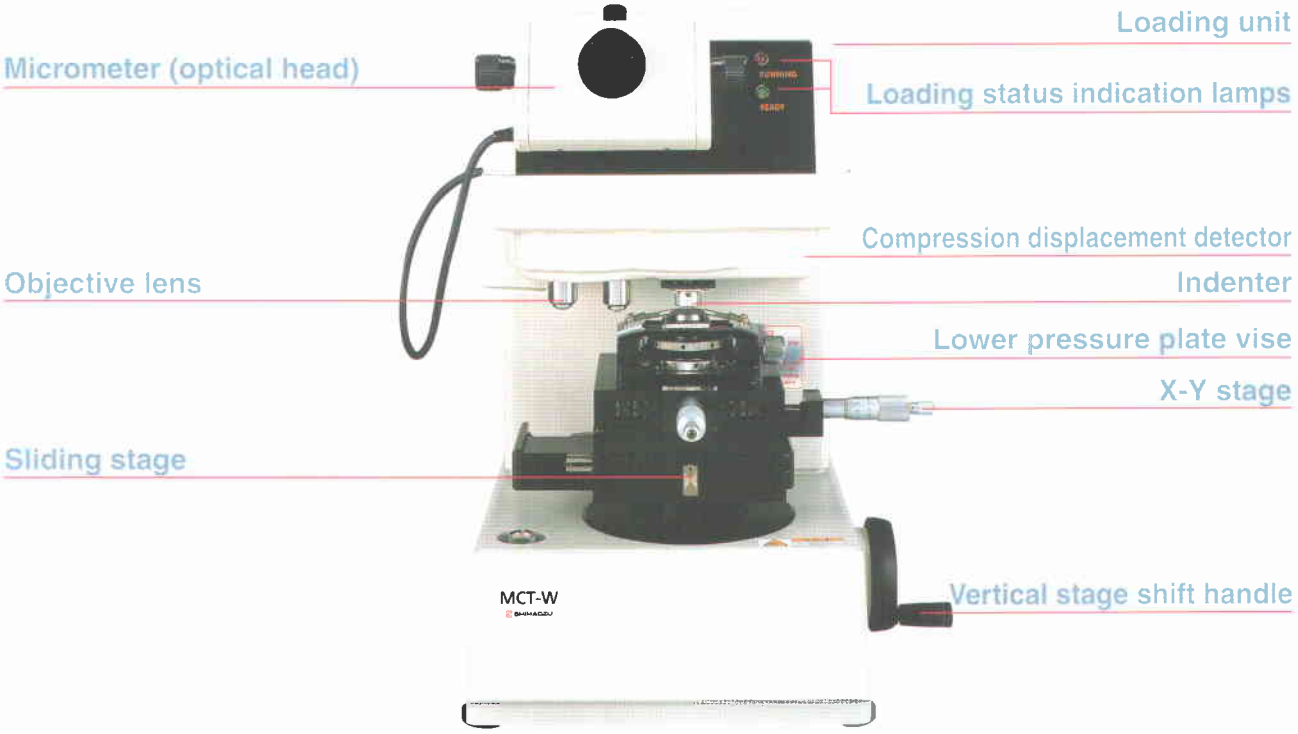
Use the optional length measurement kit (color or monochrome) to display the overhead image on the PC screen to measure the length of the specimen. The image can also be saved as digital data.

6 Display of Specimen Images During Compression (optional)

An image captured in side observation during compression can be displayed (the optional side observation kit is required).

7 Testing also Possible under High-Temperature Conditions (optional system)

Testing can be performed in temperature conditions ranging from 50 to 250°C.



A Design with Simplicity in Mind

Micrometer (optical head)

This unit measures the size of the specimen. The specimen is sandwiched by two indicators to enable measurement up to 200μm at an increment of 0.1μm (when the ×50 objective lens is used). The measured dimension is displayed on the PC screen where it can be further processed to calculate and display the strength of the specimen.

Objective Lenses

The standard ×50 and optional ×100 lenses are available for length measurement. For observation, the standard ×10 and optional ×20 lenses are available.

Sliding Stage

The test point is selected with the micrometer and that point is shifted to just below the indenter. The click-stop mechanism ensures accurate positioning of the specimen. The positioning accuracy is within±5μm (an accuracy of ±0.2μm can be achieved with careful handling).

Vertical Stage Shift Handle

The stage is smoothly shifted with this single handle.

Loading Unit

The test force range is from 9.8 to 4900mN or 1960mN.
The electromagnetic method ensures highly precise loading.

Loading Status Indication Lamps

The red lamp (RUNNING) is lit during loading. The green lamp (READY) indicates that the operator can touch the indenter with safety.

Compression Displacement Detector

A detector is configured in the upper section of the indenter to accurately measure the compression displacement.

Indenters

The following indenters are available.
- 50μm diameter flat indenter
- 500μm diameter flat indenter (optional)
- 115° triangular pyramid indenter (optional)

(The triangular pyramid indenter is used for tests where the specimen is larger than 500μm and cannot be broken at a test load of 4900mN.)

Lower Pressure Plate Vise

This ergonomically constructed vise firmly secures the lower pressure plate.

X-Y Stage

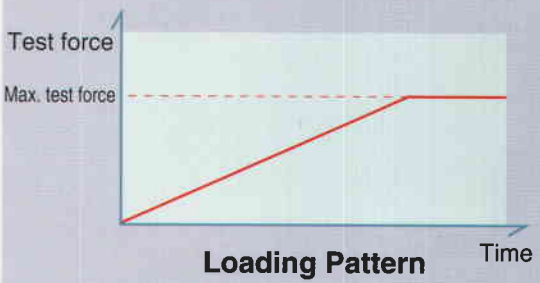
This stage can be shifted over a range of 25mm in the X-Y directions. It can be moved in increments of 0.01mm with the standard micrometer. A digital micrometer is also available as an option.

Testing of Diverse Physical Properties

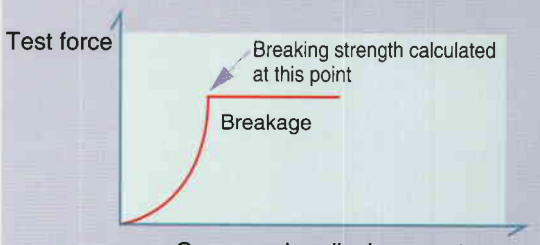
[Choose test modes that suit the purpose of the test.]

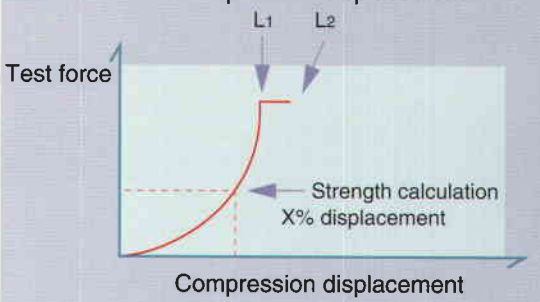
Compression Test

When a particle or fiber is selected as the specimen, force increased to the set point and the compression rupture strength is determined when the specimen breaks, or if the specimen does not break, the strength at time of specified deformation is determined.
For other types of specimens, the test ends at the preset force point.



Loading Pattern



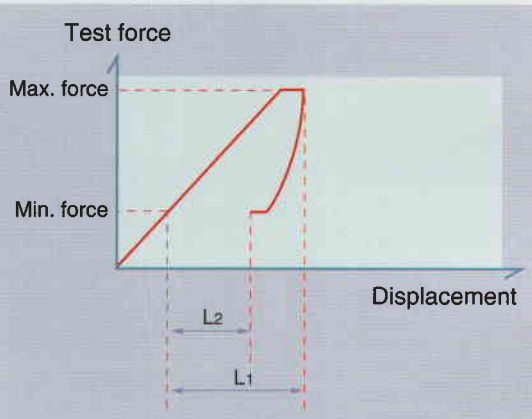


Breaking strength
Compression rupture strength is calculated at the breaking point using two parameters force at breaking point and diameter of the particle.

For particles : St(Sx)=2.8P/ (π × d × d)
For fibers : St(Sx)=2P/ (π × L × d)
St : Strength (MPa)
Sx : Reference strength (MPa)
P : Test force (N)
d : Diameter of particle or fiber (mm)
L : Fiber length (mm)

Load-unload Test

Test force is increased to the maximum force point and then decreased to the minimum force point.



Loading Pattern

For particles and fibers
Compression rate Cr = L1/d × 100
Recovery rate Rr = (L1 - L2)/d × 100

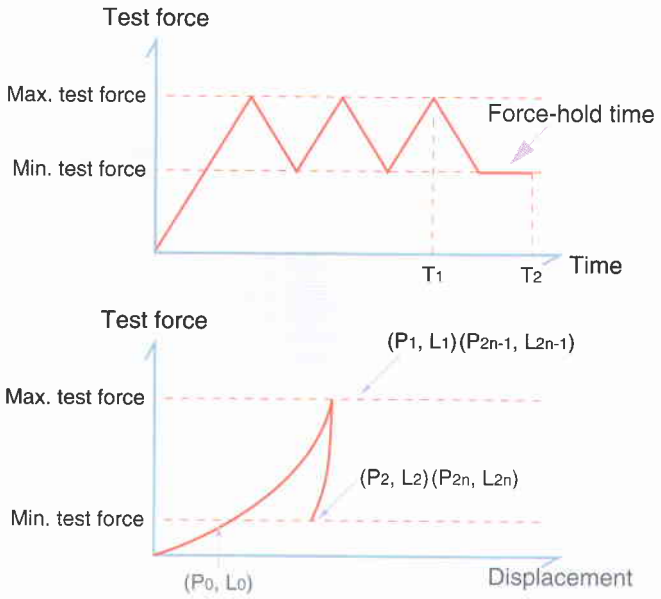
Cr : Compression rate (%)
Rr : Recovery rate (%)
d : Diameter of particle or fiber (μm)
L1 : Displacement 1 (μm)
L2 : Displacement 2 (μm)

Rate of Change
The rate of change is calculated from the displacements at the beginning (L1) and the end (L2) of the load-hold time.

For particles and fibers: Rate of change Cp= (L2 – L1) /d × 100
Other specimens: Variation Dp= L2 – L1
Cp : Rate of change (%)
Dp : Variation (μm)
d : Diameter of particle or fiber (μm)
L1 : Displacement at the beginning of load-hold time (μm)
L2 : Displacement at the end of load-hold time (μm)

Cyclic Test

Test force is repeatedly increased and decreased up to 250 times to evaluate the property of the specimen under repeatedly applied force.



Loading Pattern

The rate or amount of compression and recovery are determined for each cycle.

For particles and fibers :

Compression rate Cr at cycle n = $(L_{2n-1} - L_0)/d \times 100$

Recovery rate Rr at cycle n = $(L_{2n-1} - L_{2n})/d \times 100$

d : Diameter of particle or fiber (μm)

For other specimens :

Amount of compression at cycle n $L_{2n-1} - L_0$

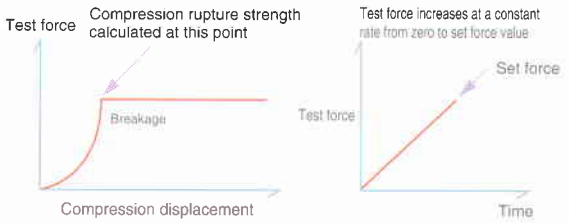
Amount of recovery at cycle n $L_{2n-1} - L_{2n}$

Measurement Principle

A test force at a constant augmented rate is applied to the specimen, secured between the upper pressure indenter (a 50μm flat indenter provided as standard) and the lower pressure plate. The amount of deformation of the specimen is then automatically measured.

The test force can be set between 9.8 and 4900mN, or between 9.8 and 1960mN. Measurement is possible up to 100μm or 10μm at a resolution of 0.01μm or 0.001μm. The pressure and amount of deformation during the specimen deformation are measured and recorded.

This allows dynamic measurement of deformation characteristics of fine particles and provides a wealth of information. Moreover, specimens that include different size of particles can also be evaluated because specimen size can be measured using a microscope.



- A rapid increase in displacement shows that the specimen has been broken.
- The specimens mechanical strength (torsion strength) is determined from the force causing the rupture.

Force: 9.8 to 4900mN or 1960mN load using electromagnetic force

Indenter: Flat indenter
50μm diameter,
500μm diameter (option)
115° triangular pyramid indenter (option)

Compression displacement measurement:
0 to 100μm or 10μm

Specimen : Individual compression of 1 to 500μm diameter particles possible.
Compression of 1 to 500μm diameter fibers possible.
Diluting agent (alcohol, etc.) required in order to dilute specimen for separation.

Specimen sizing : Specimen size can be measured at an increment of 0.1μm using an optical microscope.

●For particles
Mechanical strength acquired using the equation of Hiramatsu et al*.

$$St = \frac{2.8P}{\pi d^2,}$$

●For fibers

$$St = \frac{2P}{\pi dL}$$

St : Torsion strength (MPa)
P : Force (N)
d : Particle diameter or fiber diameter (mm)
L : Fiber length (mm)

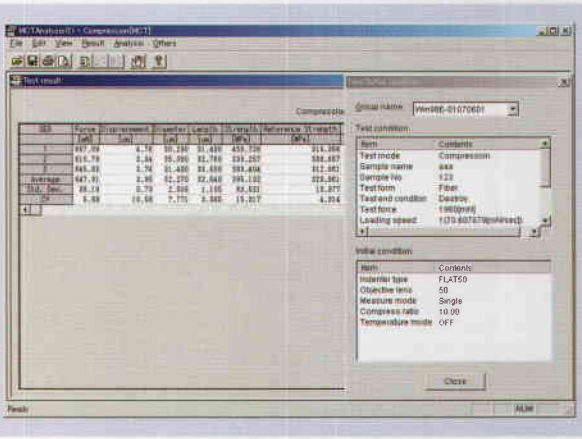
Reference material:
* Hiramatsu, Oka, Kiyama: MMIJ Journal Vol. 81 (1965)

Abundant Analysis Functions Aid Evaluation of Compression Characteristics

Examples of data processing

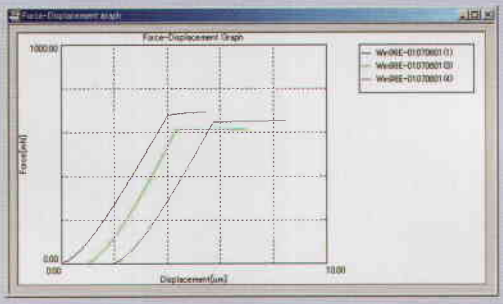
Display of Test Force, Displacement and Strength

Test results (test force, displacement and strength, etc.) are displayed together with the mean values and test parameters.



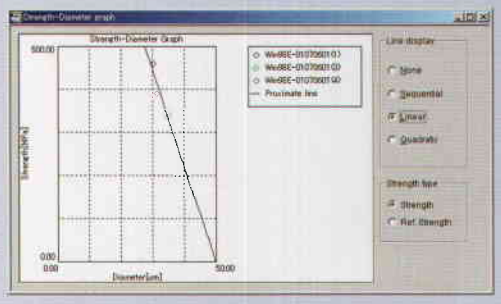
Superimposed Test Force – Displacement Curves

Differences in deformation characteristics of multiple specimens can be graphed for easy comparison by superimposing the test force – displacement curves. The curves can be plotted from the same point of origin.



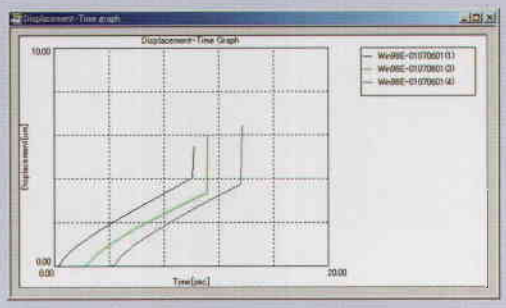
Strength - Particle Diameter Curve

The relationship between particle size and strength is displayed in a graph.



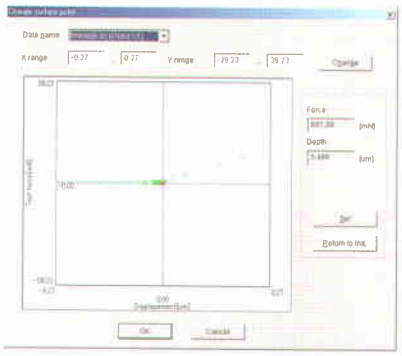
Displacement -Time Curves

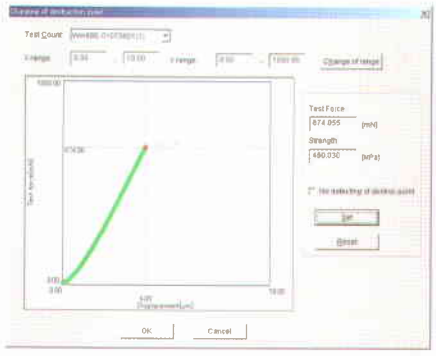
These curves provide information about the deformation resistance the indenter receives from the specimen during deformation.



Checks and Changes for Surface Detection Point and Break Point

The surface detection point and break point - major influences on test results - can be checked and changed during analysis, as well as during testing.





Overhead Image Display on PC Screen

An overhead image of the specimen can be displayed on the PC screen (when the optional length measurement kit is used).

Image Observation During Compression test

The optional side observation kit allows monitoring the specimen from the side direction during compression.

Before compression | Point of contact with specimen | During compression | After breakage

Specifications

	MCT-W Series			
	500	501	200	201
Loading unit				
Loading method	Electromagnetic force			
Loading range(mN)	9.8~4903		9.8~1961	
Load Accuracy	Within ±1% of displayed test force or 0.1mN (whichever is greater)			
Readability	5mN (when testing at 49mN or less)		2mN (when testing at 19mN or less)	
Displacement measurement unit				
Method	Differential transformer			
Measurement range (μm)	0~100	0~10	0~100	0~10
Min. increment (μm)	0.01	0.001	0.01	0.001
Linearity	Within ±2% of full scale			
Optical monitor				
Total magnification	Approx. ×100, ×500 (×200, ×400, ×1000 with option)			
Objective lens	×10, ×50 (×20, ×40, ×100 with option)			
Eyepiece	×10			
Illumination method	Epiluminescent			
Illumination lamp	Halogen 20W / 6V			
Light path	Switching between observation and photography possible			
Optical Head				
Collimation method	Individual collimation on both sides (direct link between encoder and knobs)			
Detector	Optical encoder			
Effective measurement range (μm)	Approx. 200 (with ×50 objective lens)			
Min. increment	0.1μm			
Indenter				
Upper pressure indenter	Type: Flat indenter (50μmdiameter)			
	(500μmflat indenter and triangular pyramid indenter available as option)			
	Material:Diamond, Weight:2.1g±0.02g			
Lower pressure plate	SKS flat plate (Diamond pressure plate available as option)			
Specimen stage				
Vertical positioning range	Approx. 60mm			
Area	Approx. W 130mm × D 130mm			
Horizontal positioning range	25mm for both X and Y directions			
	Min. increment: 0.01mm (0.001mm with option)			
Positioning accuracy	Within ±0.5μm			
Available test parameters				
Test mode	Compression test, load-unload test, cyclic test			
Shape of specimen	Particle, fiber or other shapes			
Specimen name	Max. 16 alphanumeric characters			
Specimen number	Max. 16 alphanumeric characters			
Number of test cycles	Max. 1000			
Comment	Max. 32 alphanumeric characters			
Data Processing Items	Calculation of compression strength, display of test parameters and results			
	Display of test force and displacement data			
	Display of test force/displacement curve			
	Display of test force/displacement identification value			
	Display of strength/particle diameter curve			
	Display of displacement/time curve			
	Display of strength/parameter curve			
Power Supply	AC 50/60Hz 115, 220, 240V ±10% (Selectable) 800VA			
Environment				
Temperature	Recommended temperature: 22°C ±1°C			
	Operating range: 10 to 35°C			
	Temperature change during operation to be kept to within ±1°C			
Humidity	80% or less (no condensation)			
Weight				
Tester Unit	Approx. 45kg			
Control Unit	Approx. 13kg			

Configuration

●Testing machine

	Name	Q' ty
1)	Testing machine main unit	1
2)	Optical head	1
3)	Objective lens (×10)	1
4)	Objective lens (×50)	1
5)	Flat indenter (50μm diameter)	1
6)	Specimen stage (X-Ystage)	1
7)	Micrometer head	2
8)	Thin specimen attachment, type 3	1
9)	Lower compression plate	1

●Control Unit

	Name	Q' ty
1)	Control unit	1
2)	PC	1
3)	Display	1
4)	Printer	1

* Items 2) to 4) are not included in the standard configuration.

PC requirements
OS : Windows 98/Me/NT 4.0/2000
Expansion slot : PCI space x2 (175mm, 120mm, one each to be slotted)

Installation precautions

Read the following precautions to aid selection of installation site.

1.Avoid vibration

(1) Select site with minimal floor vibration. In principle the testing machine should be installed on a shock-absorbing bench.
(2) Avoid installing at sites with heavy human traffic.
(3) Do not place the testing machine near devices that generate vibration.
(4) If possible, do not install the testing machine on second floor or higher, as building may sway.
(5) Install equipment away from roads and rail tracks.
(6) Do not use the testing machine when equipment such as cranes are being operated.

2.Avoid air turbulence and sound

(1) Keep the testing machine away from devices creating air turbulence such as air conditioners and make sure that air turbulence does not directly or indirectly come into contact with the testing machine.
(2) Use a wind breaker when testing.
(3) Do not open and close doors during testing.
(4) Do not place the testing machine close to devices generating sound such as telephones.

External Dimensions

The PC set (PC, CRT and printer) must be purchased separately. This diagram includes the PC set.
Unit : mm