Automotive Industry Applications

Shimadzu Precision Universal Tester
Since its founding more than 130 years ago, Shimadzu Corporation has strived to realize the dreams of both individuals and society, and to bring each generation cutting-edge technology. Shimadzu testing machines were created as an expression of our corporate philosophy, "Contributing to Society through Science and Technology."

Shimadzu testing machines represent our commitment to high-level precision and operability without compromise, cultivated through long years of experience.

For the automotive industry, with its heightened interest in safety, reliability and environmental friendliness, we continue to offer satisfying solutions by being our customers’ best partner.

 CONTENTS

Evaluating Car Body and Exterior Sheet Steel Strength pg. 4
Evaluating Suspension and Transmission Part Strength pg. 4
Evaluating Engine Part Strength pg. 5
Evaluating Interior Part Strength: Seat Fabric Tensile Testing pg. 6
Plastic Film Frictional Coefficient Measurement pg. 7
Circuit Board Cyclic Bending Strength and Resistance Evaluation (Lead-Free Solder) pg. 8
of the World's Next-Generation Cars

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Sales offices
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Distributors
Evaluating Car Body, Engine, Suspension,

Evaluating Car Body and Exterior Sheet Steel Strength

Strength evaluations of sheet steel used for car doors and hoods are performed as standard tests. In an effort to strike a balance between fuel economy and safety, sheet steel manufacturers compete aggressively to develop lightweight, high-strength materials. To develop this type of sheet steel and perform quality control and machinability inspections, testing machines are used for tensile testing to obtain process-hardening coefficients (n values), rupture strength and elastic modulus.

The Shimadzu Autograph features a variety of grips, displacement measuring devices and width sensors designed for these tensile tests, and with the TRAPEZIUMX computer system, they can be performed efficiently by anyone.

Results

<table>
<thead>
<tr>
<th>Name</th>
<th>Break Force</th>
<th>Break Stress</th>
<th>Break Stroke</th>
<th>Max Force</th>
<th>Max Stroke</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit</td>
<td>kN</td>
<td>N/mm²</td>
<td>mm</td>
<td>kN</td>
<td>mm</td>
</tr>
<tr>
<td>1-1</td>
<td>7.05724</td>
<td>282.290</td>
<td>27.6682</td>
<td>7.83951</td>
<td>18.3498</td>
</tr>
<tr>
<td>1-2</td>
<td>5.24435</td>
<td>209.774</td>
<td>28.6615</td>
<td>7.73773</td>
<td>17.9883</td>
</tr>
<tr>
<td>1-3</td>
<td>5.46401</td>
<td>218.561</td>
<td>29.0765</td>
<td>7.77510</td>
<td>18.4499</td>
</tr>
</tbody>
</table>

Evaluating Suspension and Transmission Part Strength

With manual transmissions, the engine and drive train are connected via the clutch mechanism at every gear change. A clutch functions hundreds or thousands of times while you drive, and requires optimal tuning. In addition, with high-output engines the strength of the engine/drive train connection must be sufficient to efficiently transmit engine power. Thus, strength testing is performed to evaluate clutch spring force and satisfy a variety of conditions.

The Shimadzu Autograph features a variety of jigs, including compression plates for spring compression, and displacement measuring devices, enabling the measurement of even slight distortions.

<Configuration>

- AG-100 kNX
- Non-shift wedge type grips (MWG)
- Strain gauge type one-touch extensometer SSG-H
- Windows software TRAPEZIUM X

<Configuration>

- AG-50 kNXD
- Spherical seat type compression plates
- Compression plate displacement measuring device
and Transmission Part Strength

### Evaluating Engine Part Strength

An engine is the heart of an automobile and has always been relied on for power, response and other road performance aspects. In recent years, however, there is an increasing need for economic and environmental performance as well. For this reason, strength evaluation of both new engine-part materials and actual parts has become widespread. Here is an example of an evaluation of wires used not only in engines, but in brakes and a variety of other car parts.

Non-contact elongation measurement using the Shimadzu Video Extensometer DVE-201 is an effective way to measure the elongation of wires and other narrow-diameter samples, for which conventional extensometers cannot be used.

![PC Monitor for DVE Extensometer](image)

### Controlling Conditions during Strength Evaluations

There is now a strong demand for the measurement of materials and parts used in automobiles under real-life conditions. This includes engine parts and materials that rotate at high speeds without friction at high temperatures.

Increasingly, environmental control equipment is being added to conventional tensile tests performed at normal temperatures. High-functionality environmental control equipment is becoming more common, providing control not only of temperature, but of humidity as well.

The Shimadzu Autograph features a range of thermostatic chambers and thermo-hygrostats, including refrigerated models and gas-injected models.

Temperature control is simple, via a color LCD touch panel and PC software.

![Temperature Monitoring via PC](image)

<Configuration>
- AG-20 kNXD
- Thermostatic chamber TCR Type
- -40 degrees to 250 degrees
- LCD touch panel or PC software
Comfortable automobile seats are developed by identifying repulsive and restorative forces, then creating a database linked to actual subjective evaluations. Many sampling evaluations of seats are performed for quality control and, in general, all automobile seat manufacturers use this type of tester. Due to the test sample being a large seat, a wide-design testing instrument is often required. With the Shimadzu Autograph, the Wide-Type Series offers test widths of 975 mm, 1100 mm, and 1375 mm.

### Evaluating Interior Part Strength: Seat Foam Rubber Testing

<table>
<thead>
<tr>
<th>Force</th>
<th>Precompression</th>
<th>Testing</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>75%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>65%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<Configuration>
- AG-100 kNX
- Foam rubber compression jigs

Automotive seat fabrics are usually composites, consisting of a high-quality synthetic leather exterior and an elastic sponge-like foam interior. As a result, tensile tests are performed for each production lot, with strict quality control in lot increments. However, while seat fabrics are soft, pliant materials, their shape is often warped, making it a difficult material for automated testing. To improve test efficiency, testers are used that stretch three samples simultaneously. In addition to seat fabrics, this type of multi-sample tester is also frequently used for rubber products.

### Evaluating Interior Part Strength: Seat Fabric Tensile Testing

This is an example of data acquisition via special testing software. During testing a 3-line curve is displayed in real time, and when the test is complete, the combined results from each sample are automatically displayed together with the statistical results.

<Configuration>
- AG-10 kNX
- Load Cell 1kN 3 pcs
- Pneumatic flag grips (PFG) 1kN 3pcs
- Foot valve unit
Rubber Strength

Evaluating Strength of Reinforced Plastics used for Bumpers

A variety of resin materials have been developed that, compared to conventional materials, are lightweight, strong, weatherproof, and increasingly in demand. One characteristic of these materials is the use of high-function fibers (light, strong, non-deforming, corrosion and heat resistant), including carbon fiber reinforced plastics (CFRP) and glass fiber reinforced plastics (GFRP).

In the CFRP evaluation shown here, Poisson’s ratio was obtained using a displacement measurement device to measure longitudinal strain, and a width sensor to measure transverse strain. Compared to soft iron and rubber, values from this type of material are one digit smaller, and the amount of distortion is very small.

Plastic Film Frictional Coefficient Measurement

Plastic films include a variety of coating and wrapping materials. Often it is necessary to measure the amount of friction between films themselves or between the film and a different material. With the Shimadzu Autograph, static and dynamic frictional coefficients can easily be obtained using frictional coefficient measurement devices, and Peel mode in the Windows TRAPEZIUMX software.
Evaluating Electronic Part Strength

Gull Wing Type Surface-Mount Parts, Solder Weld Peel Strength Tests

Often used in automotive electronics, surface-mount parts can develop stress at the solder weld between the board land and the component terminals due to inherent heating of the equipment during use and repetitive ambient thermal fluctuations, which can have a significant impact on product reliability. In these cases, solder weld peel strength tests can be used for evaluation. These tests are often adopted when the objective is lead-free solder development and quality control.

The example shown here involves a 45° peel test performed on solder welds (joints) of a QFP, one type of gull wing surface mounted part.

<table>
<thead>
<tr>
<th>Test Method</th>
<th>Resistance Meter</th>
<th>Load Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 sec to 5 sec hold</td>
<td>±1~2mm</td>
<td>Speed: 5~60mm/min</td>
</tr>
</tbody>
</table>

Circuit Board Cyclic Bending Strength and Resistance Evaluation (Lead-Free Solder)

In recent years, from the standpoint of reducing environmental load, there is a tendency to replace solder used for electrical and mechanical welds with so-called lead-free solder. Steps to switch to lead-free solder are being taken in a variety of industries, including the primary industries of automobiles and electronics.

However, the characteristics of lead-free solder differ from those of conventional eutectic solders with respect to strength, melting point, and wettability. As a result, it is important to perform even more strength and durability evaluations with actual products under normal-usage conditions. Evaluation includes not only the solder itself, but cyclic testing with the item mounted on the printed circuit board. Simultaneous evaluation and testing of conductivity can also be performed by simultaneously reading resistance values.

<table>
<thead>
<tr>
<th>&lt;Configuration&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Micro Autograph MST-I</td>
</tr>
<tr>
<td>Substrate 45-degree peeling test jig</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test Method</th>
<th>Equipment for Resistance Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 sec to 5 sec hold</td>
<td>AG-10 kNX</td>
</tr>
<tr>
<td>±1~2mm</td>
<td>Jig for repeated bending tests for printed circuit board</td>
</tr>
<tr>
<td>Speed: 5~60mm/min</td>
<td>Equipment for Resistance Evaluation</td>
</tr>
<tr>
<td>Load Mode</td>
<td>Windows Software TRAPEZIUM X</td>
</tr>
</tbody>
</table>

Temperature Monitoring via PC
Example of 45° Peel Test

Jigs for cyclic bending tests of printer circuit boards

Equipment for Resistance Evaluation
Strength evaluation of Si chips used on printed circuit boards is prescribed in the SEMI standard: G86-0303. Primary specifications and test jigs are as follows:

Test force measurement precision: ±1% of displayed value
Test speed: 5 mm/min max.
Punch and support size: R 0.3 mm ±0.02 mm
Support spacing (L):
- 2 mm d L and L d 20 h when the sample thickness (h) is 0.1 mm or larger
- L d 2 mm and L d 50 H when the sample thickness (h) is less than 0.1 mm

Silicon Chip (Die) 3-Point Bending Test

Crimp-style terminals are types of connector terminals attached to electrical wire ends. They are fastened by applying physical pressure to the wire and the terminal. They are used as an alternative to soldering in order to improve workability.

Withdrawal tests are performed with the Autograph to evaluate fastening strength between the wire and the terminal. Terminal parts may be damaged if gripped directly, so they are sometimes pinched using an L-shaped metal piece (designed to prevent withdrawal) as a cushioning material.
Solutions for You

AG-X
The door to the future

Specifications

Capacity
- 1N ~ 50kN Table-Top
- 20kN ~ 300kN Floor Type

Crosshead Speed Range
- Free step-less setting
- 0.0005 to 1000
- 250kN/300kN: 0.0005 to 500

Test Force
- High-precision unit:
  - Within ± 0.5% of displayed test force (for 1/100 to 1/1000 of load cell rated capacity)
  - Within ± 0.3% of displayed test force (for 1/1 to 1/100 of load cell rated capacity)
- Standard-precision unit:
  - Within ± 1% of displayed test force (for 1/1 to 1/1000 of load cell rated capacity)
  - Within ± 1% of displayed test force (for 1/1 to 1/500 of load cell rated capacity)

Ultra high-speed sampling
- 0.2msec

Dimensions
- W777 x D510 x H1580mm (Table-Top), W955 x D579 x H1606mm (Table-Top 20kN/50kN)
- W1186 x D752 x H2164mm (Floor Type), W1186 x D752 x H2414mm (Floor Type 250/300kN)

Software
- TRAPEZIUM X Single, Cycle, Control, Texture
Intuitive machine operation
1. Perform high-efficiency, continuous testing with fast data searches and one-touch method selection.

Receive data quickly
1. Speed, dimension, and report information can be entered quickly and directly from the main window using the [Quick panel].
2. Advanced navigation system with learning functions.
3. Functions include re-test, file syntheses, as well as specimen insertion, addition and order changes in any position.

Generate detailed reports
Richly expressive report creation includes free positioning of report elements and a wealth of web-compatible output functions. Report Designer allows flexible layout.

Choose from four software components to fit your specific application
- Single software
- Control software
- Cycle software
- Texture software
Other products

- Autograph AGS-J
- Texture Analyzer EZ Test Series
- Universal Testing Machine UH Series
- Servo-hydraulic fatigue testing machine SERVO
- High-speed Puncture Impact Testing Machine HITS-P10
- Compact Hydraulic Actuator JFSeries

Founded in 1875, Shimadzu Corporation, a leader in the development of advanced technologies, has a distinguished history of innovation built on the foundation of contributing to society through science and technology. We maintain a global network of sales, service, technical support and applications centers on six continents, and have established long-term relationships with a host of highly trained distributors located in over 100 countries. For information about Shimadzu, and to contact your local office, please visit our Web site at www.shimadzu.com

SHIMADZU CORPORATION. International Marketing Division
3. Kanda-Nishikicho 1-chome, Chiyoda-ku, Tokyo 101-8448, Japan
Phone: 81(3)3219-5641 Fax: 81(3)3219-5710
URL http://www.shimadzu.com

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