

For the Development and Safety of Next-Generation Automobiles

# Automobile Evaluation Instruments



# **Analytical Instruments, Inspection Systems, and Testing Machines for Providing the Ideal Response to Extensive Evaluation Requirements from Development to Quality Control**

The technologies used in automobiles are being refined and innovated on an ongoing basis to improve safety and comfort and to reduce the impact on the environment. At production sites, too, competition to build reliable automobile parts quickly and cheaply is becoming more and more intense.

This has prompted a shift to the evaluation of the performance of not only individual parts but also modules in various ways, which has necessitated more advanced analysis, inspection, and testing. This catalog introduces Shimadzu's extensive range of evaluation instruments as well as its substantial lineup of analytical, inspection, and testing machines designed to achieve the current themes of:

## **Lighter automobile bodies, and Increased use of clean energy**

\* The products listed in this catalog are part of those offered by Shimadzu.  
Please contact us if you require other options.



## Engines, Motors, and Power Sources

Quality Control of Pig Iron, Aluminum Alloy, and Die Cast Parts  
 Tensile Testing Evaluation of O-Rings  
 Quality Control of Raw Materials, Parts, etc.  
 Qualitative Analysis and Residual Stress Measurement of Various Materials  
 Fatigue/Endurance Testing Machine of Various Materials and Compact Parts  
 Thermal Fatigue Testing of Engine-Related Tubing Materials  
 Internal Pressure Fatigue Testing of Pipes etc.  
 Dynamic Properties Evaluation of Rubber Vibration Isolators  
 Observations of High-Speed Phenomena Related to Automobiles



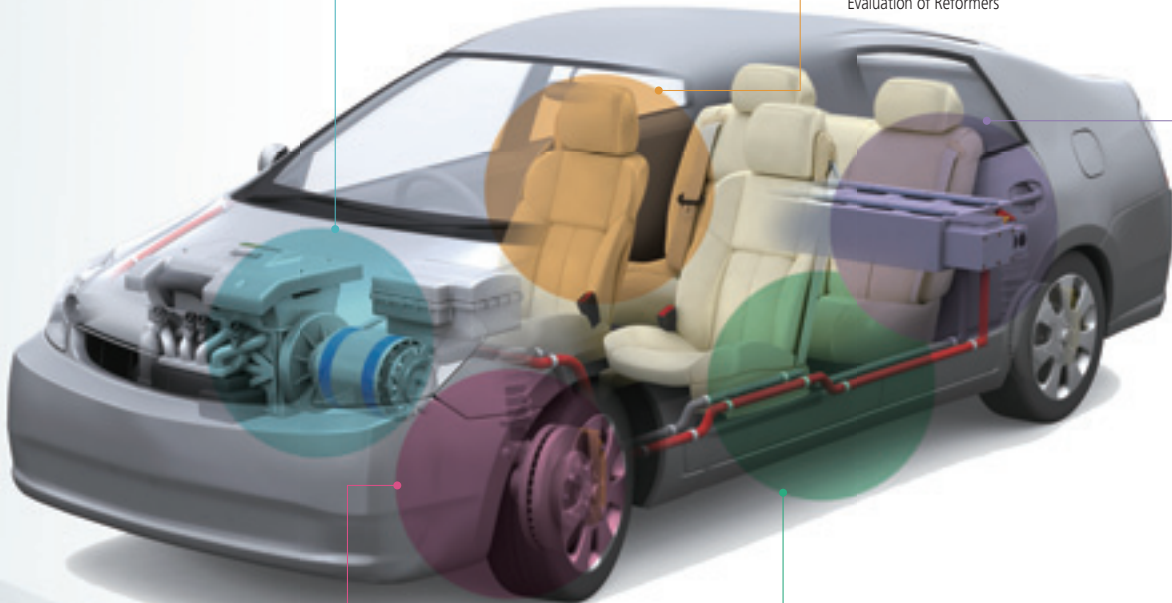
## Bodies and Interiors

Evaluation of Strength of Steel Plating and Various Materials for Bodies  
 Tensile Testing of Seat Belts and Seats  
 Foam Rubber Evaluation of Car Seats  
 Component Analysis/Defect Analysis of Polymer Materials  
 Compositional Verification of Incoming Materials and Evaluation of Plating  
 VOC Measurement & Odor Analysis Inside Automobiles/Physical Properties Evaluation and Structural Analysis of Polymer Materials for Interiors  
 Thermal Analysis of Rubber, Plastics, and Other Polymer Materials  
 High-Speed Tensile Testing of Various Materials and Members and Materials  
 Observations of High-Speed Phenomena Related to Automobiles  
 Testing of Steel Plating for Bodies  
 Evaluation of Thin Plate Formability (Draw Bead Testing)  
 Operation Force Evaluation of Turning Indicator and Wiper Levers  
 Official Certification of Internal Sensors in Crash Test Dummies  
 Static Strength Evaluation of Automobile Bodies  
 Vibration Testing of Various On-Board Component Parts  
 Rollover Evaluation of Car Seats  
 Frictionality Evaluation of Car Seats  
 Durability Evaluation of Seat Belt Buckles  
 Car Seat Lockoff Testing  
 Evaluation of Seat Belt Anchorage  
 Measurement of Automobile Interior VOCs



## Lithium-Ion Rechargeable Batteries and Fuel Cells

Development and Evaluation of All Sorts of Automobile Materials  
 Nanoparticle Measurement of Cathode Materials  
 Internal Observation of Polymer Electrolyte Fuel Cells  
 Surface Observation of Separators/Electrolytes  
 Actual Battery Tests (Nail Penetration/Crush) and Fatigue Testing of Various Actual Parts and Materials for Automobiles  
 Compression Evaluation of Lithium-Ion Rechargeable Batteries  
 X-Ray CT Observation of Batteries and Electronic Instrumentation Components  
 Structural Analysis of Active Materials and Various Materials  
 Compression Characteristics Evaluation of Anode Active Material Particles  
 Non-Contact Elongation/Width Measurement of Films and Foil Used as Separators  
 Nanoparticle Measurement of Cathode Materials  
 Thermal Characteristics Evaluation of Various Polymer Materials  
 Thermal Expansion/Mechanical Properties Evaluation of Various Materials  
 Particle Size Distribution Measurement of Cathode/Anode Active Materials  
 Separation/Quantitation of Electrolytic Solution Components  
 Tensile Strength Evaluation of Electrolyte Films  
 High-Sensitivity Inorganic Gas Analysis  
 Evaluation of Reformers



## Suspension and Other Power Transmission Systems

Measurement of Spring Constant for Suspension  
 Hardness Evaluation of Surface Hardened Layers, Paints, Plated Layers, etc.  
 High-Precision Composition Analysis of Various Materials  
 Composition Analysis of Various Materials for Automobiles  
 Fatigue/Endurance Testing of Various Rotating Parts for Automobiles  
 Torsion Endurance Testing of Drive Shafts, Ball Joints, and Clutches  
 Tire Compression Evaluation  
 Evaluation of Coil Springs/Plate Springs  
 Durability Testing Under Operating Temperature Environments  
 Strength Measurement of Clutch Springs  
 Ultra Micro Hardness Measurement of Various Materials  
 Damping Force Characteristics Evaluation of Automobile Shock Absorbers  
 Endurance Testing of Modules  
 Fatigue Testing Using High Frequency  
 Cyclic Endurance Testing of Automobile Parts  
 Endurance Testing of Engine Mounts  
 Endurance Evaluation of Automobile Parts by Frequency Sweep and Resonance Frequency Tracking Test  
 Endurance Evaluation of Automobile Parts by Multi-Axis Real-Road Wave Testing



## Electronic Instrumentation Components

Various Test Jigs  
 Fatigue/Endurance Testing of Compact Electronic Components  
 Environmental Resistance of Electronic Instrumentation Components  
 Evaluation of Voids in Solder



## Environmental Conservation

Control of VOCs (Volatile Organic Compounds) in Drainage  
 Control of Fluorine, Nitrate Nitrogen, and Nitrite Nitrogen in Drainage  
 Control of Hexavalent Chromium by Simple Measurements  
 Management of Toxic Metals in Drainage, Including Lead (Pb), Total Mercury (Hg), and Cadmium (Cd)



# Instruments in This Catalog

Engines, Motors, and Power Sources

Bodies and Interiors

Lithium-Ion Rechargeable Batteries and Fuel Cells

Suspension and Other Power Transmission Systems

Electronic Instrumentation Components

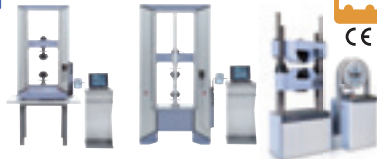
Environmental Conservation

## Quality Control

Evaluation of Strength of Steel Plating and Various Materials for Bodies

Material Tests Used for Automobile Parts

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50 kN Table-Top Model 100 kN Floor Model UH-X/FX Series



Tensile Testing of Seat Belts and Seats  
Measuring the Breaking Strength of Seat Belts

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Foam Rubber Evaluation of Car Seats  
Compression Testing Machine for Foam Rubber Specimens (Autograph)

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Component Analysis/Defect Analysis of Polymer Materials

Infrared Microscope Measuring System  
IRTracer-100 FTIR Spectrophotometer

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Compositional Verification of Incoming Materials and Evaluation of Plating

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

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Measurement of Spring Constant for Suspension  
Large-Capacity Plate Spring Characteristics Evaluation Instrument

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Hardness Evaluation of Surface Hardened Layers, Paints, Plated Layers, etc.

HMV-G Series Micro Hardness Testers

P11



Quality Control of Pig Iron, Aluminum Alloy, and Die Cast Parts

PDA Series Optical Emission Spectrometers

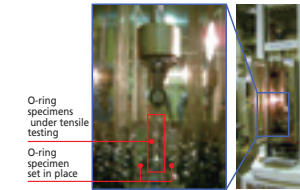
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Tensile Testing Evaluation of O-Rings

Simple In-Chamber Tensile Testing for O-Rings (Autograph)

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O-ring specimens under tensile testing  
O-ring specimen set in place



## Quality Assurance

VOC Measurement & Odor Analysis Inside Automobiles/Physical Properties Evaluation and Structural Analysis of Polymer Materials for Interiors

GCMS-QP2020 Gas Chromatograph Mass Spectrometers

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Thermal Desorption Analysis System



Thermal Decomposition Analysis System



Thermal Analysis of Rubber, Plastics, and Other Polymer Materials

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

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High-Precision Composition Analysis of Various Materials

LAB CENTER XRF-1800 Sequential X-Ray Fluorescence Spectrometer

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Composition Analysis of Various Materials for Automobiles

ICP Series Plasma Emission Spectrometers

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ICPE-9800 Multitype



Composition Analysis of Various Materials for Automobiles

ICP Series Plasma Emission Spectrometers

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ICPS-8100 Twin Sequential Type



Quality Control of Raw Materials, Parts, etc.

MXF-2400 Multi-Channel X-Ray Fluorescence Spectrometer

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Qualitative Analysis and Residual Stress Measurement of Various Materials

XRD-7000S/7000L X-Ray Diffractometer

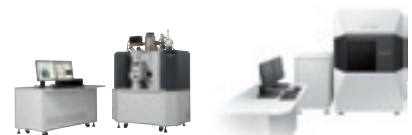
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Development and Evaluation of All Sorts of Automobile Materials

Electron Probe Microanalyzer

P13



EPMA-1720/1720H

EPMA-8050G



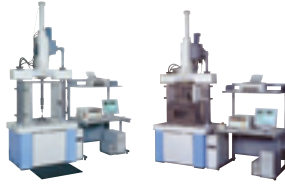
# Instruments in This Catalog

## Research and Development

### High-Speed Tensile Testing of Various Materials and Members and Materials

HITS-T10 HydrosHOT High-Speed Tensile Testing Machine  
Puncture Impact Testing Machine

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### Observations of High-Speed Phenomena Related to Automobiles

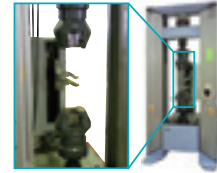
HyperVision HPV-X2 High-Speed Video Camera

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### Testing of Steel Plating for Bodies

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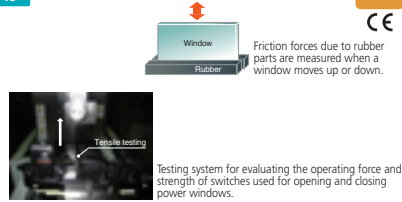
### Evaluation of Thin Plate Formability (Draw Bead Testing)

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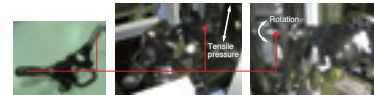
### Testing of Steel Plating for Bodies

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### Operation Force Evaluation of Turning Indicator and Wiper Levers

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### Official Certification of Internal Sensors in Crash Test Dummies

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### Vibration Testing of Various On-Board Component Parts

EHV Series Vibration Testing Machines

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### Measurement of Automobile Interior VOCs

Prominence Series High-Performance Liquid Chromatographs Aldehyde Analysis Systems

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### Fatigue/Endurance Testing of Various Rotating Parts for Automobiles

Torsional Fatigue Testing Machine

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### Torsion Endurance Testing of Drive Shafts, Ball Joints, and Clutches

Torsional Testing Machine for Large Specimens

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### Tire Compression Evaluation

Tire Compression Testing Machine

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### Evaluation of Coil Springs/Plate Springs

Coil Spring/Plate Spring Endurance Testing Machine

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### Durability Testing Under Operating Temperature Environments

Endurance Bench

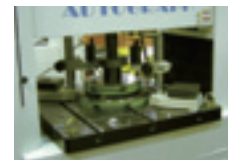
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### Strength Measurement of Clutch Springs

Supported on Autograph

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### Ultra Micro Hardness Measurement of Various Materials

DUH-211/211S Dynamic Ultra Micro Hardness Tester

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### Damping Force Characteristics Evaluation of Automobile Shock Absorbers

Shock Absorber Testing Machine

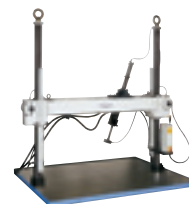
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### Endurance Testing of Modules

Endurance Testing Machine for Modules

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**Fatigue Testing Using High Frequency**

USF-2000 Ultrasonic Fatigue Testing Machine

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**Cyclic Endurance Testing of Automobile Parts**

Compact Hydraulic Actuators  
JF Series Force Simulators

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**Endurance Testing of Engine Mounts**

Multi-Axis Endurance Testing System for Automobile Parts

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**Endurance Evaluation of Automobile Parts by Frequency Sweep and Resonance Frequency Tracking Test**

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**Endurance Evaluation of Automobile Parts by Multi-Axis Real-Road Wave Testing**

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**Fatigue/Endurance Testing Machine of Various Materials and Compact Parts**

Servopulser E Series Fatigue/Endurance Testing Machines

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**Fatigue/Endurance Testing Machine of Various Materials and Compact Parts**

Gasket Compression Testing Machine for Cylinder Heads

P20



**Thermal Fatigue Testing of Engine-Related Tubing Materials**

Thermal Fatigue Testing Machines (Servopulser E Series)

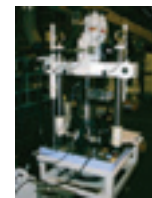
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**Internal Pressure Fatigue Testing of Pipes, etc.**

Internal Pressure Fatigue Testing Machine

P20



**Dynamic Properties Evaluation of Rubber Vibration Isolators**

Rubber Vibration Isolator Dynamic Characteristics Testing Machine

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**Various Test Jigs**

45° Peel Test Jig for Printed Circuit Boards

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**Various Test Jigs**

Shearing Test Jig for Electronic Components

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**Various Test Jigs**

Three-/Four-Point Bending Test Jigs for Printed Circuit Boards

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**Various Test Jigs**

Cyclic Bending Test Jig for Printed Circuit Boards

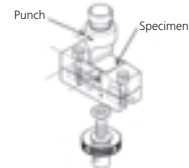
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**Various Test Jigs**

Strength Test Jig for Surface Mounted Components

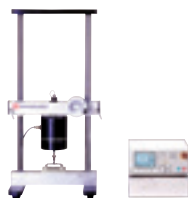
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**Fatigue/Endurance Testing of Compact Electronic Components**

MMT Series Electromagnetic Force Micro Material Testing Machines

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Air-Servo ADT-A Series Pneumatic Fatigue/Endurance Testing Machines

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**Environmental Resistance of Electronic Instrumentation Components**

WET-SPM Series Environment Controlled Scanning Probe Microscopes

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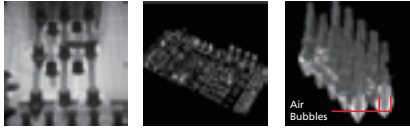
# Instruments in This Catalog

## Research and Development

### Evaluation of Voids in Solder

inspeXio SMX-225CT Microfocus X-Ray CT System

P21



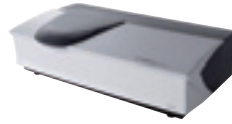
Fluoroscopic Image of Solder Sections    CT Image of Solder on Printed Circuit Board    CT Image of Solder Deficiency and Air Bubbles in Solder



### Nanoparticle Measurement of Cathode Materials

IG-1000 Plus Single Nanoparticle Size Analyzer

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### Observations of High-Speed Phenomena Related to Automobiles

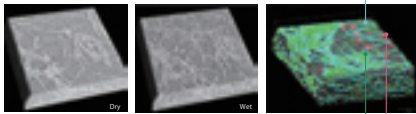
HyperVision HPV-X2 High-Speed Video Camera

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### Internal Observation of Polymer Electrolyte Fuel Cells

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3D Image of Waterdrops Inside GDL Taken by X-Ray CT



### Surface Observation of Separators/Electrolytes

SPM-9700 Scanning Probe Microscope

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### Actual Battery Tests (Nail Penetration/Crush) and Fatigue Testing of Various Actual Parts and Materials for Automobiles

Servopulser EHF-UM/UV Series/Servopulser EMT Series

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EHF-UM/UV Series

### Actual Battery Tests (Nail Penetration/Crush) and Fatigue Testing of Various Actual Parts and Materials for Automobiles

Servopulser EHF-UM/UV Series/Servopulser EMT Series

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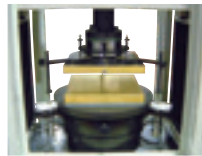
EMT Series



### Compression Evaluation of Lithium-Ion Rechargeable Batteries

Battery Compression Evaluation Instrument

P23



### X-Ray CT Observation of Batteries and Electronic Instrumentation Components

inspeXio SMX-225CT FPD Microfocus X-Ray CT System

P23



### Structural Analysis of Active Materials and Various Materials

XRD-6100 X-Ray Diffractometer

P24



### Compression Characteristics Evaluation of Anode Active Material Particles

MCT Series Micro Compression Testing Machines

P24



### Non-Contact Elongation/Width Measurement of Films and Foil Used as Separators

TRViewX Video Type Non-Contact Extensometer/Width Sensor

P24



### Nanoparticle Measurement of Cathode Materials

IG-1000 Plus Single Nanoparticle Size Analyzer

P24



### Thermal Characteristics Evaluation of Various Polymer Materials

DSC-60 Plus/60A Plus Differential Scanning Calorimeter

P24



### Thermal Expansion/Mechanical Properties Evaluation of Various Materials

TMA-60/60H Thermal Analysis Instrument

P24



### Particle Size Distribution Measurement of Cathode/Anode Active Materials

SALD-7500 nano Laser Diffraction Particle Size Analyzer

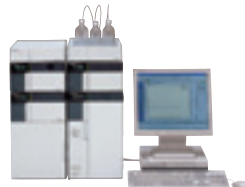
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### Separation/Quantitation of Electrolytic Solution Components

Prominence HIC-SP Ion Chromatograph

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### Tensile Strength Evaluation of Electrolyte Films

Micro Autograph MST-I Micro Strain Tester

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High-Sensitivity Inorganic Gas Analysis

GC-2014 Gas Chromatograph

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Evaluation of Reformers

CGT-7100 Portable Continuous Gas Analyzer

P25



Environmental Conservation

Control of VOCs (Volatile Organic Compounds) in Drainage

GCMS-QP2020 Gas Chromatograph Mass Spectrometer

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Headspace Analysis System



Control of Fluorine, Nitrate Nitrogen, and Nitrite Nitrogen in Drainage

Prominence HPLC Ion Analysis System

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Control of Hexavalent Chromium by Simple Measurements

UV-1280 Water Quality Analysis System

P27



Management of Toxic Metals in Drainage, Including Lead (Pb), Total Mercury (Hg), and Cadmium (Cd)

AA-7000 Series of Atomic Absorption Spectrophotometers

P27

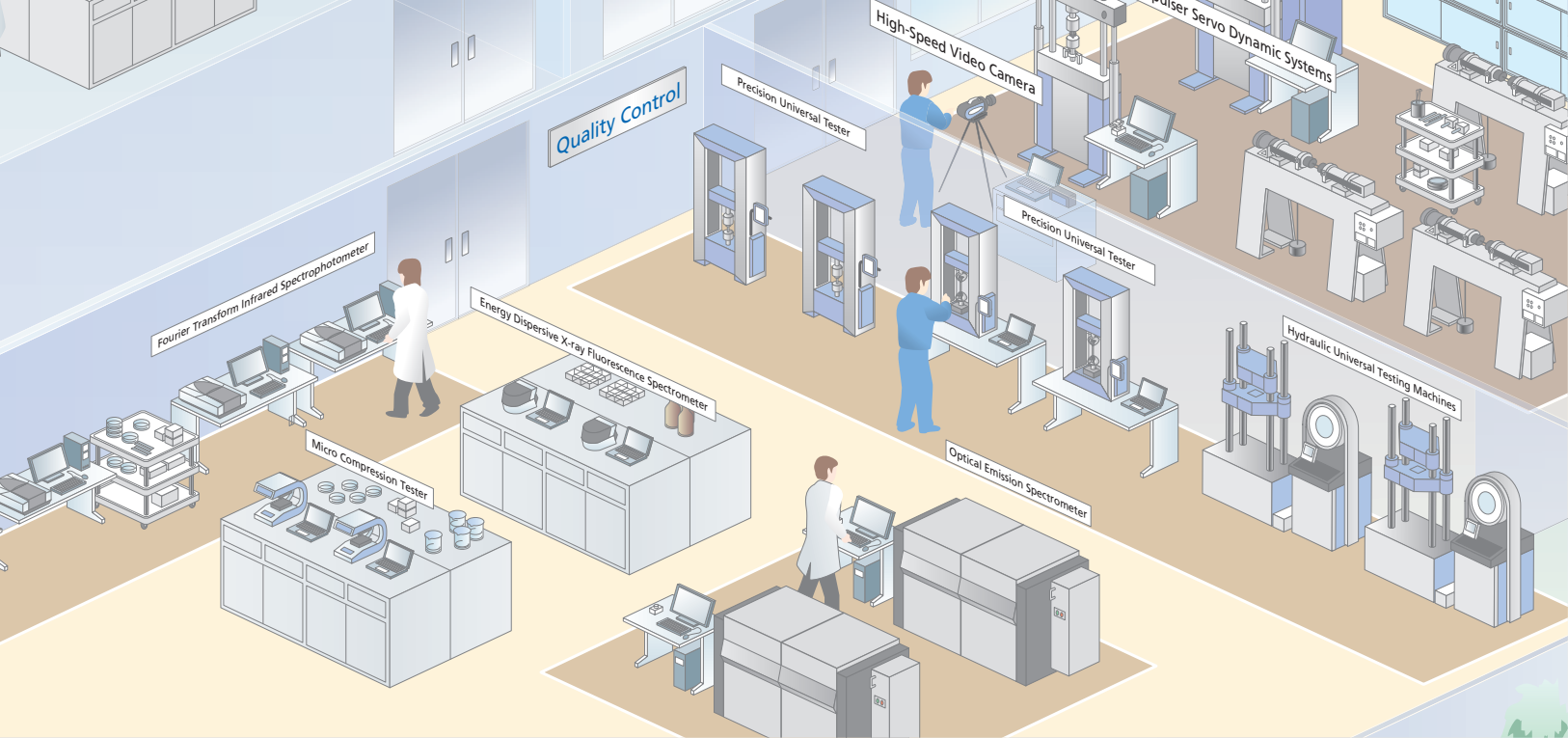


Management of Toxic Metals in Drainage, Including Lead (Pb), Total Mercury (Hg), and Cadmium (Cd)

ICPE-9800 Series of ICP Atomic Emission Spectrometers

P27





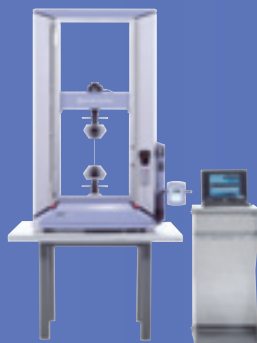
# Quality Control

Automobiles require a high level of safety performance, so performance standards have been established for the materials used in order to maintain safety during design. The strength of materials is used for the standards. For this reason, strength must be evaluated when selecting materials to satisfy the standards and in acceptance inspections. With metal materials, the strength of the material is largely determined by the composition, while with polymers, it is largely determined by the type and density of the molecules used. As a result, a composition analysis of the materials must be performed in order to ensure that the strength of the material is stable. Therefore,

product quality control departments perform strength evaluations and composition analyses of raw materials used in automobiles, including metals, resins, and raw materials with various other material properties. For strength evaluations, tensile, compression, and bending tests, as well as hardness tests are used, while evaluations of material composition require inorganic element analysis and compound analysis. In addition to acceptance inspections in order to confirm that the materials purchased from suppliers meet the required specifications, defect analyses are implemented during the manufacturing process, and are utilized for process improvements.

## Material Tests Used for Automobile Parts

Tests of static characteristics of springs, failure tests of parts, and strength evaluations of the various materials used in automobile parts, including metals, plastics, rubbers, and films, are required. These include acceptance inspections, the evaluation of materials selected, and tests to confirm changes in characteristics due to machining. Tests can be performed in accordance with ISO, ASTM, and other standards.



50 kN Table-Top Model



100 kN Floor Model

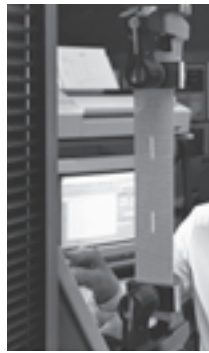


UH-X/FX Series



## Tensile Testing of Seat Belts and Seats

The breaking strength of seat belts is measured.



## Foam Rubber Evaluation of Car Seats

### Compression Testing Machine for Foam Rubber Specimens (Autograph)

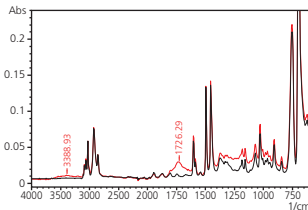
JIS-based compression testing of foam rubber used in seats can be performed. This machine comprises exclusive accessories added onto an Autograph precision universal testing machine.



## Component Analysis/ Defect Analysis of Polymer Materials for Interiors

### Infrared Microscope Measuring System IRTracer-100 FTIR Spectrophotometer

This system can judge the materials of plastics and rubber used in automobile interior parts and battery materials, and can easily analyze their components, deterioration, and defects. Combined with a microscope, this system can analyze even smaller areas and residual quantities.



Infrared Spectrum Comparison of Polystyrene (black: before UV irradiation, red: after UV irradiation)

## Compositional Verification of Incoming Materials and Evaluation of Plating

### 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.



## Hardness Evaluation of Surface Hardened Layers, Paints, Plated Layers, etc.

### 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



## Measurement of Spring Constant for Suspension

### Large-Capacity Plate Spring Characteristics Evaluation Instrument

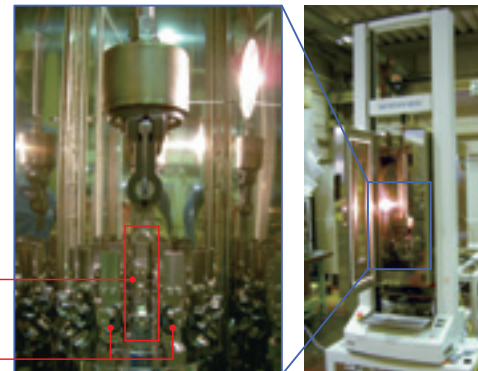
Belleville springs etc. for suspensions, dampers, seats, and motors can be evaluated.



## Tensile Testing Evaluation of O-Rings

### Simple In-Chamber Tensile Testing of O-Rings (Autograph)

16 O-rings can be continuously tested by the dedicated software. This highly versatile instrument also supports conventional manual testing.



O-ring specimen under tensile testing

O-ring specimen set in place

## Quality Control of Pig Iron, Aluminum Alloy, and Die Cast Parts

### PDA Series Optical Emission Spectrometers

This series of spectrometers can be used for controlling the quality of pig iron and aluminum die cast materials used in automobile parts. It adopts a proprietary horizontal spark stand and a time-resolved PDA spectroscopic method to improve analytical sensitivity in the trace amount region.





# Quality Assurance

The product quality assurance department performs a variety of tests and analyses in order to assure product performance. As with the quality control department, confirmations are performed to ensure that raw materials satisfy the standards. Further, to resolve product defects, procedures are also performed to specify the causes of such defects, including what damaged the parts and how malfunctions occurred. In addition, microscopic analyses, surface analyses, and morphological observations are performed. These are even more detailed than the foreign

material inspections, fracture surface analyses and other analyses performed by the quality control department. In addition, in analyzing the causes of fractures, strength evaluations are performed on materials excised from defective parts in order to investigate causes from multiple perspectives. Other evaluations/tests include substantive evaluations of the processes leading to damage and problems via endurance evaluations, as well as strength evaluations under simulated usage conditions, and failure tests of actual products and parts.

## VOC Measurement & Odor Analysis Inside Automobiles/Physical Properties Evaluation and Structural Analysis of Polymer Materials for Interiors



GCMS-QP2020 Gas Chromatograph Mass Spectrometers

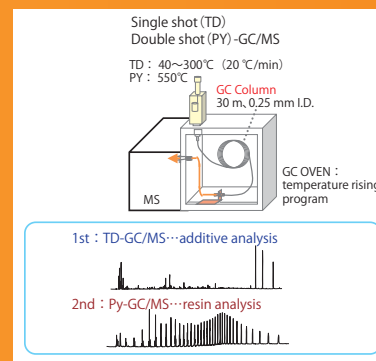
### ● Thermal Desorption Analysis System

This thermal desorption system heats samples in a sample tube and then focuses the thermally desorbed gases before injection into a GCMS system. It is used to measure volatile organic compounds (VOCs) within the automobile cabin or measure trace components released from resin sample pieces out of parts and materials.



### ● Thermal Decomposition Analysis System

This system analyzes plastics, rubbers, resins and other polymer compounds characteristic of materials used in automotive interiors, batteries, and so on, by decomposing the sample at temperatures above 500 °C and then using GC-MS to analyze the resulting thermal decomposition products. The system is also suitable for analyzing the structure of polymers, because the resulting thermal decomposition products reflect the original structure of the polymer compound. It is also used to measure plasticizers and other additives.



## Thermal Analysis of Rubber, Plastics, and Other Polymer Materials

### 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.



## High-Precision Composition Analysis of Various Materials

### 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 μm-compatible mapping, as well as higher operability.



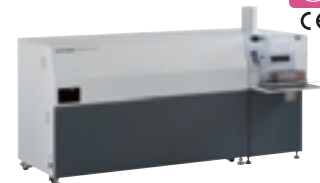
## Composition Analysis of Various Materials for Automobiles

### ICP Series Plasma Emission Spectrometers

This series can analyze the composition of all kinds of materials used in automobiles at high sensitivity and with high precision. The substantial lineup of models includes a low running cost, high-throughput multitype model and a high-resolution, high-precision sequential type model.



ICPE-9800 Multitype



ICPS-8100 Twin Sequential Type



CE

## Quality Control of Raw Materials, Parts, etc.

### MXF-2400 Multi-Channel X-Ray Fluorescence Spectrometer

Capable of simultaneous analysis of 36 elements, this system quickly and easily performs non-destructive analysis for factory control, research, and automated systems with high precision. It can be applied to the control analysis and research analysis of raw materials, new materials, and products, and can analyze trace amounts to high-content amounts of a diverse range of specimens.



## Qualitative Analysis and Residual Stress Measurement of Various Materials

### XRD-7000S/7000L X-Ray Diffractometer

This X-ray diffractometer incorporates a horizontal goniometer that can accommodate large-size specimens up to 350 mm in diameter. It can be applied to the surface qualitative analysis of automobile mechanical elements, quantitation of austenite, and residual stress measurement. It can also be used for the qualitative analysis of various catalysts for treating gas emissions.



## Development and Evaluation of All Sorts of Automobile Materials

### 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.



EPMA-1720/1720H



EPMA-8050G



Engines, Motors, and Power Sources	Bodies and Interiors	Lithium-Ion Rechargeable Batteries and Fuel Cells
Suspension and Other Power Transmission Systems	Electronic Instrumentation Components	Environmental Conservation

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# Research and Development

In the product research and development department, tests and analyses are performed on newly adopted candidate materials for the purpose of product development. To resolve problems occurring at the prototype stage, trial products are also subjected to defect analyses, in the same way as in the quality

assurance department. Furthermore, in the R&D department, special cutting-edge tests and analyses are required in addition to proprietary evaluations capable of confirming the performance to be evaluated in developed products.

## High-Speed Tensile/Puncture Testing of Members and Various Materials for Bodies

HITS-T10 HydrosHOT High-Speed Tensile Testing Machine /  
HITS-P10 HydrosHOT High-Speed Puncture Impact Testing Machine

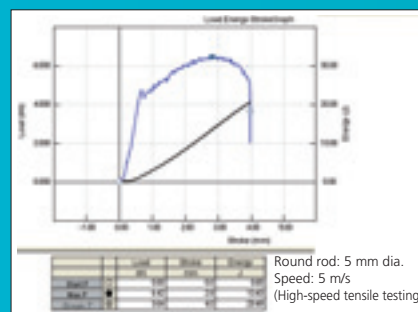
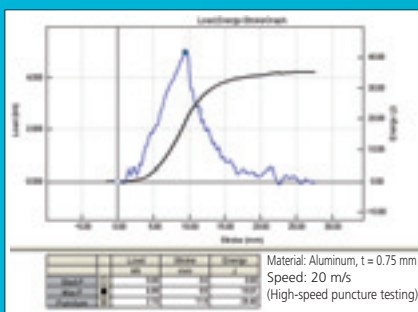
Along with a higher demand for improved safety and reliability, the evaluation of the dynamic strength (impact resistance) of materials and parts is becoming more and more important. This system can reliably measure various physical property values of aluminum and compound materials for bodies, values that are required for energy absorption efficiency at impact and CAE analysis at high-speed deformation. High-speed tensile testing and puncture testing up to a maximum speed of 72 km/h (20 m/sec) and a maximum test force of 10 kN are possible.



HITS-T10 HydrosHOT  
High-Speed Tensile Testing Machine



HITS-P10 HydrosHOT  
High-Speed Puncture Impact Testing Machine



Example of Aluminum Experimental Data

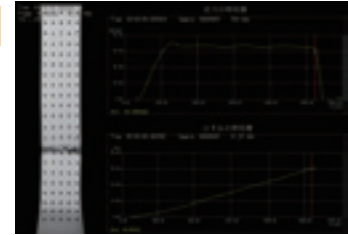
## Distortion Measurement in High-Speed Tensile Testing of Resin, Composite Materials, and Metals

### HyperVision HPV-X2 High-Speed Video Camera

A combination of the HITS hydroshot high-speed tensile testing machine and HPV high-speed video camera enables the measurement of distortion and test force under high-speed loads. The analytical data obtained can be used for simulation development in CAE analysis, for example, and is useful for shortening the development cycle of members and parts using the target material and for reducing development costs. The HPV can record the breaking of specimens at a high image capture speed of 1 million frames per second (fps), and the breaking of specimens can be expressed in sync with S-S curves by performing image analysis.



HyperVision HPV-X2 High-Speed Video Camera

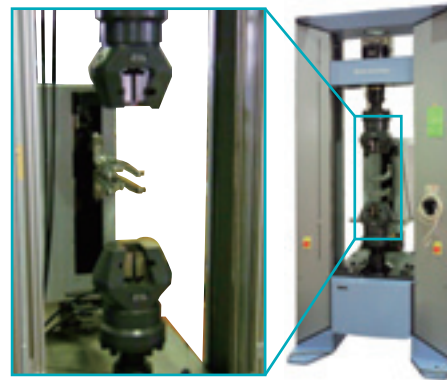
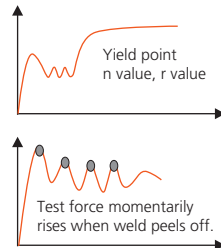


High-Speed Tensile Testing of ABS Resin (Synchronous Image Capture by High-Speed Video Camera)

## Testing of Steel Plating for Bodies

Steel plating for bodies is required to have increasingly higher tensile strength so that automobile frames can be made lighter. This system for tensile testing of high tensile strength steel plates lightens the load placed on measuring personnel since the specimen and extensometer can be set up by operating buttons.

It also allows almost all of the material characteristics required to be measured in tensile testing - modulus of elasticity, tensile strength,  $n$  and  $r$  values, etc. - to be measured simultaneously. Tensile testing of aluminum members for engines and peel testing of spot welding and parts for securing air bags can also be performed.

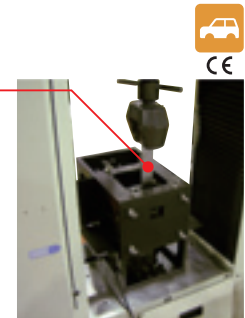
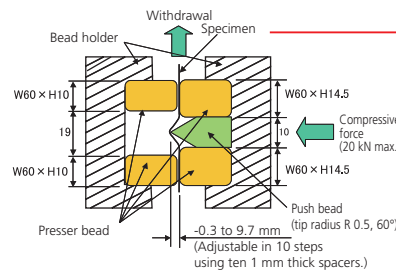


- Semi-Automatic System
- Fracture elongation extensometer
  - Hydraulic grips
  - Pinch prevention
  - Dedicated software
  - Transfer to host



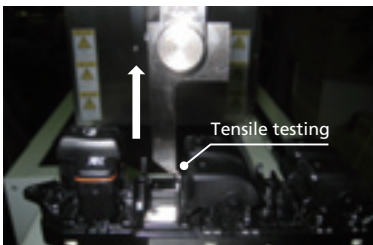
## Evaluation of Thin Plate Formability (Draw Bead Testing)

Automobile bodies are formed by press working. The press conditions are determined according to various conditions, including the iron plate thickness, formed shape, and strength. This testing unit is mounted on the Shimadzu Autograph to perform draw bead testing of steel plate specimens. Press formability is evaluated and tested by hydraulically pressing against the steel plate specimen and chucking one end of the specimen with a grip to pull it up.

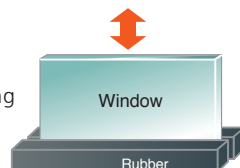


## Friction Force Measurement of Power Windows and Operation Force Evaluation of Operation Switches

Friction forces due to rubber parts are measured when a window moves up or down.



Tensile testing

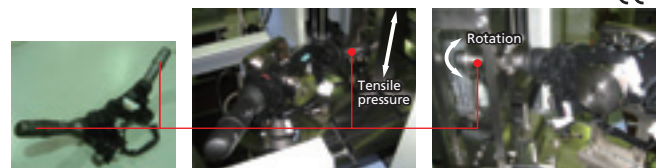


Testing system for evaluating the operating force and strength of switches used for opening and closing power windows.



## Operation Force Evaluation of Turning Indicator and Wiper Levers

This system evaluates the operation force and strength of turning indicator and wiper levers, which are repeatedly operated together with the steering wheel during driving. Autograph applies vertical motion and rotary load to each of the levers, and quantitatively evaluates the force for operating them.



The operation lever assembly is secured on the bed and the turning indicator lever is moved.



## Official Certification of Internal Sensors in Crash Test Dummies

Autograph can be used for official certification of the internal sensors in crash test dummies. It confirms that force, displacement, and angle sensors measure accurately.



## Vibration Testing of Various On-Board Component Parts

### EHV Series

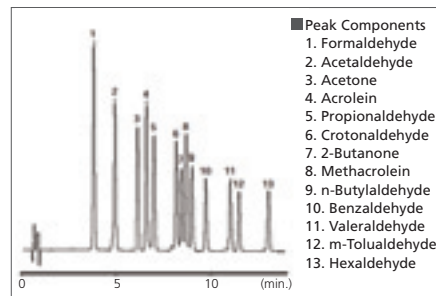
This series can perform the vibration testing of on-board components, for example, and simulations based on real-road waves. This system features a maximum test force of 500 kN, maximum size table of 3 m x 3 m, and long excitation stroke, thus supporting testing of large-size specimens. In addition to sine waves, testing by seismic waves and random waves is possible.



## Measurement of Automobile Interior VOCs

### Prominence Series High-Performance Liquid Chromatograph Aldehyde Analysis Systems

These systems analyze aldehydes, such as formaldehyde, that are generated from seats and other interior materials. Aldehydes are analyzed after 2,3-DNPH derivatization.

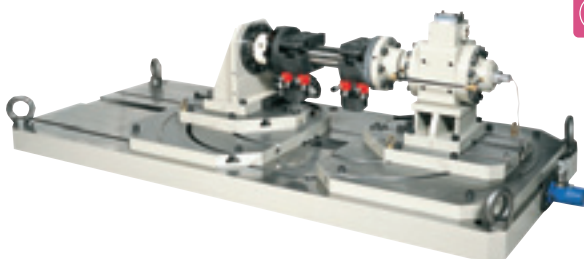


Chromatogram of 13 Standard Aldehydes

## Torsion Endurance Testing of Drive Shafts, Ball Joints, and Clutches

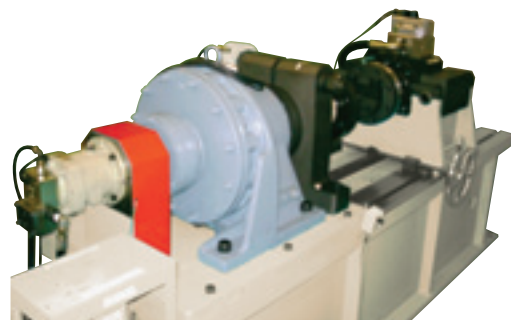
### Torsional Fatigue Testing Machine

This machine measures torsional dynamic characteristics (dynamic spring constant, damping coefficient, loss coefficient) and tests fatigue.



### Torsional Testing Machine for Large Specimens

Torsional endurance tests matched to various capacities can be performed by combining with a speed reducer.





## Tire Compression Evaluation

### Tire Compression Testing Machine

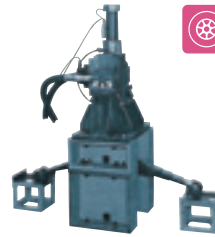
The compression strength, torsional characteristics, and other properties of tires are tested.



## Evaluation of Coil Springs/ Plate Springs

### Coil Spring/Plate Spring Endurance Testing Machine

A force simulator can be assembled into an exclusive mechanical frame to perform endurance testing of springs.



## Durability Testing Under Operating Temperature Environments

### Endurance Bench

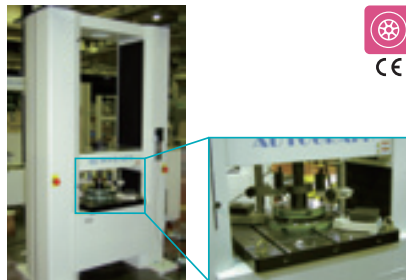
This thermostatic chamber bench is for testing the endurance of various parts at actual operating temperatures.



## Strength Measurement of Clutch Springs

### Supported on Autograph

A load is applied to the clutch springs of manual transmissions and 3-point displacement is measured by a dial gauge.



## Ultra Micro Hardness Measurement of Surface Processed Layers of Various Materials

### DUH-211/211S Dynamic Ultra Micro Hardness Tester

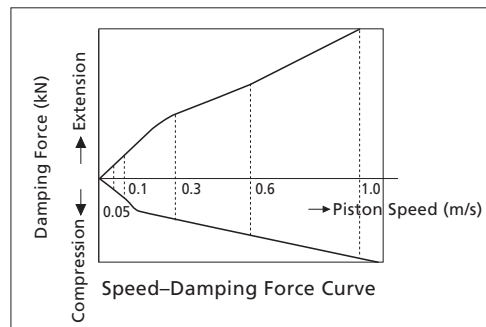
This system is for evaluating the strength of materials, such as semiconductors, LSIs, ceramics, hard disks, evaporated thin films, and coating layers, in the micro region, that cannot be handled on conventional testing machines. It can also be used for the hardness evaluation of plastics and rubber.



## Damping Force Characteristics Evaluation of Automobile Shock Absorbers

### Shock Absorber Testing Machine

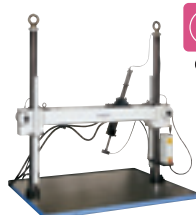
This testing machine measures the damping force with respect to the piston speed inside the shock absorber body. It allows a variety of curves to be plotted, including speed-damping force curves and displacement-damping force Lissajous curves.



## Endurance Testing of Modules

### Endurance Testing Machine for Modules

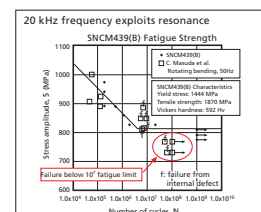
The actuator fixing position can be changed on the crosshead to match the load position on the specimen. Screw holes for installing the specimen at the desired position are provided on the table surface.



## Fatigue Testing Machine Using High Frequency

### USF-2000 Ultrasonic Fatigue Testing Machine

$10^9$  and  $10^{10}$  times fatigue testing can be performed in a short time since a test frequency of 20 kHz is adopted. This testing machine can be used for evaluating the materials and raw materials of crankshafts, axles, turbine blades, and engine-related parts.



Data supplied by Dr. Ishii, Department of Mechanical Engineering, Faculty of Engineering, Shizuoka University



Engines, Motors, and Power Sources	Bodies and Interiors	Lithium-Ion Rechargeable Batteries and Fuel Cells
Suspension and Other Power Transmission Systems	Electronic Instrumentation Components	Environmental Conservation

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## Cyclic Endurance Testing of Automobile Parts

### Shimadzu JF Series Force Simulators / Compact Hydraulic Actuators

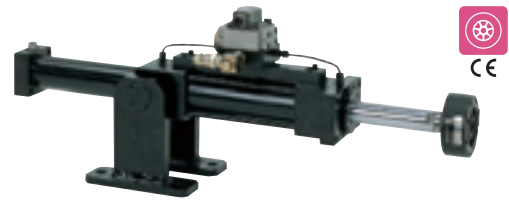
This series can evaluate the endurance of automobile parts and other products by actually applying a cyclic load.

#### Actuator Size and Weight

Model	Stroke	±25mm	±50mm	±100mm	±150mm
JF5kN	Weight *1	15kg	17kg	20kg	26kg
	Overall Length *2	440mm	565mm	815mm	1065mm
JF10kN	Weight *1	19kg	21kg	25kg	28kg
	Overall Length *2	445mm	570mm	820mm	1070mm
JF20kN	Weight *1	36kg	40kg	47kg	54kg
	Overall Length *2	590mm	715mm	965mm	1215mm

\*1 The weight includes the load cell and servo valve.

\*2 The overall length is the dimension at the central position, with the load cell attached.

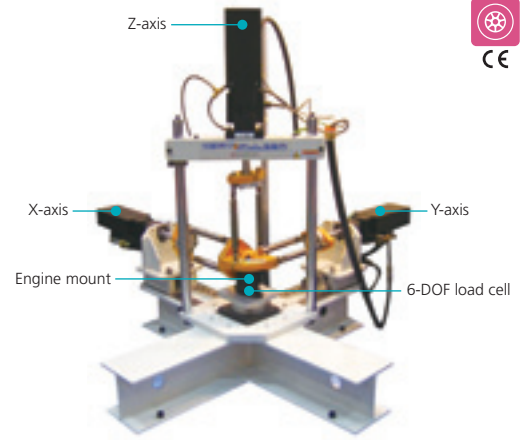
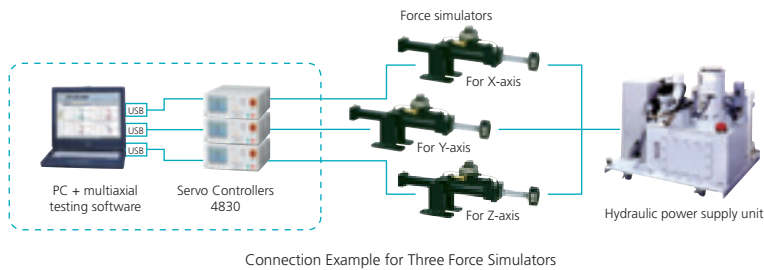


- Lightweight**  
 The actuator (20 kN ±100 mm) weighs only 25 kg (40 % less than previous Shimadzu models), which means less influence of the actuator deadweight on the specimen when a dynamic load is applied.
- Compact**  
 The actuator is compact and takes up less space when installed on the specimen.
- Easy Operation**  
 It is compact and lightweight, which makes it easy to carry and install. One-touch couplers are used so connections to the hydraulic system are easy to perform.
- Diverse Testing System**  
 A portable hydraulic unit, Servo Controller 4830, and test jigs can be combined on the actuator to configure the required system.

## Endurance Testing of Engine Mounts

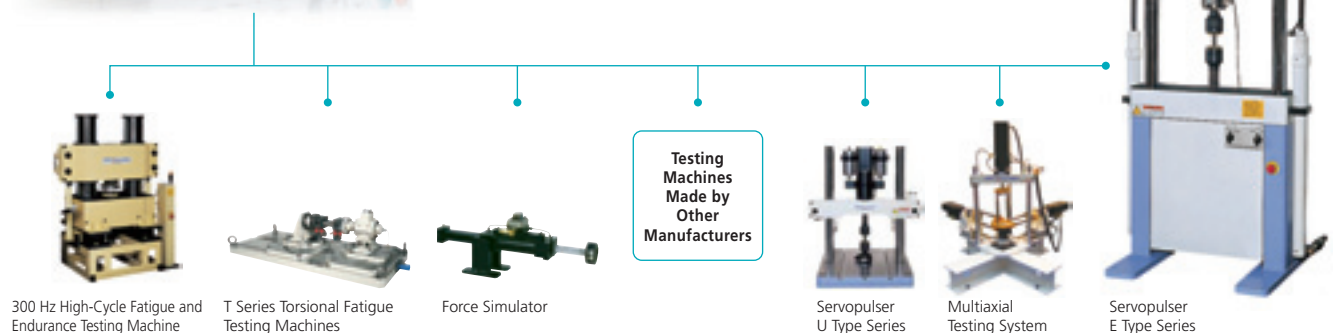
### Multi-Axis Endurance Testing System for Automobile Parts

With Servo Controllers 4830 connected, this small-capacity, compact multi-axis endurance testing system can measure specimens while synchronously controlling up to four force simulators. The phases of the force simulators can also be set as desired.



### Servo Controller 4830

The precision of endurance and dynamic strength evaluation can be dramatically improved from raw materials to actual products. It can also be connected to control various Shimadzu fatigue/endurance testing machines as well as those made by other manufacturers.



## Endurance Evaluation of Automobile Parts by Frequency Sweep and Resonance Frequency Tracking Test

Frequency sweep and resonance frequency tracking tests can be performed using Servo Controllers 4830.



### Dynamic characteristics

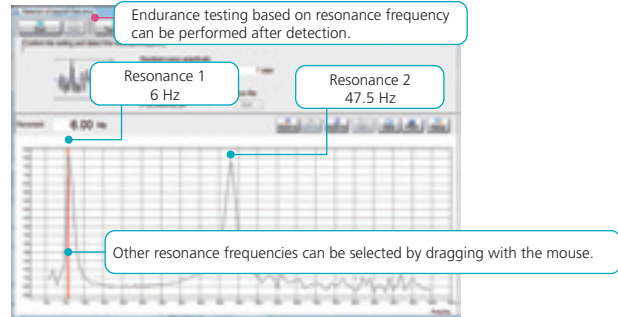
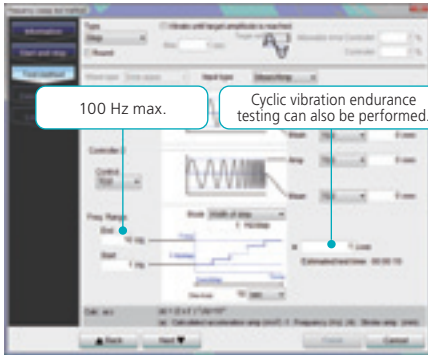
Frequency can be changed in stages so that dynamic characteristics at each frequency can be measured.

### Vibration endurance

Sweep endurance tests can also be performed.

### Resonance frequency detection

Resonance frequency is detected in just several seconds by random waves. The resonance frequency that changes during testing can also be tracked.



### Fixed acceleration

Acceleration and strain amplitude can be set directly. Control is performed so that the preset acceleration and strain amplitude are attained even if the specimen state changes.

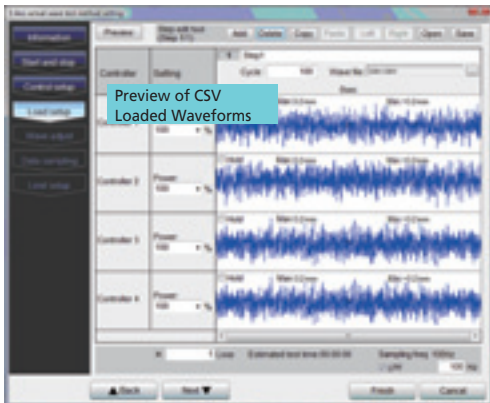
## Endurance Evaluation of Automobile Parts by Multi-Axis Real-Road Wave Testing

Advanced real-road wave reproducibility tests can be performed simply by loading waveforms in CSV format and starting the test.

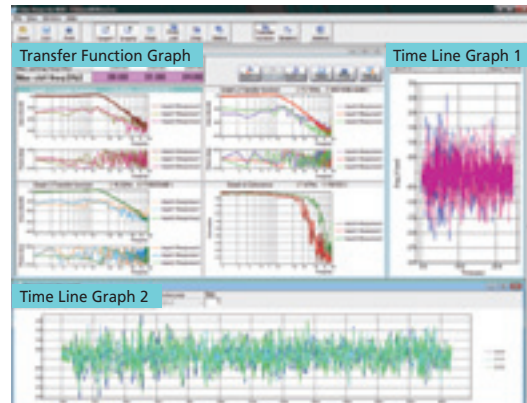
Servo Controller 4830 uses the basic software of other controllers.



Condition Setup Window

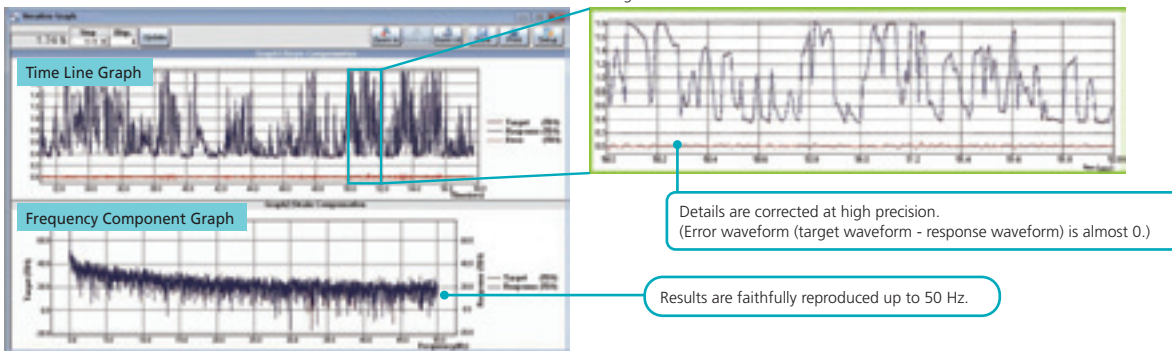


Test Result Window



Example of Real-Road Wave Reproducibility Test (1-Axis Test Force Control)

Enlarged View



## Fatigue/Endurance Testing Machine for Various Materials and Compact Parts

### Servopulser E Series Fatigue/Endurance Testing Machines

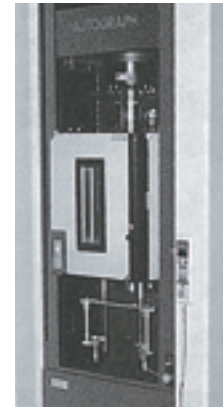
This standard series, typical of the lineup of Shimadzu electrohydraulic servo-type fatigue testing machines, boasts an extensive track record and consistent performance. It can cover static testing to fatigue tests.

- 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



### Gasket Compression Testing Machine for Cylinder Heads

Gaskets are widely used as automobile materials because they provide air and water tightness. So numerous performance properties including heat, pressure, and chemical resistance are required of gaskets. This testing machine can obtain compression, fatigue, and sealing characteristics in low- to high-temperature environments. Static and dynamic tests are supported by the Autograph and Servopulser, respectively.



## Thermal Fatigue Testing of Engine-Related Tubing Materials

### Thermal Fatigue Testing Machine

This testing machine is capable of temperature cycle testing at high control precision. The strain constraint ratio can be set to any value by synchronizing the temperature waveform with the strain control waveform (triangular, trapezoidal, or program wave). As a result, this testing machine is ideal for thermal fatigue testing of engine-related tubing materials, including mufflers, exhaust manifolds, and exhaust pipes. It is compatible with the Servopulser E Type Series.



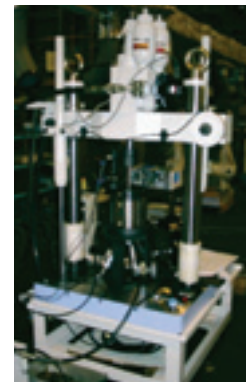
## Internal Pressure Fatigue Testing of Pipes etc.

### Internal Pressure Fatigue Testing Machine

This testing machine can apply loads using a sine wave of max. 10 Hz and max. pressure of 250 MPa on pressure sensors and pipe materials. To raise the number of test cycles, the internal generator is designed in a non-sealed structure, and the gap between the pressure intensifier and special surface treated plunger is controlled to several  $\mu\text{m}$ . (Also available are testing machines that support a maximum pressure of 300 MPa.)



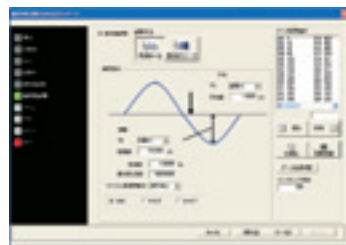
CE



## Dynamic Properties Evaluation of Rubber Vibration Isolators

### Rubber Vibration Isolator Dynamic Characteristics Testing Machine

This testing machine can calculate the properties of viscoelastic materials from a static state to high cycles (max. 300 Hz). It can simply measure spring constant, damping coefficient, and loss coefficient. It also accommodates testing under temperature-controlled environments in thermostatic chambers.



Dynamic Characteristics Setting Window

## Various Test Jigs

### 45° Peel Test Jig for Printed Circuit Boards

This test jig is for peel testing of electric and electronic components on printed circuit boards. It also supports test methods for lead-free solders (JIS Z3198-6).



### Shearing Test Jig for Electronic Components

This test jig is for shearing testing of electric and electronic components mounted on printed circuit boards. The position of the specimen is determined by the X-Y stage.



### Three-/Four-Point Bending Test Jigs for Printed Circuit Boards

Bending test jigs for printed circuit boards and printed circuit boards mounted with components.



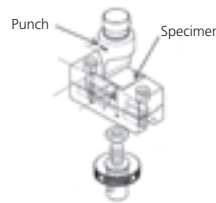
### Cyclic Bending Test Jig for Printed Circuit Boards

This test jig is for cyclic bending tests of printed circuit boards. Properties such as resistance fluctuations due to the application of cycle loads can be observed.



### Strength Test Jig for Surface Mounted Components

This jig is for body strength bending tests of surface-mounted components based on JEITA (Japan Electronics and Information Technology Industries Association).



## Fatigue/Endurance Testing of Compact Electronic Components

### 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.



### Air-Servo ADT-A Series Pneumatic Fatigue/Endurance Testing Machines

This series of fatigue/endurance testing machines adopts a servo-controlled system that operates by air, not oil. It is ideal for evaluating new materials and electronic instrumentation parts such as printed circuit boards and connectors. It comes in four models,  $\pm 1$ ,  $\pm 2$ ,  $\pm 5$ , and  $\pm 10$  kN.



## Environmental Resistance Evaluation of Electronic Instrumentation Components

### WET-SPM Series Environment Controlled Scanning Probe Microscopes

This series of microscopes can observe changes in the surface shape of specimens at a high magnification of several tens of thousands while controlling temperature and humidity. This makes it ideal for analyzing electronic instrumentation parts and various other parts for automobiles under various environmental conditions.



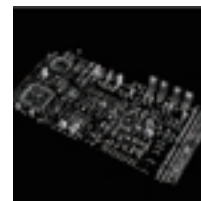
## Evaluation of Voids in Solder

### inspeXio SMX-225CT Microfocus X-Ray CT System

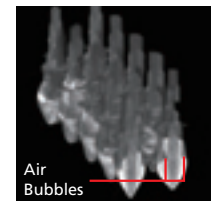
Quality can be controlled by inspecting the electronic printed circuit boards used inside automobiles or in the harsh environment of the engine compartment. In particular, discovery of the amount of solder under mounted components and air bubbles in the solder can help minimize defects such as cracking due to heat and vibration.



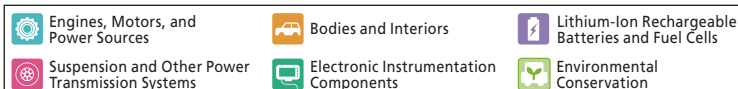
Fluoroscopic Image of Solder Sections



CT Image of Solder on Printed Circuit Board



CT Image of Solder Deficiency and Air Bubbles in Solder

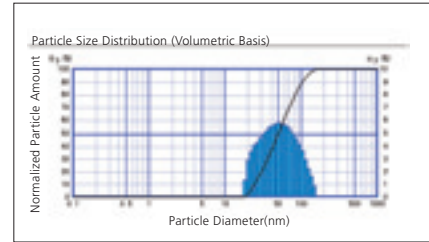


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## Evaluation of Catalysts

### IG-1000 Plus Single Nano Particle Size Analyzer

This instrument can rapidly measure the particle size of nano-particles. Such measurements are essential to increase the performance of cerium oxide used as a co-catalyst in three-way catalysts for automobiles.



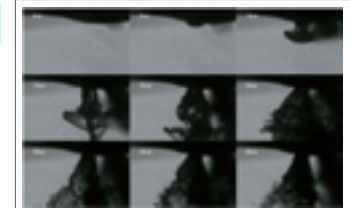
Measurement of Particle Size Distribution of Cerium Oxide

## Observations of High-Speed Phenomena Related to Automobiles

### Hyper Vision HPV-X2 High-Speed Video Camera

Many high-speed phenomena occur in the automotive field. These include the observations and analysis of the fuel injection process to assist in the development of low-fuel-consumption engines. The HPV-X2 can take 100 consecutive images at up to one million frames per second at a high 50K pixel resolution, allowing observation of high-speed phenomena, such as fuel injection.

- Recording Speed: 30 to 1,000,000 frames per second
- Resolution: 312 (horizontal) × 260 (vertical) pixels
- Stored Images: 100
- Color Representation, Gradations: Monochrome, 10-bit
- Data Format: Dedicated format, BMP, AVI, JPEG, TIFF, TIFF16
- Synchronous Recording: Synchronous recording with up to four units
- External Trigger Input: TTL level (5 V, positive or negative), contact input
- Lens Mounting: Nikon F-mount



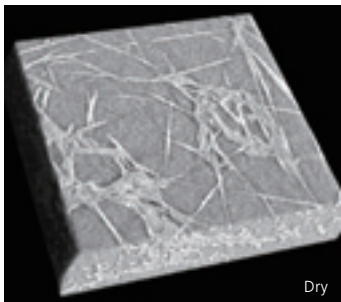
Recording speed: 2 million frames per second (images at 5 μsec intervals provided by Associate Prof. Kawahara, Okayama University)

Observations of Gasoline Fuel Injection

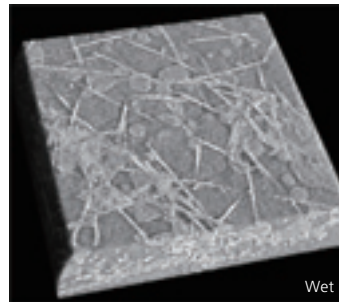
## Internal Observation of Polymer Electrolyte Fuel Cells

A problem experienced with polymer electrolyte fuel cells (PEFCs) is how to manage the water that is generated when they generate electricity.

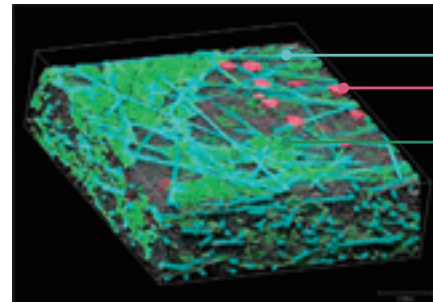
X-ray CT observation of GDL after water drops are permeated internally is effective for directly observing the state of water drops inside the cell.



Dry



Wet



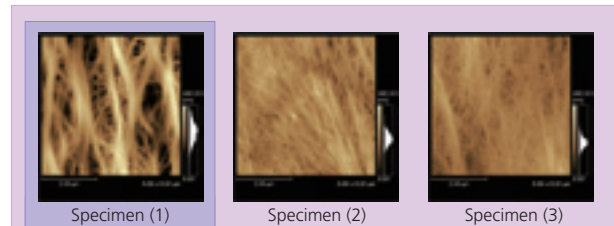
- Carbon fiber
- Water drop
- Binder

3D Image of Waterdrops Inside GDL Taken by X-Ray CT

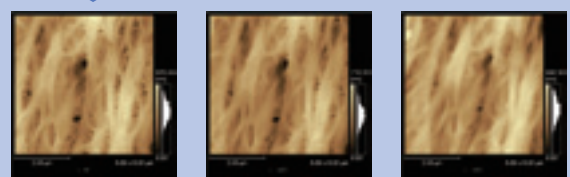
## Surface Observation of Lithium-Ion Rechargeable Battery Separators/Electrolytes

### 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. (p. 21)



Comparison of 3 Types of Separators



Room temperature 125°C 140°C  
Changes Caused by Heating of Specimen (1)

## Actual Battery Tests (Nail Penetration/Crush) and Fatigue Testing of Various Actual Parts and Materials for Automobiles



### Servopulser EHF-UM/UV Series/Servopulser EMT Series

These testing machines evaluate the durability of the component members of batteries and finished battery products against repeated stress, and can apply accurate loads (e.g. test force, displacement) at high speed. They also support nail penetration testing and crush testing. Moreover, they are compatible with constant-temperature environments. The hydraulic model (EHF-U series) is ideal for large-capacity specimens, whereas the easy-to-install electromagnetic model (EMT series) is ideal for small-capacity specimens.



EHF-UM/UV Series

EMT Series

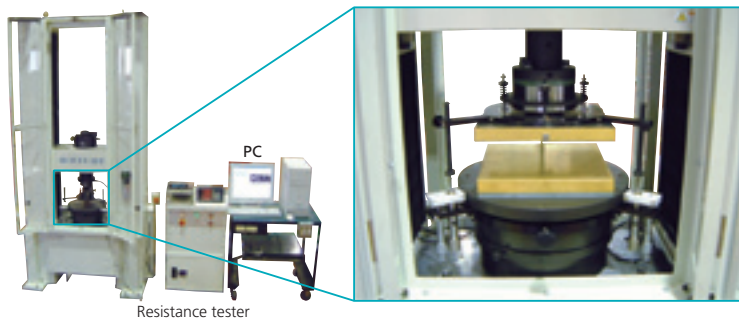
## Compression Evaluation of Lithium-Ion Rechargeable Batteries and Fuel Cells



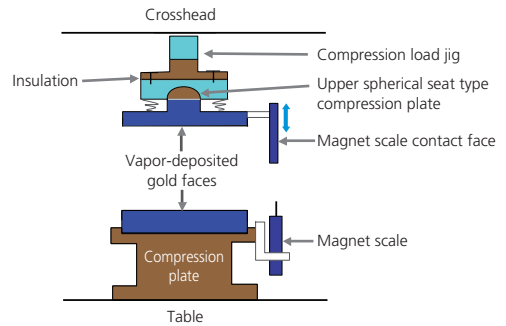
### Battery Compression Evaluation Instrument

Testing on this instrument differs from compression failure evaluation in that changes in battery characteristics and generating efficiency, etc. in the compression process are measured. The compression plate has an

improved parallel structure for thin films, and electrical resistance is reduced by vapor-deposited gold faces. Current and voltage generated when a specimen is compressed are measured.



Resistance tester

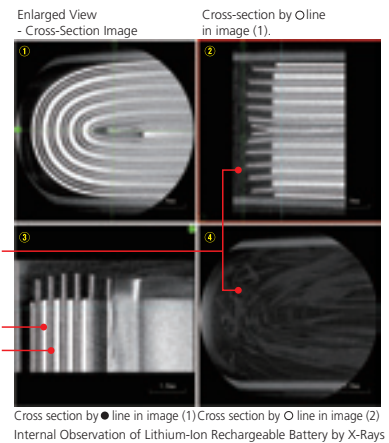


## X-Ray Non-Destructive Inspection and Analysis of Battery Modules, On-Board Electronic Components, and Die Cast Parts

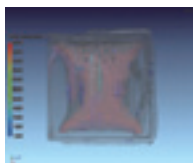


### inspeXio SMX-225CT FPD Microfocus X-Ray CT System

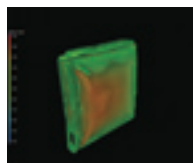
X-ray CT systems for industry can observe the internal structure of target objects non-destructively. As a result, they are very useful for accurately ascertaining the inside of particularly complex electrical machinery and electronic products.



Cross section by ● line in image (1) Cross section by ○ line in image (2)  
Internal Observation of Lithium-Ion Rechargeable Battery by X-Rays



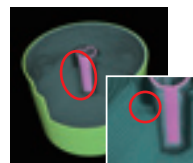
Data Obtained by Visualizing (Color-Coding) Voids in Frequently Charged/Discharged Used Products



Visual Data Obtained by Overlapping New and Used Products and Measuring Respective Differences



18650-Type Lithium-Ion Battery - Deteriorated Battery CT Image



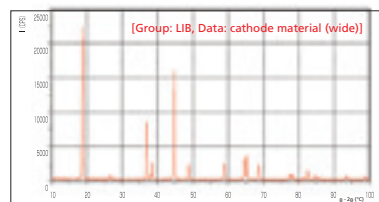
18650-Type Lithium-Ion Battery - Deteriorated Battery VR Image

## Structural Analysis of Lithium-Ion Rechargeable Battery Active Materials and Various Materials

### XRD-6100 X-Ray Diffractometer



X-ray diffractometers are used in a wide range of fields related to new materials, ceramics, metals, semiconductors, and polymers, and the number of specimens to be measured in each field is diverse. For example, with batteries, the crystalline structure of cathode and anode active materials and their orientation and size can be analyzed. With separators, material quality can be qualitatively analyzed and the degree of crystallinity, orientation, and other properties can be analyzed as well. A polycapillary optical system also enables high-sensitivity analysis.

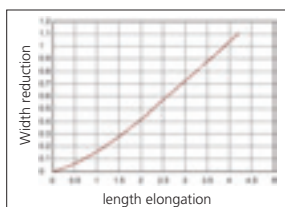


Diffraction Pattern of Lithium-Ion Rechargeable Battery/Cathode Materials

## Non-Contact Elongation/Width Measurement of Films and Foil Used as Separators

### TRViewX Video Type Non-Contact Extensometer/Width Sensor

The elongation and width of polymer films used as separators for lithium-ion rechargeable batteries can now be measured. Plastics, metals, foil, etc. can also be measured in addition to films.



Width reduction and length elongation graph of separator's tensile test



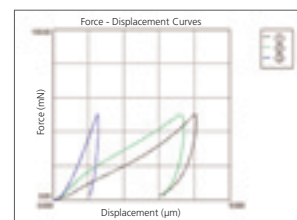
## Compression Characteristics Evaluation of Anode Active Material Particles



### 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.



Compression Test Results of 3 Types of Separators

## Nanoparticle Measurement of Cathode Materials

### IG-1000 Plus Single Nanoparticle Size Analyzer

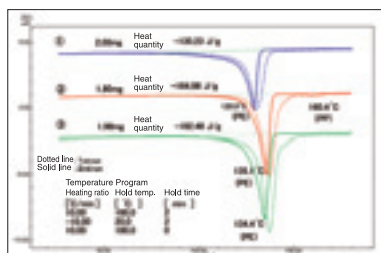
With ternary system cathode materials used in lithium-ion rechargeable batteries becoming more and more minute, this analyzer is suited to particle size measurement in the nano order, the final target measurement level.



## Thermal Characteristics Evaluation of Electrolytes, Separators, and Other Polymer Materials for Lithium-Ion Rechargeable Batteries

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

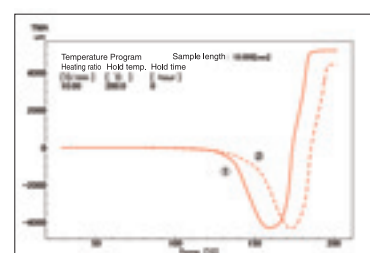
This calorimeter is useful for evaluating thermal characteristics such as melting of the separators and transformation/decomposition of electrolytes during heating. Features of this calorimeter include a low noise level of 0.5  $\mu\text{W}$  or less, high sensitivity, and high resolution. The cooling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



Measurement of Melting of 3 Types of Separators

### 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.



Measurement of Contraction Behavior of Separators by TMA

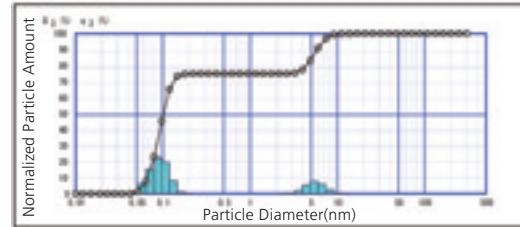


## Particle Size Distribution Measurement of Cathode/Anode Active Materials

### SALD-7500 nano Nanoparticle Size Analyzer

This analyzer measures the distribution of particle size of cathode and anode active materials, for example. It utilizes the laser diffraction/scattering method and incorporates a UV semiconductor laser light source (wavelength 375 nm), thus enabling the measurement of

particle sizes of 10 nm to 300  $\mu\text{m}$ . Various options, including a high-concentration sample measurement system and software for gathering data at 1-second intervals, are also available.



Evaluation of the Presence of 5  $\mu\text{m}$  Particles Contained in a 90 nm Particulate Sample

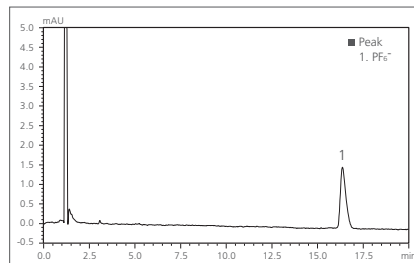


## Separation/Quantitation of Lithium-Ion Rechargeable Battery Electrolytic Solution Components

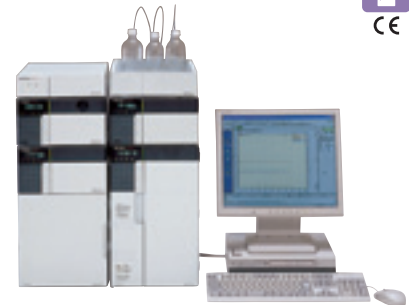
### Prominence HIC-SP Ion Chromatograph

This system can be used to separate and quantitatively analyze inorganic ions contained in organic electrolyte solutions.

By combining the optimum units from a substantial product lineup, a wide measurement range from the ppb level up to the percent order can be accommodated. In addition to measuring concentration, systems can be configured to measure the distribution of polymer molecular weights.



LC Analysis of  $\text{PF}_6^-$  (Hexafluorophosphate Ions) Contained in Electrolytic Solution



## Tensile Strength Evaluation of Electrolyte Films

### Micro Autograph MST-I Micro Strain Tester

This tester is ideal for the strength evaluation of electronic parts, microdevices, ultrafine wires, and other micro specimens. High-precision drive and measuring systems enable the measurement and control of micro test forces and displacement to obtain various data. Also available are a stereomicroscope and an X-Y stage for simplifying the positioning and observation of specimens.



## High-Sensitivity Inorganic Gas Analysis

### GC-2014 Gas Chromatograph

This instrument can measure down to the ppm region, which could not be analyzed by conventional TCD. It can measure CO in gas emissions from reformers with high sensitivity.

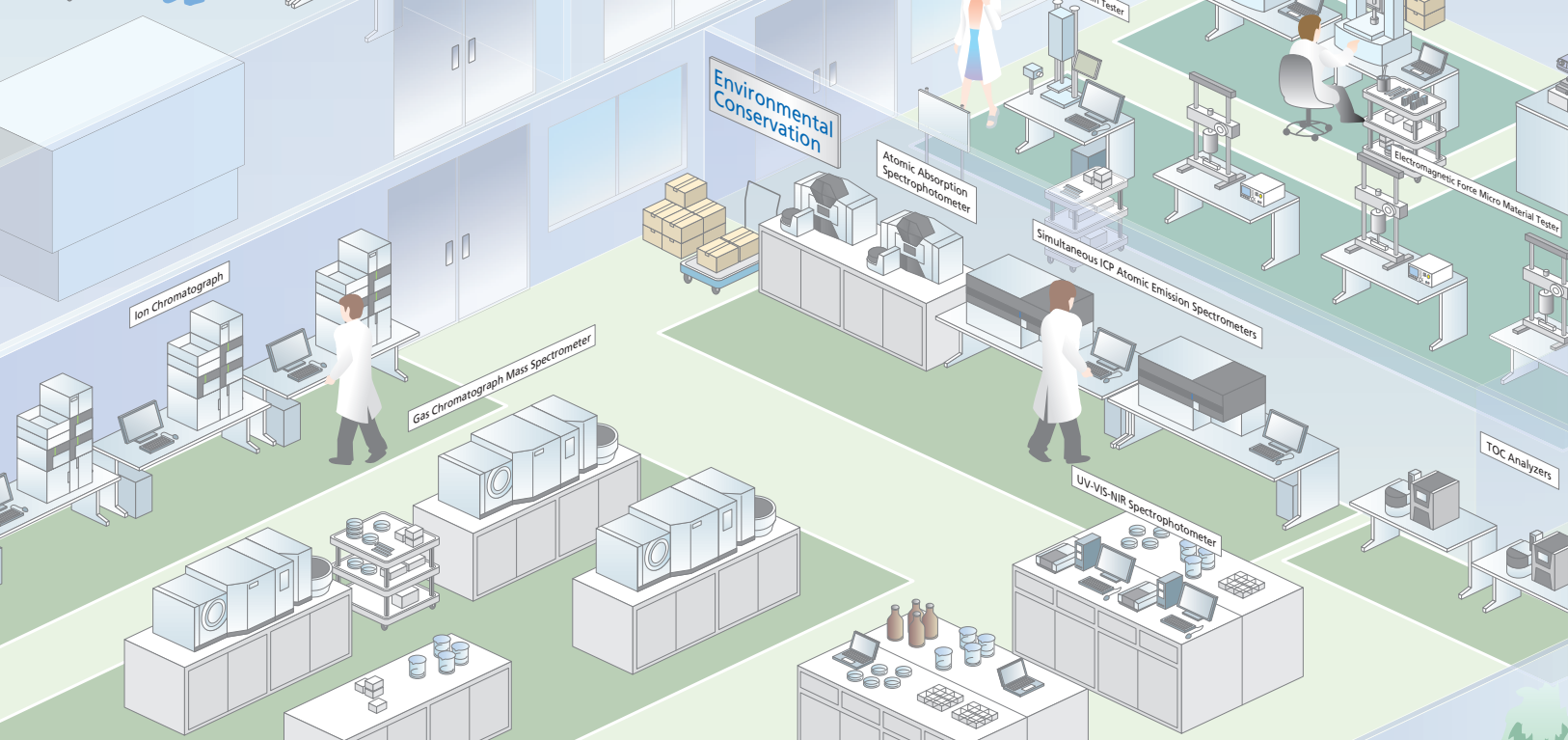


## Evaluation of Reformers

### CGT-7100 Portable Continuous Gas Analyzer

In addition to measuring low concentrations of CO emitted from the gas reformer, this portable size infrared gas analyzer can also measure up to two other components, such as  $\text{CO}_2$  and  $\text{CH}_4$ .





# Environmental Conservation

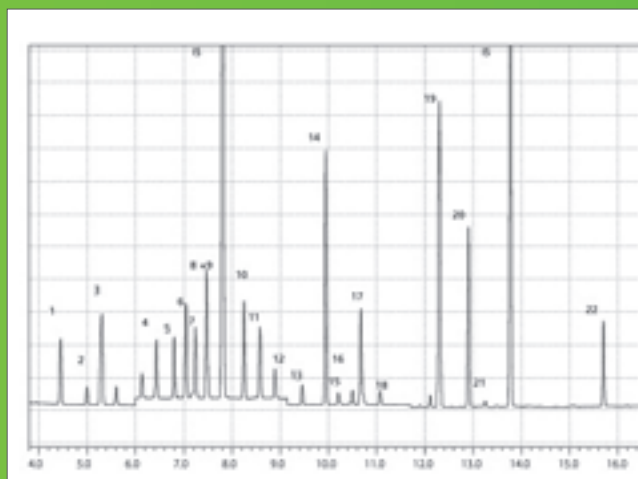
At plant facilities, analyses of toxic elements and VOCs (volatile organic compounds) in drainage are performed, for the purpose of environmental conservation. In terms of PM2.5 particles, which have been increasingly monitored as air pollutants in recent years, measures are being pursued not only to reduce such particles in automobile gas emissions but also from plants.

## Control of VOCs (Volatile Organic Compounds) in Drainage

### GCMS-QP2020 Gas Chromatograph Mass Spectrometer

#### Headspace Analysis System

The outstanding core performance of the HS-20 headspace sampler and user-friendly design serve as powerful backup for analyzing VOCs in effluent water.



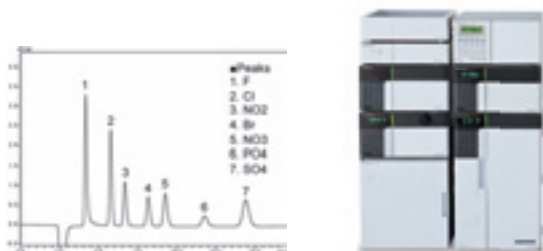
Repeatability of VOC 0.1 ppb, %RSD (n = 5)

1	1,1-Dichloroethene	1.8
2	Dichloromethane	3.0
3	trans-1,2-Dichloroethene	1.4
4	cis-1,2-Dichloroethene	2.8
5	Chloroform	2.3
6	1,1,1-Trichloroethane	1.7
7	Carbon tetrachloride	2.2
8	1,2-Dichloroethane	2.7
9	Benzene	0.7
10	Trichloroethene	1.2
11	1,2-Dichloropropane	3.1
12	Bromochloroethane	2.0
13	cis-1,3-Dichloropropane	1.8
14	Toluene	1.4
15	trans-1,3-Dichloropropane	1.8
16	1,1,2-Trichloroethane	2.9
17	Tetrachloroethene	0.8
18	Dibromochloromethane	2.1
19	m+p-Xylene	1.7
20	o-Xylene	1.4
21	Bromoform	2.3
22	1,4-Dichlorobenzene	1.2

## Control of Fluorine, Nitrate Nitrogen, and Nitrite Nitrogen in Drainage

### 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.



## Control of Hexavalent Chromium by Simple Measurements

### UV-1280 Water Quality Analysis System

CE

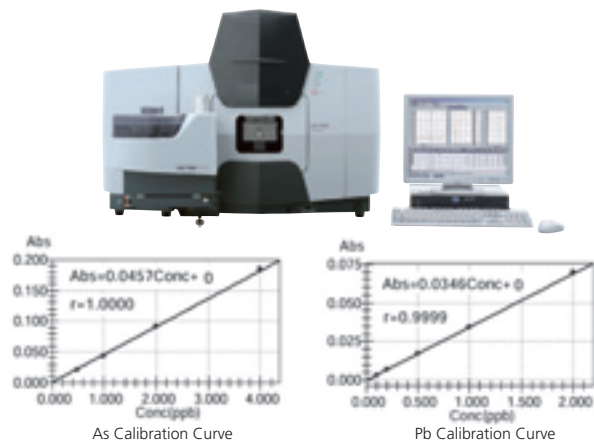
Due to the simple reagent kits used, this system does not require any complicated pretreatment processes. Because calibration curves are prepared internally by the program, there is no need to prepare calibration curves using standard samples, making it easy to perform measurements. In addition to measuring Cr<sup>6+</sup>, it can also measure 39 other components in water, such as Cu and cyanide.



## Management of Toxic Metals in Drainage, Including Lead (Pb), Total Mercury (Hg), and Cadmium (Cd)

### AA-7000 Series of 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.

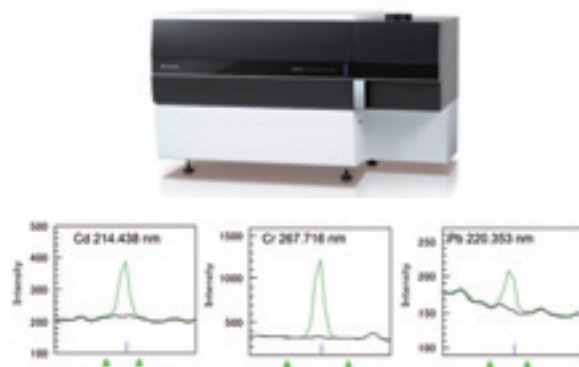


<Application News No. A302>

### ICPE-9800 Series of 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



<Application News No. J104>

CE

## Example of Systems Used to Analyze PM2.5 Particles in Air

Measured Component	Analysis System	Instrument Used for Pretreatment	Compatible System
Polycyclic aromatic hydrocarbons (PAH)	GC-MS or HPLC	<ul style="list-style-type: none"> <li>Extraction: Ultrasonic extractor and Soxhlet extractor</li> <li>Concentration: Nitrogen gas concentrator, rotary evaporator, and Kuderna-Danish concentrator</li> <li>Centrifugation: Centrifuge unit</li> </ul>	GCMS-QP2020 Prominence Nexera X2
Levoglucosan	GC-MS	<ul style="list-style-type: none"> <li>Extraction and concentration as above</li> <li>Derivatization: Thermostatic chamber</li> </ul>	GCMS-QP2020
Water soluble organic carbon (WSOC)	Total Organic Carbon Analysis	Ultrasonic extractor	TOC-L
Ion components <sup>Note 1</sup>	Ion Chromatography	Ultrasonic extractor	HIC-SP/NS
Inorganic element components <sup>Note 2</sup> (Fluorescent X-ray method)	X-ray Fluorescence Spectroscopy		EDX-7000/8000

Note 1) Ion components:

Sulfate ions, nitrate ions, chloride ions, sodium ions, potassium ions, calcium ions, magnesium ions, ammonium ions, etc.

Note 2) Inorganic element components:

Sodium, aluminum, potassium, calcium, scandium, titanium, vanadium, chromium, manganese, iron, cobalt, nickel, copper, zinc, arsenic, selenium, rubidium, molybdenum, antimony, cesium, barium, lanthanum, cerium, samarium, hafnium, tungsten, tantalum, thorium, lead, etc.

The atomic absorption method or ICP-AES method can be used depending on the target element.

As per the Interim Manual from the Ministry of the Environment (2007)



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