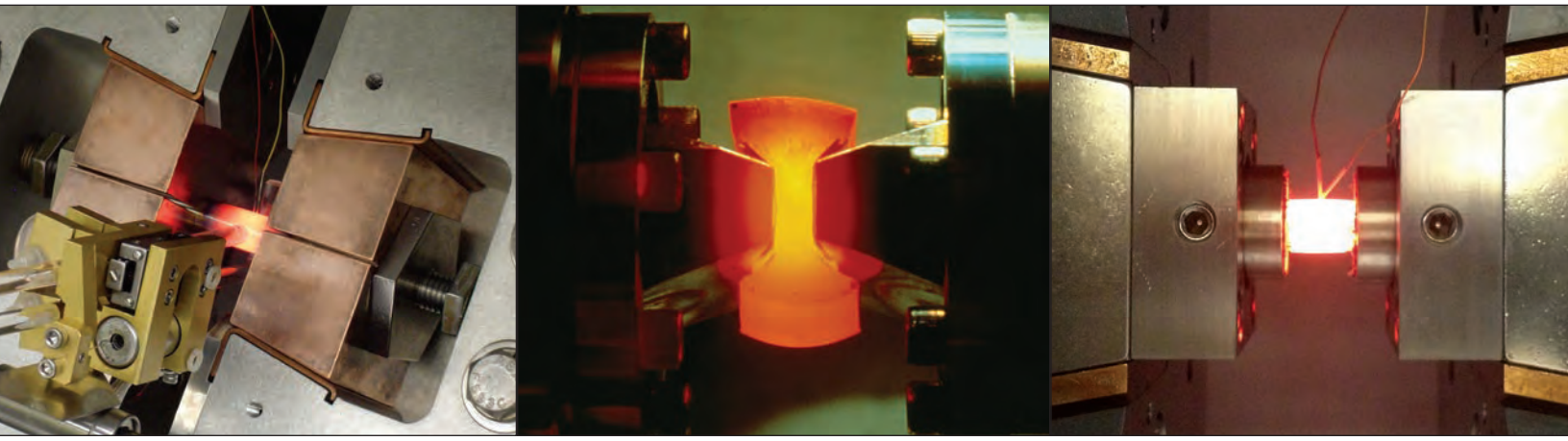
GLEEBLE®
A VPG Brand

DYNAMIC SYSTEMS INC. OVER 65 Years of Excellence 1957 Present www.GLEEBLE.com

Thermal-Mechanical Simulators

A Complete Family of Research Tools to Improve Materials, Optimize Processes & Increase Profits



Physical Simulation is a valuable tool used to study metallurgical processes, develop new materials and replicate real-world conditions in the laboratory.

Lower Costs - Reduce product development, processing & energy costs

Optimize Manufacturing Processes - Develop new procedures & troubleshoot existing processes

Optimize Materials - Develop new materials and applications

Increase Production - Reduce scrap and maximize output and efficiency

Faster Product Development - Reduce time to market and R&D expense

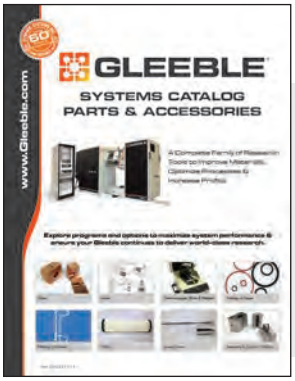
Improved Product Quality - Improve product consistency and quality

Materials researchers are frequently asked to extend the boundaries of what is possible in their industries. To help in this quest, Dynamic Systems Inc. (DSI) has developed a comprehensive line of dynamic thermal-mechanical physical simulators and testing machines.

Whether you need to characterize new materials, optimize existing processes, explore new production techniques, or simulate the conditions of new applications, you will find that there is a Gleeble system that will help you reduce costs, shorten development times, and open doors to new ideas, processes and profits.

Gleeble systems feature high-speed closed-loop heating systems coupled with robust closed-loop mechanical capabilities and digital control. Easy-to-use computer software is designed to provide a user-friendly interface for preparing test programs, controlling thermal and mechanical systems, and collecting data.

Whatever your goal, there is a Gleeble system that will help you extend the reach of your investigations and provide the state-of-the-art tools required for today's modern laboratory.



The Gleeble Catalog is available online.

For more detail on Gleeble systems, as well as popular parts and accessories, please download the full Gleeble Catalog by visiting **www.Gleeble.com/Catalog**

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Popular Gleeble Applications

Materials Testing

- Hot/warm tensile testing on a wide variety of specimen geometries
- Hot/warm compression testing
  - Uniaxial compression
  - Plane strain compression
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- TNR determination
- Stress vs. Strain curves
- Melting and solidification
- Nil-strength testing
- Hot ductility testing
- Thermal cycling/heat treatment
- Dilatometry/phase transformation
  - During heating or cooling
  - Continuous or non-continuous
  - Isothermal
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- Creep/stress rupture
- Low cylce fatigue
  - Thermal fatigue
  - Thermal/mechanical fatigue

Process Simulation

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- Weld HAZ cycles
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- Diffusion bonding
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- Additive manufacturing
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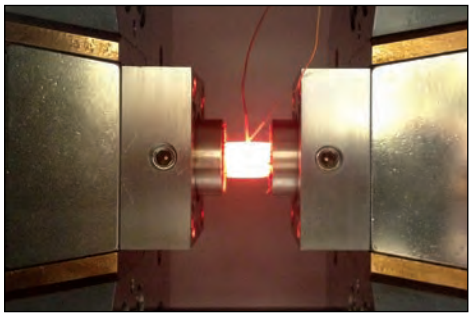
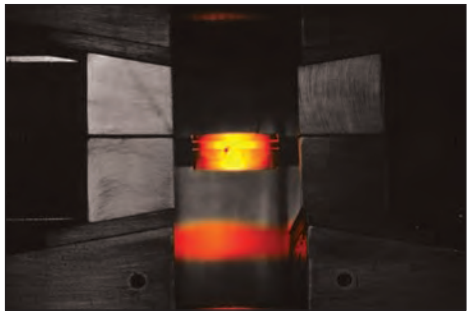
- Batch annealing
- Heat treating
- Quenching
- Self-Heating Synthesis (SHS)
- Brazing
- Mushy zone processing
- Liquid metal embrittlement

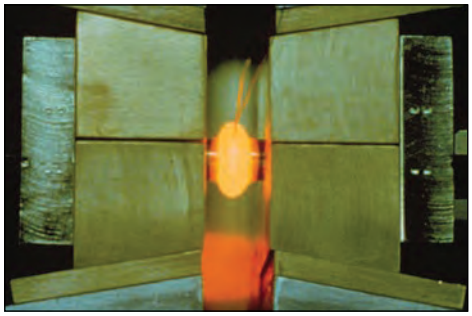
Thermal Cycles and Heat Treatments: Many different grips are available to support uniform temperature zones and a variety of specimen configurations. Other grips can be used to create thermal gradients in the specimen for weld HAZ and process simulation.



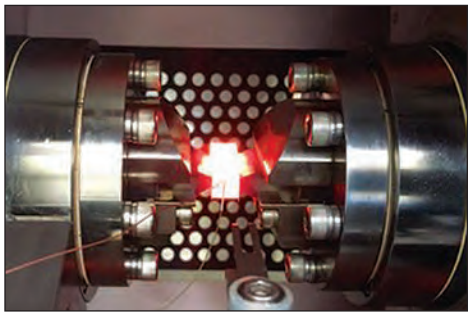
ISO-T Uniaxial Compression Testing: ISO-T Uniaxial Compression (flow stress) anvils provide a uniform temperature distribution throughout the compression specimen during single and multiple-hit deformation tests.



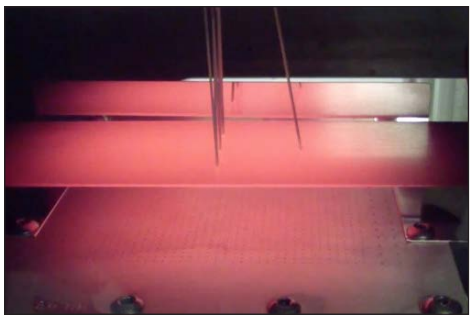
Melting and Solidification: Melting and controlled solidification can be performed in-situ. Thermal and mechanical testing of the as-cast structure can then be performed to identify cast structure properties and ductility dip regions.



Strain-Induced Crack Opening (SICO) Procedure: The SICO procedure is a quick and cost-effective method for thermal-mechanical process optimization in forging and forming operations.



Hot/Warm Deformation: Shown above is a plane strain compression test. In single or multiple-hit compression tests, strain and strain rate are controlled separately yet synchronously using the optional Hydrawedge, simulating hot rolling or multi-hit hot forging.



Strip Annealing Process Simulation: Both batch and continuous annealing processes can be simulated using a strip annealing jaw system.

Gleeble 3000 Series

The Standard for Thermal-Mechanical Simulators

Now equipped with Gleeble Touch Control (GTC) Technology

Gleeble systems are available in several models, each with a wide variety of available options and configurations. This flexibility allows the tailoring of a Gleeble system to meet your exact testing requirements. Available options include Induction Heating System, transducers, load cells, contact and non-contact measurement devices, infrared pyrometers, quench systems, jaws, grips and vacuum systems.

The most popular machines are the Gleeble 3180-GTC, Gleeble 3500-GTC and Gleeble 3800-GTC. Mobile Conversion Units (MCUs) which provide application-specific capabilities are available for the 3500-GTC and the 3800-GTC models. MCUs include the Hydrawedge, MAXStrain, Hot Torsion and the new Ultra High Temp System. Gleebles can also be equipped with a Laser Ultrasonic Measurement System (LUMet) for real-time microstructure monitoring.

Gleeble 3180-GTC

The Gleeble 3180-GTC provides a physical simulation system for researchers who require the quality and accuracy of a Gleeble system on an affordable scale. The Gleeble 3180-GTC is ideal for weld HAZ simulations, hot tensile tests, thermal cycling, heat treatment studies, uniaxial compression, and low force tests.

Gleeble 3500-GTC

The Gleeble 3500-GTC is the industry standard for thermal-mechanical physical simulation. With its high-speed heating and wide range of mechanical capabilities, the Gleeble 3500-GTC is ideal for weld HAZ simulations, nil-strength tests, thermal cycling, heat treatment studies, low force tests, hot tensile tests, high-speed compression, multi-hit hot deformation tests, melting and solidification, and strip annealing simulations.

Gleeble 3800-GTC

The Gleeble 3800-GTC is the most powerful Gleeble, available with a mechanical system capable of exerting as much as 20 tons of compressive force. This system can be equipped for the same applications as a Gleeble 3500-GTC, but with twice the force and speed. It is particularly well suited for hot rolling and multi-hit forging simulations. The additional force and speed provide the ability to use larger samples, test stronger materials, achieve higher strain rates, and test at lower temperatures.

Gleeble 500 Series

An All-New Research Platform Optimzed for Performance, Versatility and Value

The 500 Series of Gleeble systems are tailored to provide a compact, economical solution for researchers while retaining the world-class capabilities that have made Gleeble systems the industry standard.

Features Include:

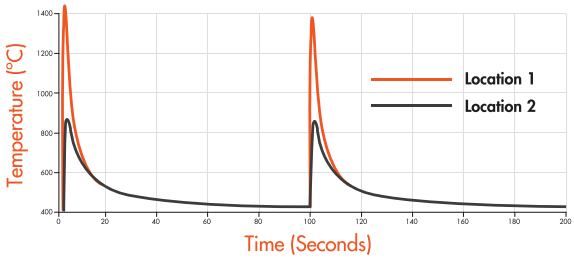
- High-speed, direct resistance heating up to 10,000°C/second
- Controlled cooling or accelerated cooling with optional quench (air/gas/water)
- Simulation of multiple applications, processes and materials
- Ability to test in vacuum, air or inert gas
- User-friendly and easy-to-use controls and software
- Quiet operation, easy installation and a small laboratory footprint

The Gleeble 500 Series includes the Gleeble 563, Gleeble 540 and Gleeble 525. While these economical and compact systems require a lower investment, they are able to perform a wide range of testing and process simulations.

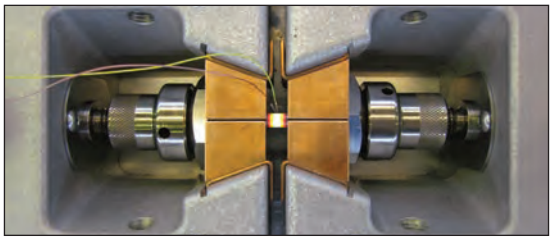
Materials testing capabilities of the Gleeble 540 & Gleeble 563:

- Hot ductility and hot tensile testing on a wide variety of specimen geometries
- Strain-Induced Crack Opening (SICO)
- Stress vs. strain curves
- Melting and solidification
- Nil-Strength testing
- Thermal cycling/heat treatment
- Weld HAZ simulations
- Charpy specimen heat treatment
- Study of localized brittle zones
- Embrittlement and crack susceptibility
- Liquid metal embrittlement
- Welding/HAZ phase transformation studies
- Creep/stress rupture
- Low cycle thermal-mechanical fatigue

HAZ Simulation of Successive Weld Passes



Weld HAZ simulations can reproduce thermal gradients and characteristics at any location in a weld. The graph shows the thermal profile of two locations during a multi-pass weld.



Direct resistance heating provides extremely fast heating rates with precise control. Water-cooled jaws contribute to very fast cooling rates and enable researchers to simulate steep thermal gradients.

Gleeble 540: Welding Simulator

Over 60 years ago, the Gleeble was developed to study weld HAZ. While Gleeble systems have evolved and grown over time, the new Gleeble 540 Welding Simulator focuses on applications necessary for welding research. However, the 540 performs much more than just HAZ simulations. Adding a wide range of capabilities including studies of ductility, crack susceptibility, nil-strength determination and much more.

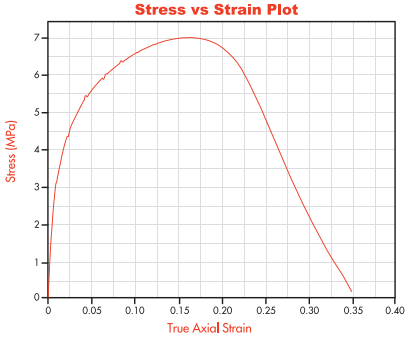
Gleeble 563: TMS System

The Gleeble 563 Thermal-Mechanical Simulation (TMS) System can perform all of the testing possible with the Gleeble 540, and adds the ability to conduct uniaxial and plane strain compression tests. The flexibility of the 563 delivers maximum value by enabling researchers to conduct many different types of tests and simulations with a minimum investment.

The Gleeble 563 offers the following additional capabilities:

- Hot compression testing, including uniaxial and plane strain studies
- Stress relaxation studies
- Phase transformation studies, including CCT/TTT curve development with and without deformation

Stress vs Strain Plot



Gleeble 525: Annealing Simulator

A Dedicated Simulation System for Optimizing Continuous Annealing, Galvanizing and Coating Lines

The Gleeble 525 is a low-cost system built specifically for simulating thermal cycles in sheet specimens, including continuous annealing lines, batch annealing, quenching and tempering (Q+T), quenching and partitioning (Q+P) and other heat treatment processes. The Gleeble 525 is designed to be used on the production floor or in a research lab. This easy-to-use system can quickly run tests and simulations on flat specimens, to help researchers make better processing decisions.

Gleeble System Comparison Chart

The Gleeble family of systems is growing. Find out which system is the right fit for your engineering challenge. DSI offers a range of Gleeble models, each of which are flexible and customizable to fit a wide range of applications. The comparison chart below lists the key features, capabilities and applications of popular Gleeble systems.

The guide below is a good place to start. However, to identify the best solution for your needs and budget, please contact one of our system experts at Info@Gleeble.com to discuss your research needs and model/configuration options.

Force	Maximum Compressive Force	20 Metric Tons	10 Metric Tons	8 Metric Tons	3 Metric Tons	3 Metric Tons	–
	Maximum Tensile Force	10 Metric Tons	10 Metric Tons	8 Metric Tons	3 Metric Tons	3 Metric Tons	50 kgf
Stroke	Maximum Stroke Distance	125mm	100mm	100mm	100mm	100 mm	–
	Maximum Stroke Rate	2000mm/sec	1000 mm/sec	1000mm/sec	200mm/sec	200mm/sec	–
	Minimum Stroke Rate	0.001mm/sec	0.001 mm/sec	0.01mm/sec	0.01mm/sec	0.01mm/sec	–
Temperature Control*	Maximum Temperature	3,000°C*	3,000°C*	1,700°C	1,700°C	1,700°C	1,000°C
	Maximum Heating Rate	10,000°C/sec	10,000°C/sec	8,000°C/sec	10,000°C/sec	10,000°C/sec	50°C/sec
	Maximum Quenching Rate*	10,000°C/sec	10,000°C/sec	10,000°C/sec	10,000°C/sec	10,000°C/sec	57°C/sec
	Maximum Specimen Size	20mm dia	20mm dia	12mm dia	11mm sq	11mm sq	50mm x 260mm
Mobile Conversion Units	Torsion MCU	✓	✓	–	–	–	–
	Hydrawedge MCU	✓	✓	–	–	–	–
	Strip Annealing MCU	✓	✓	–	–	–	–
	High Temp Testing MCU	✓	✓	–	–	–	–
	MAXStrain® MCU	✓	–	–	–	–	–
	LUMet	✓	✓	–	–	–	–
Applications & Research Areas*	Hot Tensile Testing	✓	✓	✓	✓	✓	–
	Uniaxial Compression – High Speed	✓	✓	–	–	–	–
	Uniaxial Compression – Low Speed	✓	✓	✓	✓	–	–
	Plane Strain Compression – High Speed	✓	✓	–	–	–	–
	Plane Strain Compression – Low Speed	✓	✓	✓	✓	–	–
	Dilatometry – Static Dilatometry	✓	✓	✓	✓	–	–
	Dilatometry – Deformation Dilatometry	✓	✓	✓	✓	–	–
	Strain Induced Crack Opening (SICO)	✓	✓	✓	✓	✓	–
	Heat Treating	✓	✓	✓	✓	✓	✓
	Melting & Solidification	✓	✓	✓	✓	✓	–
	Welding & Weld HAZ Studies	✓	✓	✓	✓	✓	–
	Nil-Strength Testing	✓	✓	✓	✓	✓	–
	Rolling Simulation	✓	✓	–	–	–	–
	MultiAxis Forming *(Creation of Ultrafine-grain & Nanomaterials)*	✓	–	–	–	–	–
	Continuous Casting	✓	✓	✓	✓	✓	–
	Mushy Zone Processing	✓	✓	✓	✓	✓	–
	Forging	✓	✓	✓	✓	–	–
	Stress Relaxation	✓	✓	✓	✓	✓	–
	Strip Annealing	✓	✓	–	–	–	✓
	Extrusion	✓	✓	✓	–	–	–
	Torsion Testing	✓	✓	–	–	–	–
	Powder Metallurgy/Sintering	✓	✓	–	–	–	–
	Recrystallization & Grain Growth	✓	✓	✓	✓	✓	✓
	Fatigue (Thermal/Thermal-Mechanical)	✓	✓	✓	✓	–	–
	Friction Stir Welding	✓	✓	–	–	–	–
	Quenching (Water/Air/Gas/Mist)	✓	✓	✓	✓	✓	Air/Gas
	Cryogenic Quenching	✓	✓	–	–	–	–

* Optional equipment may be required.

Gleeble Touch Control

The Next Generation of Gleeble Systems Control

Gleeble systems come equipped with control and data analysis software, including the all-new Gleeble Touch Control (GTC) System, which controls thermal and mechanical functions. QuikSim®2 software is a user-friendly interface enabling Gleeble operators to program and control the system as well as collect test data. Additionally, robust data analysis software is included, **making it easier than ever to generate and analyze data.**

All-New Touch Screen Display

- Intuitive and easy to use
- Large screen and simple icons
- Clear presentation of key data

Quick Function Panel

- Power Switch
- Reset Switch
- Emergency Stop

Gleeble systems come standard with a workstation that includes a desk, a well-equipped desktop computer, thermocouple welder, printer, monitor, keyboard and mouse.

Wireless communication with workstation reduces wire clutter

Lower Panel

- Large touch-reactive control knobs make system adjustment easier and more accurate
- Ergonomically designed for added user comfort
- Standard buttons include: Run, Stop, Mechanical, Door Lock

GTC utilizes modules to maximize compatibility with external measurement systems & accessories

Features Include:

- Simultaneous thermal and mechanical control
- Manual and/or computer control
- Smooth transitions in mechanical control mode
- Measurement units easily configured by user
- High-speed data acquisition
- Test progress readout via Virtual Panel Meters (VPMs)

QuikSim®2 Software

- User-friendly interface for programming and controlling the Gleeble System
- Independent workstation with full Windows® multitasking during testing
- Highly versatile
- Fast set-up times allow users to run more tests in less time
- Password protection
- Arbitrary waveform generation
- Three programming methods available:
  - Table form (fill in the blanks)
  - Optional Deformation Control Software for sequential multi-hit deformantion
  - Gleeble Script Language (GSL) for maximum flexibility

Data Processing

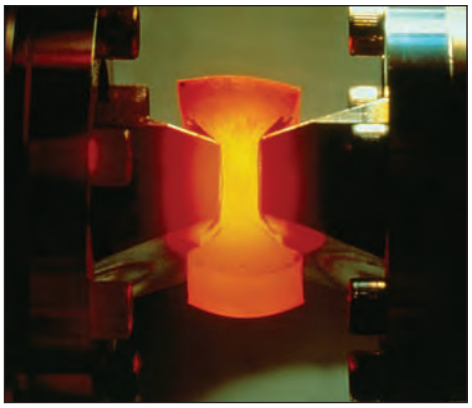
- Powerful and flexible data processing
- Publication quality data plots and graphs
- User-created templates save considerable time when completing repetitive tasks
- Built-in mathematical functions
- Automatic data file loading, “Copy & Paste” or link data to other applications

Available as an UPGRADE to existing Gleeble Systems

MCU: Hydrawedge®

COMPATIBLE WITH 3500 COMPATIBLE WITH 3800

The Ultimate Tool for Optimizing Hot Rolling & Forging Processes

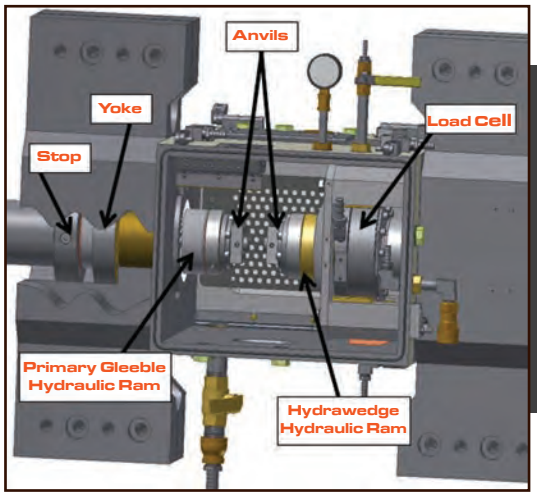


For researchers who wish to optimize multiple-hit, high-speed deformations — including multi-stand rolling mills and multi-hit forging processes — the Hydrawedge offers excellent physical simulation capabilities.

Available as an option for Gleeble 3500-GTC or 3800-GTC systems, the Hydrawedge is the only commercially available machine that offers the capability to perform high-speed deformation simulations with complete independent control of both strain and strain rate.

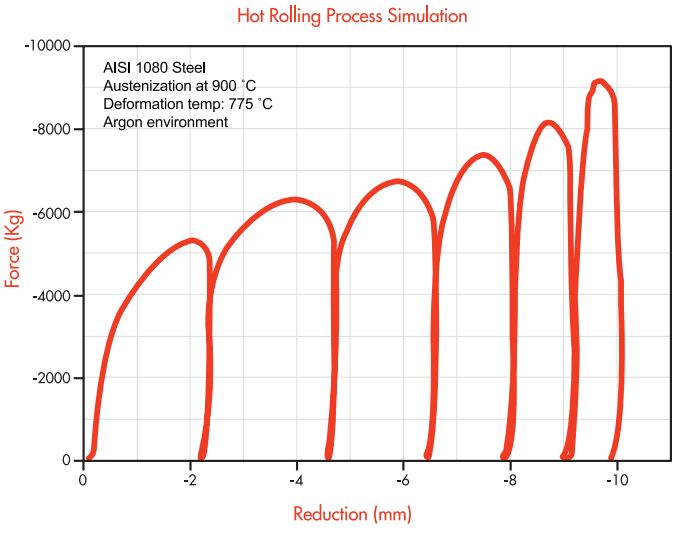
Through its patented technology, the Hydrawedge delivers test results without strain overshoot or strain rate deceleration, either one of which can reduce the validity of the simulation.

The Hydrawedge control software allows the system to be programmed with the same parameters as a rolling mill schedule. The operator programs the rolling temperature, soaking times, interpass time, controlled cooling time, strain rate, and amount of strain for each stand. The software then calculates and programs how to run that schedule on the Hydrawedge.

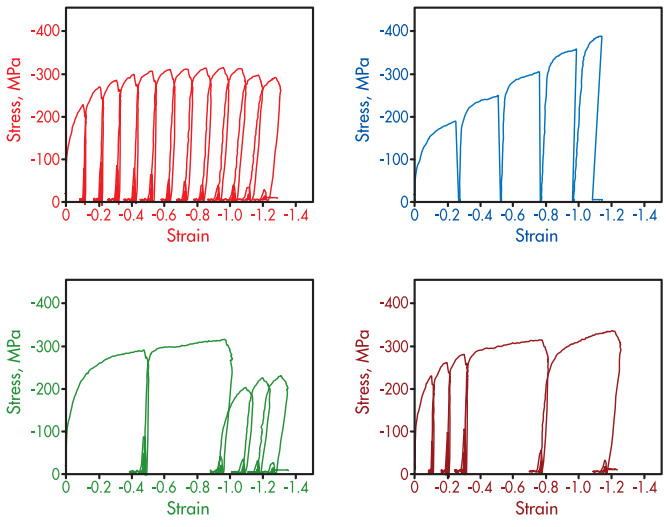


The patented Hydrawedge system is capable of multiple compressions at strain rates of up to 100/s allowing the accurate replication of an entire hot rolling or multi-hit forging process — from reheating, through multiple stand rolling, to controlled cooling.

- Multiple hits at high speed
- Independent control of strain and strain rate
- Mechanical stop eliminates deformation overshoot



The Gleeble Hydrawedge can simulate a wide variety of rolling schedules



MCU: Hot Torsion

COMPATIBLE WITH 3500 COMPATIBLE WITH 3800

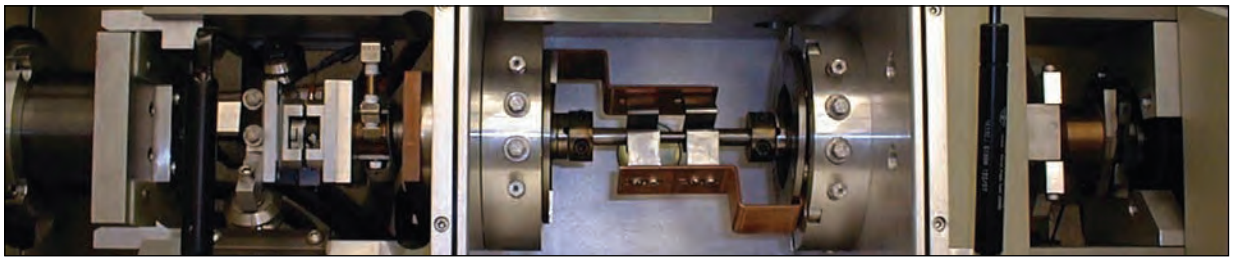
High-Speed Thermal and Mechanical Capability

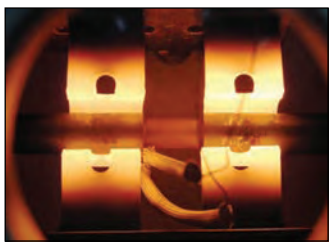
The Hot Torsion Mobile Conversion Unit (MCU) adds world-class hot torsion testing capability to Gleeble® 3500-GTC and 3800-GTC Systems. Capable of applying torque up to 100 Nm (50 Nm standard configuration), Hot Torsion Systems from Dynamic Systems are the first commercially available torsion systems to incorporate direct resistance heating.

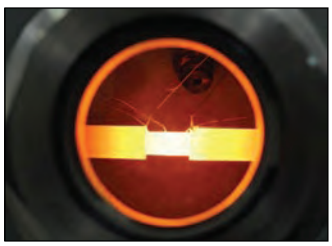
The Hot Torsion MCU uses a roll-on/roll-off design which allows the base Gleeble 3500-GTC and 3800-GTC to be easily converted to a hot torsion testing configuration.

Features Include:

- Rapid, uniform direct resistance heating of the test specimen at any time during torsion
- Rapid in-situ quenching of the test specimen at any point in the test
- Quench with air, water or mist to accelerate cooling or to freeze microstructures
- Application of controlled tension or compression axially during torsion (5 kN, 1,100 lbs limit)
- Torsion tests can be conducted with full axial restraint or no axial restraint
- High-speed hydraulic torque motor for rapid strain rate changes (1,500 RPM top speed)
- Variable torsion coupler for higher acceleration speeds
- Free coupler minimizes strain error during specimen loading
- Additional specimen furnace available to extend the uniform temperature zone
- Tests may be performed in vacuum ($5x10^{-2}$ torr), inert gas or air
- Temperature is controlled by a thermocouple attached to the fixed side of the specimen hotzone
- Specimen size: Gauge length diameter: 6-10 mm diameter
  Gauge length: 6-50 mm
- Longitudinal load cell with overload protection provides measurement of axial load on specimen
- Torque cell with overload protection provides accurate torque measurements during test
- Axial load control provides combined stress states such as tensile or compressive shear







MCU: MAXStrain®

COMPATIBLE WITH 3800

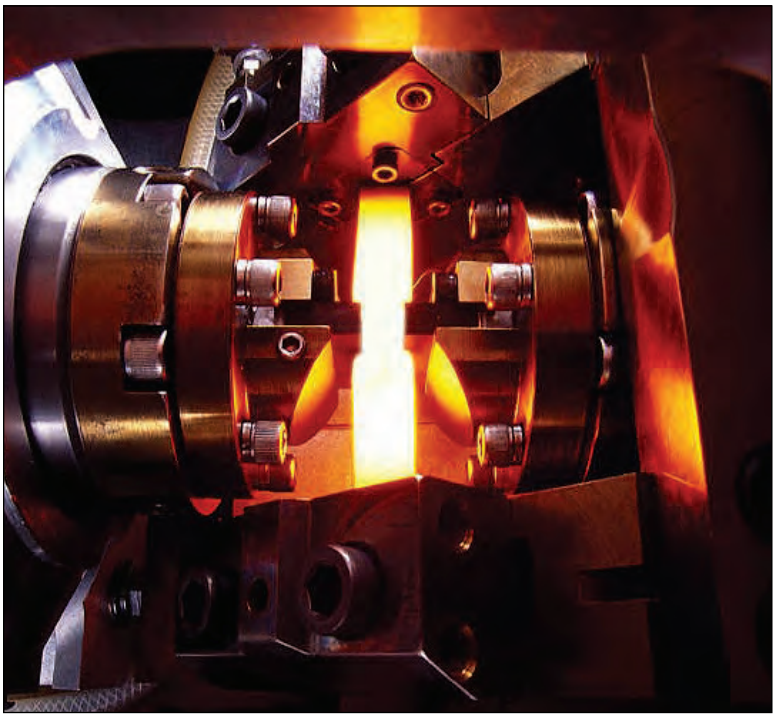
A Research Tool for Making Ultrafine-Grain and Nanomaterials

The MAXStrain multi-axis hot deformation system is a unique research tool that can subject materials to virtually unlimited strain under precise control of strain, strain rate, and temperature.

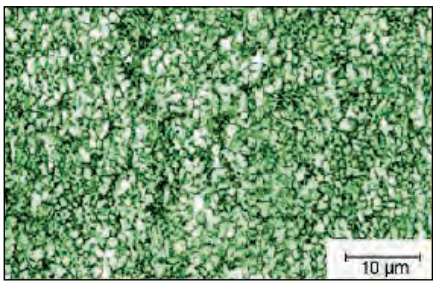
Specimens loaded into the MAXStrain are heated and rotated 90 degrees between multiple, successive compressions. The system restrains specimens lengthwise while allowing unlimited deformation in the other two dimensions. As a result, very high strain levels can be introduced into specimens to produce a sample of ultrafine-grain or nanoscale material that is large enough for subsequent properties testing.

The MAXStrain system can be used on steels, aluminum alloys, titanium, and other metals.

The MAXStrain provides unparalleled, accurate control of all parameters, thereby offering a high degree of reproducibility. Researchers quickly and precisely create materials in the laboratory under well-controlled mechanical and thermal conditions.



A steel MAXStrain specimen is heated via direct resistance while anvils deform the center section. Each end of the specimen is constrained and the specimen is rotated 90 degrees before the next compression.



Ultrafine-grain or nanoscale material can be produced due to the exceptionally high strain levels achieved in the specimen. The large specimen size enables further testing on the same sample.

Mobile Conversion Unit (MCU) Time-Saving Enhancements

Mobile Conversion Units (MCUs), available for Gleeble 3500C and 3800 systems, provide researchers with additional application-specific capabilities. MCUs feature a roll-on/roll-off design and can be connected to the Gleeble Load Unit to provide a much wider range of testing without the need to purchase separate standalone systems.

DSI has recently introduced new features to make switching MCUs easier than ever while still maintaining system stiffness and optimal performance. These features reduce the time required to switch MCUs so that Gleeble users can be more productive and spend more time running tests, and less time configuring equipment.

MCU Hydraulic Crosshead Locks

Switch MCUs quickly to complete more tests

MCUs require an extremely secure connection to the Gleeble Load Unit. Traditionally, the connection was secured using a series of superbolts. While these create a very powerful and reliable connection, superbolts can take time to properly torque. DSI has introduced a new Hydraulic Crosshead Locking System to replace superbolts and greatly reduce the time required to attach and remove MCUs.

The locks include multiple clamps which are powered by an independent hydraulic system installed in the Gleeble Load Unit. These clamps do not diminish hydraulic power to the main Gleeble unit. Crosshead locks automatically engage when the Gleeble is powered on, ensuring a secure connection between the MCU and the Gleeble Load Unit.

The Hydraulic Crosshead Locking System is available as an option on new Gleeble systems or as a retrofit for most existing Gleeble 3500 and 3800 systems. The system requires installation by a Certified Systems Service Engineer.

MCU Quick-Change

MCUs glide into place with improved suspension

Each Gleeble MCU is built for high performance and precision. Unfortunately, with added capabilities comes added weight. While MCUs are designed to roll-on / roll-off of the Gleeble Load Unit, added weight can make this difficult for a single user. DSI has recently introduced a system to make moving MCUs easier.

New articulating/ rotating/ adjusting suspension columns allow the MCU to be easily moved and adjusted to glide into the proper position on the Load Unit's crossheads. The Quick-Change suspension system is available on new Gleeble systems and as a retrofit for most existing Gleeble 3500 / 3800 MCUs.

Combined with the Hydraulic Crosshead Locks, the new MCU Quick-Change System will help your research and application teams maximize their efficiency and Gleeble testing throughput.

Strip Annealing Simulation Solutions

Gleeble Simulations Drive Process Improvement

Gleeble systems rapidly and dynamically heat and quench sheet specimens to accurately simulate annealing or galvanizing coating lines.

Annealing and coating lines are large, complex systems that require tight process control and optimization to maintain efficiency and product quality. Simulation data provides the insight needed to more efficiently schedule different grades, gauges and specifications. This can be used to reproduce and evaluate existing processes, experiment with process modifications, or troubleshoot problems.

Simulations and experiments are a safer and less costly method of producing data for optimization. Production line trials risk damaging the mill, take up valuable production time, and often result in wasted material.

Gleeble technology makes it easy to reproduce real-world annealing thermal cycles on steel sheet or strip materials.
Unlike expensive mill trials, simulations help staff quickly and efficiently optimize annealing procedures, improving profitability, increasing production, and reducing waste by quickly providing the information needed to make better processing decisions.

Annealing simulations offer substantial benefits:

- Better understand the time/temperature relationship of materials, and processing windows
- Improve product quality - Simulations help optimize material properties and meet the high demands of AHSS
- Reduce scrap, secondary coils and test coils
- Accelerate new product development
- Improve efficiency by defining process windows to allow better transitions
- Develop annealing cycles to meet specification and salvage off-chemistry or misprocessed coils
- Adjust processing settings for different alloys and grades

Gleeble Solutions

DSI offers a range of strip annealing simulation options. Each system offers impressive capabilities:

- Ultra-Fast Heating - All Gleeble strip annealing systems utilize an ultra-fast and responsive direct resistance heating system
- Proportional Quench - A dynamic cooling system with custom gas quench spray heads allows fast, yet controlled cooling
- Complex Thermal Cycles - Users can easily program complex temperature profiles, including heating, holding, controlled cooling, reheating and quenching, allowing for accurate process simulation
- Large Uniform Temperature Zones - Great care has been taken to maximize temperature uniformity within the specimen, which allows for a more representative post-treatment analysis
- Environmental control - Tests can be run in vacuum, air or inert gas
- Tension Application - Tension can be applied to the specimen to prevent buckling and simulate roll tension forces
- Wide-Surface Quenching - Custom designed quench spray heads for air or gas minimize thermal gradients during cooling

The **2-Inch Strip Annealing Jaw Set** fits within the vacuum tank of a Gleeble 3500 or 3800 and is used for heat treatment of 50 mm-wide specimens. Dynamic temperature control and quenching capabilities enable cooling rates up to 400°C/s.

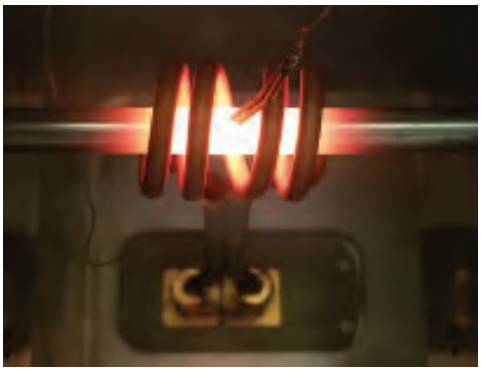
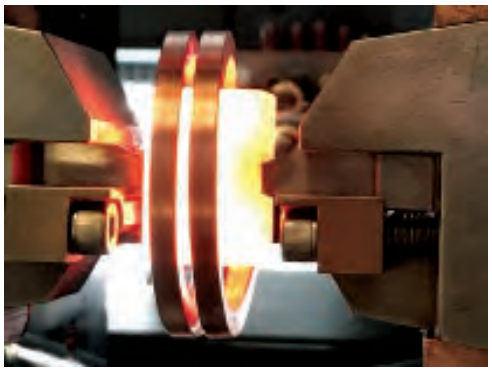
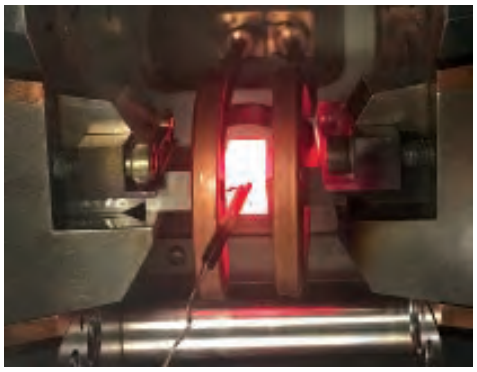
The **Large Sample Strip Annealing MCU**, available for Gleeble 3500 and 3800 systems, achieves controlled heating and cooling cycles on large sheet samples (up to 125 mm-wide) with large uniform temperature zones. The sample size is large enough to allow subsequent material properties testing of the material, including LDH and tensile test coupons.

The **Gleeble 525 Strip Annealing Simulator's** low cost, simplicity of operation and small footprint make it an ideal fit for line technicians and can be placed near each annealing line for quick implementation of results.

Simple to use, the system can be used to run tests and simulations on 50 mm-wide specimens to help staff quickly make better processing decisions.

Induction Heating

The Gleeble Induction Heating System (IHS) provides an alternative heating method to increase testing flexibility

Gleeble systems have historically relied on direct resistance heating to provide extremely fast, uniform and responsive heating. While this method offers considerable advantages over other heating techniques, there are cases where induction heating is preferred. For customers looking to heat via induction, DSI now offers the Gleeble Induction Heating System. (IHS)

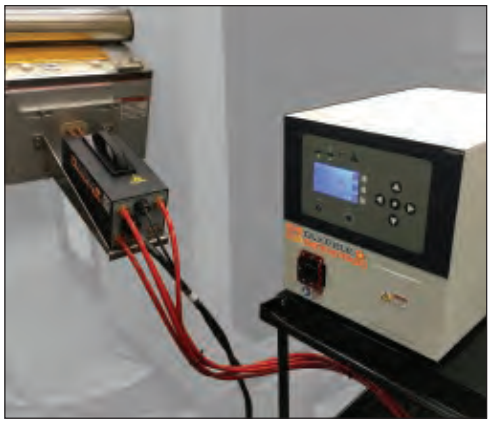
Developed in partnership with a leading supplier in the induction heating industry, the Gleeble IHS is fully integrated with the Gleeble and allows the user to select either induction or resistance heating for each test. The IHS utilizes the existing Gleeble cooling loop and is powered directly from the Gleeble load unit.

Benefits of Induction Heating:

- Useful for bimetallic, nonsymmetrical and unique specimens
- Compression Anvil Flexibility:
  - Non-thermally conductive anvils can be used, maximizing temperature uniformity
  - Non-electrically conductive anvils and lubricants can be used
- More control and flexibility of heating locations on the specimen
- Allows the heating of non-electrically conductive samples by using an induction susceptor
- Magnetic concentrators allow users to direct magnetic fields and energy in the specimen for efficient heating
- Various coils can be used depending on test types and specimen sizes.
- 3-axis adjustment of induction coils to optimize heating locations and make it easier to set up new coils
- Atmosphere: Test in air, vacuum or inert gas

Induction heating is well suited for use in uniaxial compression testing (flow stress), where it can provide a uniform temperature across the specimen from anvil to anvil. Induction heating can also be used in tensile testing, heat treating applications and plane strain compression testing.

The full capability of the high speed Gleeble direct resistance heating system is still maintained, allowing heating rates up to 10,000ºC/second when using direct resistance heating. The two heating systems are both fully integrated into the Gleeble testing machine, and software can be used to select which heating system is used for each test.



Various coil geometries are available to facilitate different types of Gleeble testing. Additional anvil materials are available.

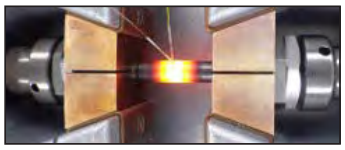
Notes:

- Heating / cooling rates vary depending on sample size and material. Specimens can be quenched using air, water, mist, or inert gas.
- Temperature measurement utilizes the same thermocouples as the traditional Gleeble direct resistance heating system.
- Compatible with Gleeble 3500 and 3800 systems, including the General Purpose and Hydrawedge Mobile Conversion Units as well as the Compression Test Adapter Set.
- The IHS requires the latest Gleeble hardware and software be installed, including the Gleeble Touch Control (GTC) system.

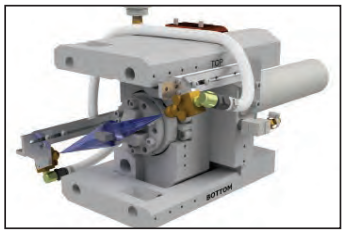
Quenching Capabilities

Gleeble systems are well-known for extremely fast heating rates - however the Gleeble is also able to achieve very fast and controlled cooling rates. Together, these capabilities allow the Gleeble to simulate nearly any combinations of heating and cooling profiles.

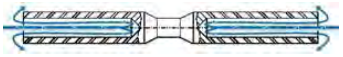
DSI offers several quenching/cooling solutions based on researchers' needs.



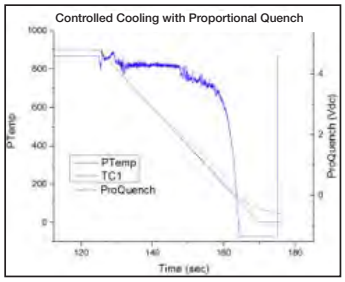
Standard Free Cooling - Gleeble operators are able to adjust thermal gradients and cooling rates by changing grip materials, grip geometry and specimen design. When the heating system is not actively heating a specimen, the specimen will cool very quickly through conduction of heat to the water-cooled jaws/grips as well through convection/radiation to the tank atmosphere.



Spray Quenching When accelerated quenching is required, air, gas, water or mist can be sprayed directly onto the specimen from a variety of nozzle types and locations. Quenching can be programmed into the Gleeble control system, including heating and cooling cycles.



ISO-Q Internal Quenching - In cases where a vacuum or atmosphere must be maintained or when measurements on the specimen surface are required, specimens can be rapidly cooled through internal quenching. The ISO-Q system pumps a cooled medium (compressed air, gas or water) into the hollow ends of the specimen. This results in extremely fast cooling rates and minimizes thermal gradients from the core to the surface of the specimen.



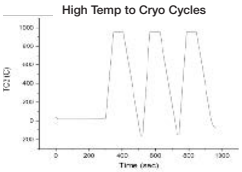
Proportional Quench - Developed for use with strip specimens, the proportional quench system simplifies programming for achieving specific cooling rates. Compressed air or inert gas flow is proportionally controlled, dynamically cooling the specimen as needed.

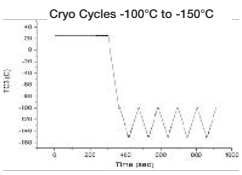
New Feature: CRYO QUENCH

Simulation of cryogenic applications and thermal treatments are increasingly important to the metallurgical community. DSI has developed an integrated system to safely and reliably achieve cryogenic quenching to -150°C.

CryoQuench supports the following applications:

- Determination of material properties at low temperatures
- Development of cryogenic treatments necessary to minimize retained austenite in highly alloyed steels
- Determination of the austenite stability in TRIP or Q&P type steels. Temperature can be applied in conjunction with applied stresses to determine the interplay between stress and temperature
- Studies of thermal shock/fatigue/cycling in materials, including both hot-to-cold and cold-to-hot
- Development of aerospace components exposed to both extreme heat and cold





There are several methods to achieve cryogenic quenching in a Gleeble.

Internal ISO-Q Quenching
Liquid nitrogen flows in and out of the hollow ends of the specimen, making it ideally suited for dilatometry, thermal cycling and static testing.

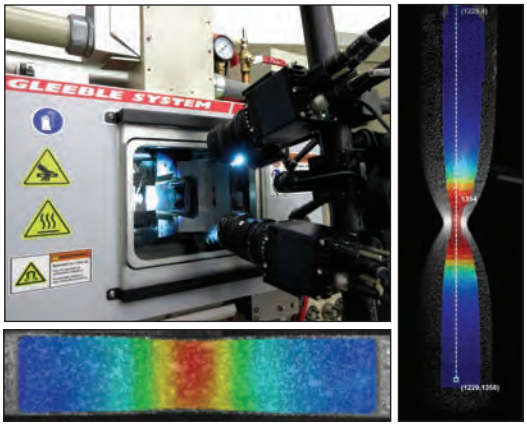
External Quench Gas Spray - Cryogenically cooled gas is sprayed onto the specimen using spray heads. Quenching mediums may include nitrogen gas or other inert gas that have been cooled via a liquid nitrogen bath. While this method allows for more types of testing, it may result in steep thermal gradients with less precise control, and will limit the types of measurement devices that can be used.

Measurement Systems

Digital Image Correlation Systems

Digital Image Correlation (DIC) can be used in conjunction with Gleeble systems for 3D non-contact optical measurements of deformation and strain. DSI has developed a successful combination of high-performance cameras, lighting, mounting hardware and licensed software to produce accurate results, even at elevated temperatures.

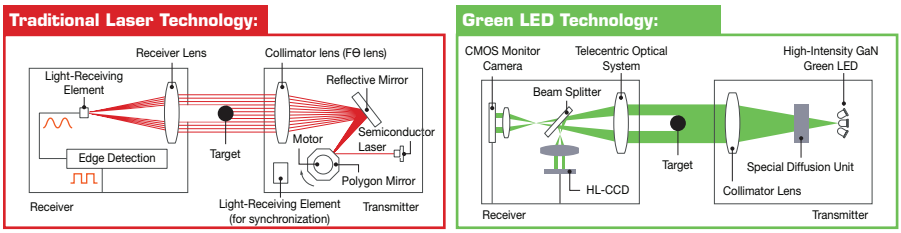
Digital Image Correlation can be utilized on a number of standard Gleeble tests including tensile tests, Strain Induced Crack Opening (SICO), and flow stress compression, as well as other standard and custom simulations.



Scanning Non-Contact Optical Dilatometer and Extensometer with Green LED Technology

Optical System Achieving High-Speed, High-Accuracy, and High-Durability
The system uses a high-intensity GaN long-life LED combined with an HL-CCD sensor to provide high-speed measurements with no moving parts. This unit has twice the speed of conventional laser-based measuring units.

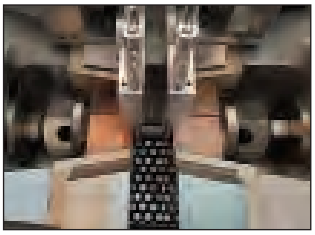
Easy-to-use, menu driven setup software is included with the unit to allow configuration of the controller on the desktop PC.



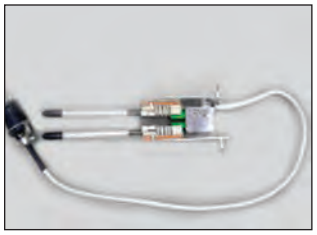
More Accurate and Easier to Use: Green LED technology achieves both quick and accurate measurement reliably and durably.

Contact Measurement Systems

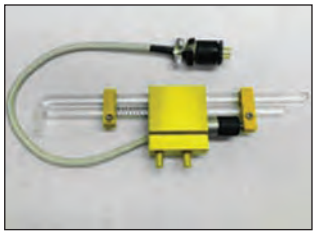
DSI offers a range of highly accurate contact extensometers that can be utilized for a variety of measurements, both crosswise and lengthwise on a wide range of specimen types, both in and out of the specimen's hot zone. Both LVDT and strain gauge measurement systems are available. These components have been designed to be easy to install and operate. Some of the more popular systems are listed below:



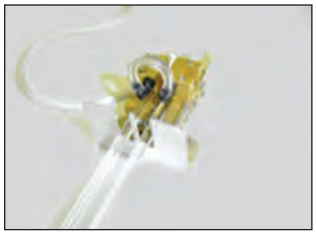
39061 – Hot Zone Lengthwise Extensometer:
This LVDT device measures lengthwise strain using alumina rods in contact with the specimen in the hot gauge area. (25mm travel).



39071 – Hot Zone L-Strain:
A strain gauge type hot zone transducer, commonly used for tests requiring high resolution with small amounts of travel. (5 mm of travel in tension, 2 mm of travel in compression).



39010 C-Gauge:
Crosswise LVDT-type gauge with large travel (12 mm) measures significant deformations.



39018 Dilatometer:
Highly accurate and reliable, the Dilatometer is commonly used to generate CCT/TTT data.

Specialty Systems

COMPATIBLE WITH 3500 COMPATIBLE WITH 3800

LUMet®

Laser-Ultrasonic Sensor for In-Situ Metallurgy Microstructure Studies

It is now possible to monitor metallic microstructures in real time, in-situ and at high temperatures while conducting physical simulations. The LUMet system provides unprecedented capabilities by allowing observation of the internal physical state of a specimen during Gleeble tests.

Researchers can gather in-situ information on:

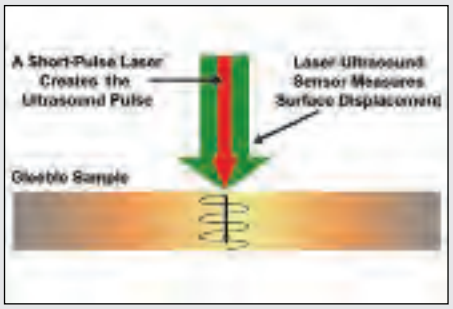
- Recrystallization
- Grain growth
- Grain size
- Phase transformations
- Elastic constants
- Texture

Laser-ultrasonics is a technology that enables non-contact ultrasonic measurements, using lasers to generate and detect ultrasound pulses. Unlike other ultrasonic technologies, it can be used on hot materials because there is no physical contact. Therefore, it is ideally suited for in-situ studies of solid metallic materials up to their melting point.

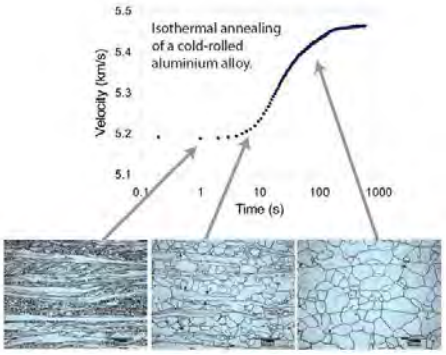
How It Works:

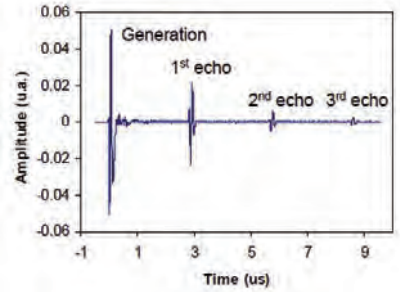
The LUMet system uses lasers to generate and detect ultrasound pulses in a sample during testing. To generate the ultrasound pulse in the sample, a high-power, short-pulse laser produces light pulses about 10 nanoseconds in duration. Each pulse causes intense pressure on the surface of the sample, and sends an ultrasonic pressure pulse through it.

A laser interferometer measures sub-nanometer surface displacement caused by the pulse laser and its subsequent reflections as it echoes through the sample with sub-nanometer resolution. Based on the measured velocity and attenuation of sound in the medium, researchers can determine texture, modulus, grain size and phase mixtures.



In the field of metallurgy and metallurgical processing, ultrasonics is a sensitive technique for measurements of elasticity, internal microstructure, phases, crystallographic texture, grain size, and more. When used with the Gleeble 3500-GTC or 3800-GTC, these measurements can be done in-situ, in real-time, during thermomechanical processing.





Example of laser-ultrasonic measurement of a single ultrasound pulse bouncing back and forth between the two faces of an 8 mm thick steel plate at 1100°C inside a Gleeble 3500-GTC.

Days and weeks of metallurgical studies yielding a few measurements on quenched samples can often be replaced by a single in-situ laser-ultrasonic measurement yielding hundreds of measurements in real time.

Specialty Systems:
HDS-V40 Direct Rolling Simulator

Unparalleled Technology for Process Development

Continuous casting followed by direct rolling (CC-DR) offers steel makers the opportunity for substantial energy savings and reduced capital expenditures, which in turn can reduce costs and increase profits.

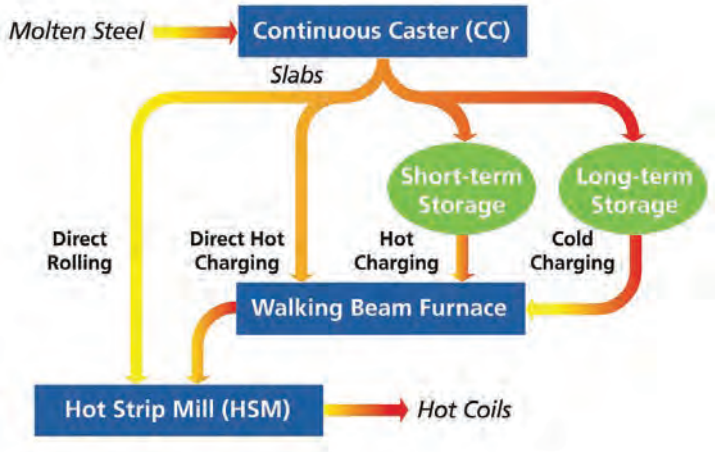
The HDS-V40 is the only commercially available laboratory system capable of simulating direct rolling, from the continuous caster to the end of the hot rolling process, all in one continuous sequence using a single specimen. Steel makers can explore the promise of continuous casting and direct rolling (CC-DR) on an affordable, reproducible laboratory scale. In addition to direct rolling, this system can be used for simulating semi-solid rolling (liquid metal core reduction), plane strain compression, hot rolling and forging.

Thermal and Mechanical Systems

The HDS-V40 uses direct resistance heating—developed on the world-renowned Gleeble—and expands the technology to utilize larger specimens to allow subsequent properties testing on the specimen material after deformation. An innovative melting containment system features a crucible that holds the molten material in place and can be removed prior to deformation.

Unprecedented Flexibility

No other system offers so much flexibility to perform melting, solidification and deformation simulations in so many different ways. The HDS-V40 can perform plane strain deformation and model deformation in different parts of the melt zone—in either the semi-solid material or in the previously melted and re-solidified material. Simulations can be performed in controlled atmospheres. In addition, the deformation anvils have separate heating controls so that the temperature of the anvils can be adjusted independently of the specimen. This allows the operator to simulate the temperature of the rolls as they contact the slab. An optional laser dilatometer allows collection of transformation data as the specimen cools.



The HDS-V40 can perform melting, solidification and hot deformation on a specimen in-situ in a single experiment, allowing simulation of any of the above processes from continuous caster to hot strip mill.

The HDS-V40 at a Glance

- Continuous Casting–Direct Rolling, liquid metal core reduction, hot rolling and hot forging simulations
- Direct resistance heating for high speed thermal capability and precise control
- Two 40-ton hydraulic systems with exact control of strain and strain rate
- Deformation speeds from 0.1 mm/sec - 1.7 meters/sec
- Simulations can be run in air, vacuum or inert gas
- Quench in-situ at any time during simulation
- Precise digital control system
- Large sample sizes. Standard sample size is 10 mm x 50 mm x 152.4 mm

Specialty Systems

GLEEBLE® BEAMLINE

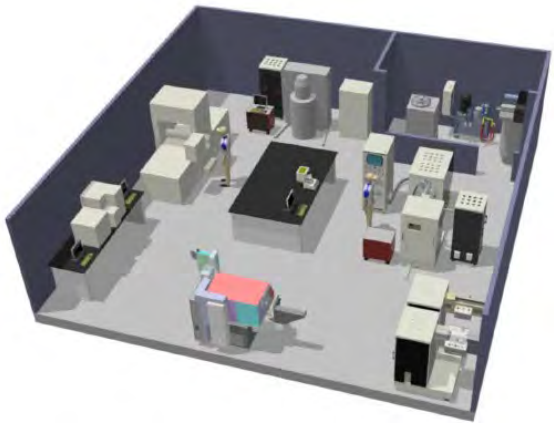
Gleeble systems can be customized to operate in various types of beam lines for unequaled in-situ materials studies during specific thermal-mechanical conditions. The system pictured here was designed specifically for use in the synchrotron beam line at the Brazilian Synchrotron Light Laboratory (LNLS) in Campinas, Brazil.

At LNLS, the system is used to perform advanced and unprecedented in-situ materials studies combining the power of high flux x-ray beams emanating from the synchrotron source and the dynamic thermal-mechanical capabilities of a Gleeble simulator, which make it possible to unveil the fundamentals of structural and functional materials behavior when subjected to specific thermo-mechanical conditions.

GLEEBLE® RAPID

Rapid Alloy Prototype Investigation and Development

DSI offers a suite of solutions to dramatically accelerate and simplify the development and characterization of new alloys.
The modular system enables researchers to create a small amount of a unique alloy and gather initial performance characteristics in hours - compared to weeks or months using traditional tools.



The system melts, mixes and casts a small amount of alloyed material. The modular design of the RAPID lab allows researchers to customize the form of the alloy output. Once created, new alloys can follow several paths to deliver the required characterization data. For example, new alloys can be characterized in their as-cast form or they can be deformed to break down the as-cast dendritic microstructure. Alloys can also be converted into powder, then printed into Gleeble specimens for characterization.

Integration with Artificial Intelligence (AI) Models
The RAPID platform supports the growing trend of using AI to develop new alloys and predict behavior. These models require massive amounts of data that can take years to gather. The RAPID ecosystem accelerates this process by quickly generating data for many unique alloys.

A new alloy can be conceived in the morning - then created and characterized by the end of the day.

Parts & Service | System Upgrades Training | Calibrations | Maintenance

Explore programs and options to maximize system performance & ensure your Gleeble continues to deliver world-class results.

Gleeble systems are powerful and highly precise scientific instruments. With proper maintenance and care, Gleebles often provide researchers with decades of reliable service. DSI's Global Service Organization is dedicated to providing customers with the support needed to keep their equipment running at peak performance.

Training: The most important part of any Gleeble research program is the human component. Knowledgeable, well-trained users ensure simulations are designed and executed correctly. Various levels of training are offered by DSI, including general operating instructions, advanced training, and application-specific training. Training is available at the DSI facility in New York, at user sites or at regional demonstration centers around the world.

Extended Warranty: Each new Gleeble system passes extensive acceptance tests - both in the DSI factory and again at the installation site - and comes with a comprehensive one-year warranty covering defects in materials and workmanship. The standard warranty can be extended to cover additional years via the purchase of an extended warranty. Older systems that are beyond their initial manufacturer's warranty period may be eligible for extended warranty protection – please contact us to learn more.

Annual Maintenance Contract (AMC): Like any complex instrument, Gleeble systems require periodic maintenance. AMCs are a great way to proactively ensure regular service and calibration for your equipment. By purchasing an AMC, organizations can schedule service visits at times that are convenient for them. Regular maintenance minimizes the risk of failures and downtime. Service visits typically require 2-3 days on-site, depending on the features and accessories installed on each system.

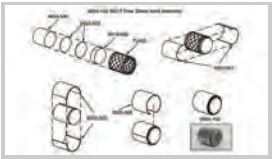
Calibration: Gleeble systems are precise, high-performance machines, and should be calibrated at least once a year by a Certified Gleeble Service Engineer. The DSI Global Service organization offers calibration as a standalone service or as part of an Annual Maintenance Contract.

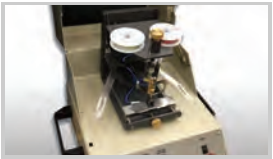
System Upgrades: A wide range of options and accessories are available to customize and add capability to your Gleeble system:

- Software and hardware upgrades
- Integration of Digital Image Correlation technology
- Mobile Conversion Units
- LED Optical Extensometer and Dilatometer
- Gleeble Touch Control – This significant software and hardware upgrade includes a range of enhancements, including improved usability and performance.

Spares, Replacements and Consumables:


Grips


Anvils

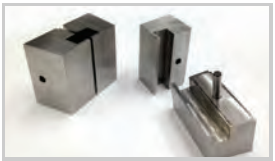

Thermocouple Wire & Welder


O-Rings & Seals


Melting Crucibles


Filters


Quartz Rods


Specialty & Custom Fixtures

About Dynamic Systems Inc.

DSI has been developing metallurgical research equipment since the 1950s. Located in New York's Tech Valley, DSI has grown from humble beginnings to become an international organization with employees and partners around the globe. Gleeble systems have become the world-standard for thermal-mechanical physical simulation systems.

DSI's first system, named the "Gleeble" by one of its creators, was originally developed to simulate the heat-affected zone of arc welding. A pneumatic system was soon added to the Gleeble, giving it limited mechanical capabilities. In 1979, the Gleeble became the first machine to combine full resistance heating thermal capabilities and hydraulic servo-mechanical testing performance in a single system. In the early 1980s, the machine was re-engineered to incorporate computers for controlling tests and data collection. Since then, DSI has introduced an increasingly advanced series of systems, which combine dynamic thermal and mechanical testing utilizing sophisticated computers for control and data acquisition.

As a result of this innovative technology, it is possible for materials to be tested in the same dynamic way that they are fabricated and used. This capability is producing new insights into materials science and new breakthroughs in productivity.

In 2019, DSI was acquired by Vishay Precision Group Inc. (NYSE: VPG). VPG is an internationally recognized designer, manufacturer and marketer of equipment, including sensors and sensor-based measurement systems specialized for the growing markets of stress, force, weight, pressure, and current measurements. Our company name, Dynamic Systems Inc. (DSI) has not changed, and the team members that you know and trust here at DSI will continue to be here to support you and your organization.

Our team is very proud of our 65+ years of dedication to supporting the world's elite research organizations, and we remain committed to continuing that legacy. We look forward to supporting our customers and the rest of the materials research community for years to come.

Gleeble Systems are Supported by DSI's Global Network of Sales, Support and Metallurgical Professionals

More Information

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