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The Gleeble® NEWSLETTER

Winter 2000–2001

Get Your Gleeble Newsletter Faster, Easier—Through Email

The Gleeble Newsletter will soon be available in electronic form for transmission through the Internet. That means readers will be able to receive their newsletter on the day it is published, without having to wait for the postal service.

Just like the printed version, there is no charge for the electronic Gleeble Newsletter. To receive the newsletter through email, visit www.gleeble.com and click on Sign Me Up.

That will put you on the electronic mail list for the newsletter. It is DSI's policy that we will not share your email address with anyone. If you have any questions or comments, contact us at DSI.

New Brochure Describes Full DSI Product Line

A new brochure that gives an overview of the complete line of thermal-mechanical simulators and thermal-mechanical testing machines offered by DSI is now available.

The 4-page, 4-color brochure describes:

- Gleeble® 3200, 3500, and 3800 systems
- Hydrawedge®
- MAXStrain® Multi-Axis Hot Deformation System
- Hot Torsion System
- ISO-Quenching and Deformation Dilatometer

For a copy of the *Thermal Mechanical Simulator Solutions Guide*, contact us here at DSI.

DSI Unveils ISO-Q™ Quenching and Deformation Dilatometer

Specifically designed to generate CCT and TTT diagrams and study phase transformation kinetics

DSI recently introduced the ISO-Q Quenching and Deformation Dilatometer. It is designed specifically to generate CCT and TTT diagrams as well as study phase transformation kinetics for use in computer modeling and process simulations. The system can be operated as a quenching dilatometer or a quenching and deformation dilatometer.

This unique system is capable of heating rates up to 8000°C/sec. and cooling rates up to 3000°C/sec. The servo hydraulic mechanical system makes it possible to achieve crosshead rates from 0.01 mm/s to 200 mm/s in single or multiple hits. The entire unit is computer controlled using Digital Signal Processors. Windows-based software is used for control, data acquisition, data analyzing and CCT diagram development. The system can be programmed to run almost any type of mathematical function for both thermal and mechanical control.

When operated as a quenching dilatometer, a tubular or solid specimen is heated with direct resistance and cooled by gas, gas/water mist or water stream at different rates in any programmed combination of heating, holding and cooling. Any number of heating cycles, cooling cycles and isothermal holds may be incorporated in the program. Transformations are measured by quartz probes (or an

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The ISO-Q Deformation Dilatometer includes a test unit, control console, hydraulic pump and desktop computer. (Hydraulic pump and desktop computer not shown.)

Recent Gleeble Papers

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Strain and Strain Rate Effects on Static and Metadynamic Recrystallization in Hot-Deformed Austenite Investigated by the Stress Relaxation Method

by L.P. Karjalainen and J.S. Perttula

Stress relaxation following axisymmetric compression was applied to determine the effects of deformation variables on static and metadynamic recrystallization in a 0.046% Nb-bearing steel and compared with those in a C-Mn steel. The effect of strain accumulation on subsequent softening in double pass deformation was also studied. In Nb steel, the power of strain is –3.3 (≥1000°C) for static recrystallization. In C-Mn steel, the range of strain leading to static recrystallization is very narrow and the power of strain is between –3 and –4. The effect of strain rate cannot be neglected, as the exponent is –0.25 for Nb steel. The apparent activation energies are 330 and 270 kJ/mol for Nb and C-Mn steels, respectively. The characteristics of metadynamic recrystallization are distinctly different from those of static recrystallization. The power of strain rate is high, –0.64, for Nb steel at strains near the peak strain, while the apparent activation energy is low, 90 kJ/mol. The law of mixtures approach was found to be more expedient than the uniform softening model in describing the recrystallization in deformed prior-partially-recrystallized austenite.

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Modeling of Multipass Hot Rolling – Constitutive Equations and Softening Behavior of Steels

by L.P. Karjalainen, J. Perttula, and P. Kantanen

The factors affecting stress-strain relationships measured in axisymmetric compression on a Gleeble were investigated. Comparisons with torsion and compression data from other laboratories were performed. Constitutive equations were determined for plain carbon, Nb and Nb-Ti steels. The effect of grain size on stress-strain behavior was investigated in detail. A stress relaxation technique has been developed and employed to determine static and metadynamic recrystallization kinetics in plain carbon and microalloyed steels. The feasibility of the technique was confirmed by comparisons with data from the literature and from double deformation tests. Recrystallization kinetics were measured for several steels.

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Stress Relaxation, A Novel Technique for Measuring the Softening Kinetics in Hot-Deformed Austenite

by L.P. Karjalainen, J. Perttula, Yurong Xu, and Jitai Niu

The principles of stress relaxation testing in the investigation of static and post-dynamic recrystallization in hot-deformed austenite has been described. Feasibility is demonstrated by a comparison with data from double-stage deformation tests. The effects of the particular characteristics of the Gleeble-type simulator on the results are briefly discussed. Interpass softening in course of the hot-working process of steels is an important even affecting both the force needed for further reduction and microstructural evolution. Softening kinetics can be followed by metallographic means, which are, however, tedious and quite difficult to apply to carbon steels, because austenite transforms during cooling to ambient temperatures, or by mechanical testing, using a double-stage deformation technique. The latter is a well established method, although slightly variable results have been obtained, depending on the procedure used (offset, back-extrapolation or mean flow stress methods) (1-3). A non-linear relationship between mechanical and metallgraphic measurements has been observed (2), even though linear relations are also reported (3). Recently, Karjalainen (4) showed that the stress relaxation method is applicable to investigation of recrystallization kinetics, and the technique is applied to C-Mn, Nb-, Nb-Ti-bearing steels as well as Type 304 and 12%Cr stainless steels at the University of Oulu (4-9). It is simple and effective, so that one relaxation test can replace several double-stage deformation tests. The method is briefly described here and its feasibility is demonstrated by comparing the data with the results from interrupted deformation tests and metallography, and the main factors affecting the results of testing on a Gleeble-type simulator are discussed.

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Weldability of Direct Quenched, Low-Carbon, Ti-B-Containing Steels

by K-s. Bang, and Y-h. Ahn

On the basis of the thermo-dynamic equilibrium between nitrides of titanium, aluminum and boron in austenite, the soluble boron that influences the hardenability of direct quenched steels was calculated. The variation in tensile strength and impact toughness of steels has a good correlation with the calculated value at the start cooling temperature, 920°C. Impact toughness of the heat-affected zone (HAZ), however, was not influenced by the soluble boron alone but by the soluble boron to soluble nitrogen ratio at the welding peak temperature, 1350°C. Only when the ratio was kept below 0.2 did that HAZ show a ferrite dominant microstructure and higher than 100J of absorbed energy at –20°C. During the welding cooling cycle, soluble boron combines with soluble nitrogen to form boron nitrides, consequently reducing the soluble boron and hardenability. Unlike conventional high-carbon steel, a low-carbon steel containing a controlled amount of boron showed no cold cracking, without preheating, and a high HAZ toughness, with an energy transition temperature of –37°C.

Series 3 Control Upgrade Available for Gleeble 1500s

Control system upgrade delivers faster programming, more accurate control & data acquisition, easier output and plotting

Gleeble 1500 owners can enjoy more productivity and more accuracy from their Gleeble 1500s by upgrading to the Series 3 Digital Control System.

The Series 3 Digital Control Update Package features the same closed-loop digital control system with high-speed Pentium computing power and Windows-based software that is standard equipment on the Gleeble 3200, 3500 and 3800.

The Series 3 control system upgrade improves the efficiency of operation by:

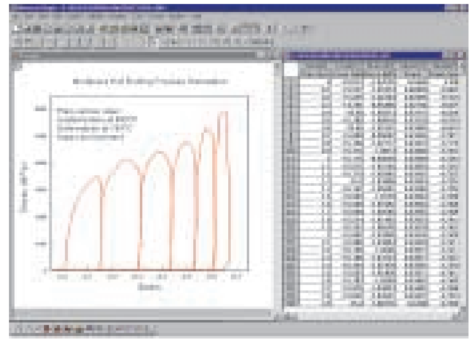
Improving accuracy of control and data acquisition—the Series 3 control offers 16-bit resolution vs. 12-bit resolution on the existing Gleeble 1500 control system.

Speeding test programming—the all Windows® software of the Series 3 is easier to use, faster to program and more versatile. As a result, users get more done in less time.

Making outputting and plotting easier—the Series 3 upgrade comes complete with Microcal Origin Data Plotting Software. In addition, Windows makes it seamless to paste plots and charts into presentations and reports.

Providing instantaneous test progress readouts—the Series 3 control system keeps the user continuously updated via Virtual Panel Meters.

For complete specifications and a quote on the Series 3 Digital Control Update Package, contact us at DSI.



Powerful and flexible data processing software is provided with every system. A stress-strain curve for a multi-hit deformation simulation is shown.

New Thermal Power Control System Offers Accuracy and Flexibility

A new system for controlling the heating energy applied to a specimen is now available for Gleeble 3200, 3500, 3800, and 1500 systems that are equipped with the Series 3 control system.

The Thermal Power Control system, consisting of optional hardware and software that can be added to new machines or retrofitted to existing machines, measures voltage and current and computes the real power that is applied to the specimen. This information can be fed to the data acquisition system and can be precisely controlled to a programmed power set point by the Series 3 control system.

The result is that now users can program linear and non-linear functions to control the power input to their specimens. This gives them another method of control beyond simply controlling the temperature that can be particularly useful when studying the effects of energy input on transformations. When studying heating or cooling transformations, the Thermal Power Control system can be used to control power applied to the specimen with a precision that was unavailable until now.

Other applications of the Thermal Power Control system include welding simulation. Welders tend to know the power cycle that a weld has been subjected to, but frequently they do not know what the thermal cycle is, unless it has been previously measured. With the new system, the Gleeble user can quickly correlate the power input of the welder with the power input of the Gleeble to make physical simulation of welding easier.

Another application of the new Thermal Power Control system is for maintaining direct control of power input during melting while still monitoring the temperature. This way, the investigator can maintain close control of the power input, making melting tests easier. Use of the Thermal Power Control system also gives the tester the option to switch between power input control and thermocouple control whenever desired during a test.

For additional information about the Thermal Power Control system, contact us here at DSI.

Gleeble Newsletter

The Gleeble Newsletter is intended to be a forum for Gleeble users worldwide to exchange ideas and information. We welcome your comments and suggestions. Letters, comments, and articles for the newsletter may be addressed to David Ferguson at Dynamic Systems Inc., e-mailed to info@gleeble.com, or faxed to us at 518-283-3160.

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ISO-Q Dilatometer

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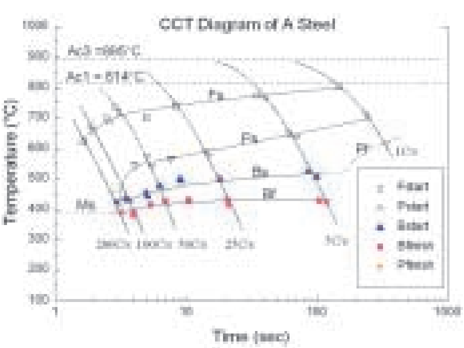
optional LASER) and displayed on the computer.

When operated as a deformation dilatometer, a solid specimen is used to measure phase transformations after deformation. The specimen can be compressed in any sequence of heating, cooling and multiple hit deformations. The effects of stress and deformation on phase transformation kinetics can be studied by using crosswise and lengthwise transducers at the same time. Phase transformation measurements are made along isothermal planes that are maintained during high heating and cooling.

Performance Specifications

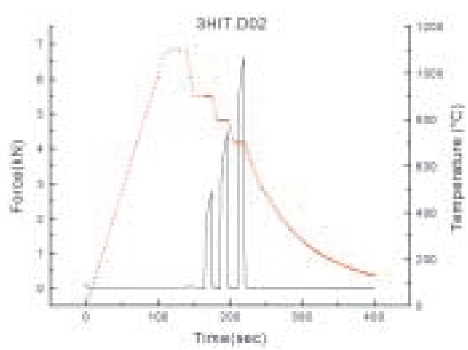
Maximum Heating rate	8000°C/s
Maximum Cooling rate	3000°C/s
Maximum Stroke rate	200 mm/s
Minimum Stroke rate	0.01 mm/s



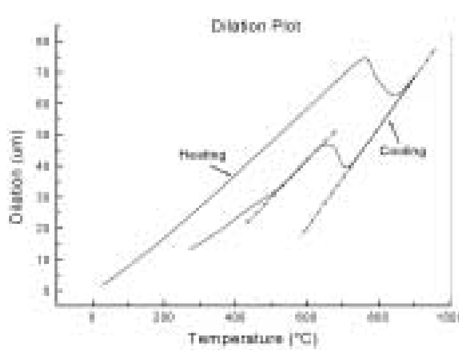
Development of CCT diagrams can be done with the aid of Windows-based software.

Specimen Sizes

Solid or hollow tube:	
5 mm dia. × 5 to 10 mm length	
6 mm dia. × 6 to 10 mm length	
Solid compression samples:	
5 mm dia. × 5 to 10 mm length	
6 mm dia. × 6 to 10 mm length	



Dynamic phase transformation studies after multiple-hit thermomechanical deformations.



Static phase transformation measurement on the isothermal plane with no deformation.

Remanufactured Gleeble 1500D System Available

From time to time, remanufactured Gleeble 1500 systems become available from DSI.

One such system, a Gleeble 1500D remanufactured to better than its original factory specifications, will soon be ready for purchase.

The mechanical and thermal systems of every Gleeble 1500D are thoroughly tested and extensively refurbished. The control system is upgraded to the Series 3 Digital Control System to provide the latest in computer control and data acquisition.

This system includes:

- Series 3 Digital Control console, computers and electronics
- Refurbished load unit
- Hydraulic pump
- Vacuum tank
- Vacuum pumping system with diffusion pump
- C-Strain transducer
- Model 1584 quench package

Other optional equipment is also available, and this system comes with a full one-year factory warranty from DSI. For additional information about this remanufactured Gleeble 1500D, contact us here at DSI.