The Gleeble® NEWSLETTER

Spring 1997

Dynamic Systems Inc.
Tel: (518) 283-5350 Fax: (518) 283-3160
Internet: www.gleeble.com/gleeble

DSI Announces Gleeble® 3200

—Low-Cost Physical Simulation System—

A low-cost physical simulation system for researchers who require the quality, accuracy, and physical simulation capabilities of a Gleeble system but who do not need the performance specifications of the larger Gleeble systems is now available from Dynamics Systems Inc.

The Gleeble 3200 is designed for applications such as:

- weld HAZ simulation,
- hot tensile tests,
- melting and solidification,
- CCT and CHT (with deformation),
- heat treatment, and
- continuous casting simulation.

At the heart of the 3200 are the features for which Gleeble systems are internationally renowned: a closed-loop direct resistance heating system, a closed-loop servo mechanical system, and a Windows®-based digital computer control and data acquisition system. Test programming is fast and easy with fill-in-the-blanks spreadsheet-style software. Virtual Panel Meters, configurable by software or manually, display test results in real time.

Gleeble 3200 Performance Specifications

Maximum heating rate—8,000°C/second
Maximum stroke rate—100 mm/second
Maximum stroke—100 mm
Maximum force—2 tons
Control methods—stroke or force, tension or compression
Specimen sizes—round 5 mm to 10 mm diameter; square 6 mm to 11 mm; flat strip 2 mm × 50 mm maximum size

Gleeble systems are used for process simulation, materials characterization, and basic research in technical institutes, industrial laboratories, and universities throughout the world.

For additional information, contact us or visit our Web site at www.gleeble.com.

The Gleeble 3200 defines an economical standard for physical simulation and thermal-mechanical testing.

German Institute Selects 3500 for Laser Welding Studies

Schweißtechnische Lehr- und Versuchsanstalt Mecklenburg-Vorpommern GmbH, Rostock, Germany, has selected a Gleeble 3500 thermal-mechanical physical simulation system for its research into laser welding.

Manufactured by Dynamic Systems Inc., the Gleeble 3500 is capable of heating specimens at 10,000°C/second and applying loads as high as 10 tons of force. The dynamic heating and cooling characteristics of the Gleeble 3500 allow investigators to physically simulate and model laser welding on a laboratory scale under precise computer control.

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ISPS '97 Proceedings Available Soon

The International Symposium on Physical Simulation (7th ISPS) was held at the National Research Institute for Metals (NRIM), Tsukuba, Japan on January 21–23, 1997. The conference was hosted by the Iron and Steel Institute of Japan and supported mainly by Dynamic Systems Inc., Nichimen Mechatronics and NRIM.

Continued on Page 4

Recent Gleeble Papers

278

An Evaluation of Heat-Affected Zone Liquation Cracking Susceptibility, Part I: Development of a Method for Quantification

by W. Lin, J.C. Lippold, and W.A. Baeslack III

A material-specific quantification of liquation cracking susceptibility was developed using the hot-ductility, spot- and longitudinal-Varestraint tests. A new methodology has been developed for quantifying heat-affected zone (HAZ) liquation cracking susceptibility. This methodology characterizes a thermal crack-susceptible region (CSR) in the HAZ. The thermal CSR was theoretically derived based on the ductility of a material during welding as obtained from the Gleeble hot-ductility test and the criteria assumed in the development of liquation cracking theories. This CSR was experimentally verified using longitudinal- and spot-Varestraint tests performed on A-286 and Type 310 stainless steels. The thermal CSR is material-specific and represents a true quantification of liquation cracking susceptibility. The development of this methodology has 1) elucidated the physical relationship among weldability test results, liquation cracking theories and material properties; 2) provided a more precise interpretation of hot-ductility, spot- and longitudinal-Varestraint tests; 3) defined a method for determining a material-specific measure of HAZ liquation cracking susceptibility; 4) eliminated the inconsistency among certain weldability test results; 5) added important insight regarding the mechanics of HAZ liquation cracking, and 6) confirmed the criterion assumed in the development of liquation cracking theories, which states that cracking results from the localized loss of gain boundary ductility due to liquation. This paper addresses the theoretical background and experimental procedure involved in the development of the methodology. A subsequent paper will describe the metallurgical basis for HAZ liquation cracking as it relates to this methodology.

279

Studies of Pressure Assisted Reactive Sintering of TiC and TiB_2

by W.Z. Misiolek, T.S. Schurman, and N.D. Sopchak

Reactive sintering is a technique in which the vast amount of surface energy, inherent in a powder compact, is violently released in an exothermic reaction. After local initiation, the reaction typically propagates throughout the specimen. Densification occurs concurrently with the combustion synthesis process and in some cases may be aided by the formation of a transient liquid phase. Generally this is known as self-propagating high temperature synthesis (SHS). This technique has been applied to the processing of ceramics, intermetallics and composites. The work presented herein focuses on the formation of the TiC and TiB_2 via a novel process, current-induced SHS. The densification mechanism is enhanced by simultaneous application of pressure. Temperature and force are applied to the punch/die independently using a specially modified Gleeble 1500 test simulator. The main process variables, such as degassing time, degassing temperature, heating rate, initiation temperature, green density, applied pressure, and time were investigated.

280

Physical Modeling of Microstructure Response in Aluminum Extrusion

by T.J. King, H.K. McGregor, W.Z. Misiolek, and R.N. Wright

A fine, controlled microstructure, throughout the extrudate, is critical to ensure uniform properties in the final product. Physical modeling is beneficial in identifying the process-microstructure relationships in the time-temperature-strain rate domain of the aluminum extrusion process. A basic analysis of deformation heating, frictional heating, and metal flow is necessary to define the process domain. Simulation of the stress-strain rate temperature conditions is necessary to provide specimens for rigorous metallographic description of the process domain. Such simulation can be undertaken on a Gleeble 1500 dynamic thermo-mechanical testing machine. An analysis suitable for a broad range of aluminum extrusion practice has been performed, and Gleeble testing has been undertaken. Microstructures of the tested Gleeble samples are being compared with those of industrial extrudates, and the credibility of the physical modeling approach is being assessed.

286

Prediction of Grain Size During Multiple Pass Radial Forging of Alloy 718

by J.P. Domblesky, L.A. Jackman, R. Shivpuri, and B.B. Hendrick

Multiple pass radial forging was simulated by generating compression data for Alloy 718 with a Gleeble testing machine. Specimens were taken from a press forged billet preform 343 mm in diameter. Variables evaluated were strain per pass, number of passes, temperature, and time per pass. Recrystallized grain size was found to be independent of the number of passes after the first couple passes for deformation above the delta solvus. Strain per pass and temperature were found to be the dominant factor affecting microstructure. A predictive relation was found that relates recrystallized grain size to the strain per pass and the starting grain size for constant temperature. Grain sizes predicted by multiple pass simulation agree well with actual grain sizes for radial forging on a GFM machine when cooling from temperature after deformation was duplicated.

Gleeble 3500 and 3800 Systems Receive CE Mark and TÜV Mark

Gleeble 3500 and Gleeble 3800 systems now meet all relevant standards for the CE mark—including Machinery Directive 89/392/EEC and EMC Directives 89/336/EEC as required for shipment into Europe. In addition, after an extensive series of tests for compliance with all the appropriate standards, the Gleeble 3500 and 3800 systems also received the widely recognized German T mark from TÜV Rheinland. These certifications provide further proof and assurance of the safety, quality, and performance of these systems.

All Gleeble 3500 and 3800 systems feature the DSI Series 3 control system and incorporate fully digital closed-loop thermal and mechanical systems. Windows-based QuikSim™, a spreadsheet-like, fill-in-the-blanks software system, provides quick and easy programming of the Gleeble. Data are automatically fed to Origin®, an industry standard, data analysis software package. Origin features templates such as stress vs. strain, force vs. time, temperature vs. time, etc. Once data have been loaded, plots are generated in a matter of moments by simply clicking on the desired template.

The first “CE” marked Gleeble 3800 system was delivered to Böhler Edelstahl GmbH in Kapfenburg, Austria in late December 1996. Böhler Edelstahl GmbH, a leading manufacturer of special steels and alloys including high strength tool steels, purchased a Gleeble 3800 for hot workability studies. Böhler’s research scientists will be able to characterize new and existing materials through hot ductility tests, thermal/mechanical fatigue studies and weld HAZ studies.

This system is also equipped with the optional 35030 Hydrawedge® system, providing the ability to study and optimize rolling operations through flow stress and plane strain compression tests. Additionally, researchers will be able to study and optimize casting processes by generating “processing maps” for a variety of materials through melting and controlled solidification studies. DSI is proud to welcome Böhler Edelstahl GmbH to the ever growing number of companies using Gleeble systems for advanced research.

New ISO-T™ Anvils Boosts Uniaxial Compression Testing with Gleeble

Uniaxial compression testing is widely used for flow stress measurement of metals and alloys. To maintain uniform deformation during compression, temperature within the volume of the specimen must be uniform.

This can be achieved by furnace heating or induction heating, when heating rates are low, and when the materials are allowed to soak for a long period to reach an equilibrium temperature. By contrast, in resistance heating, an isothermal plane across the diameter of a cylindrical specimen is always maintained during heating or cooling.

Recently, the ISO-T anvil was developed at DSI. It eliminates the axial gradient and provides a uniform temperature within the entire volume of the specimen. Through the ISO-T anvil, the best features of resistance heating—higher heating speeds, easy specimen access, short soaking time, fast cooling rates, and direct fast quenching—are combined with the uniformity of temperature distribution found in furnace heating.

With the application of suitable lubricants between the anvils and the specimen, barreling after deformation is minimized. The result is an optimal environment for uniaxial compression testing at elevated temperatures.

For additional information about ISO-T anvils, or for a copy of the Gleeble Systems Application Note, “Axisymmetric Uniaxial Compression Testing Using ISO-T Anvils on Gleeble Systems,” contact us here at DSI.

DSI at Expositions and Conferences

AEROMAT ’97, May 13–15, Williamsburg, Virginia

DSI will be exhibiting the latest in Gleeble Systems technology at Booth #5 at AEROMAT ’97, to be held at the Williamsburg Marriott.

For additional information, contact: ASM International, 9639 Kinsman Rd., Materials Park, OH 44073-0002; phone 216-338-5151; or fax 216-338-4634.

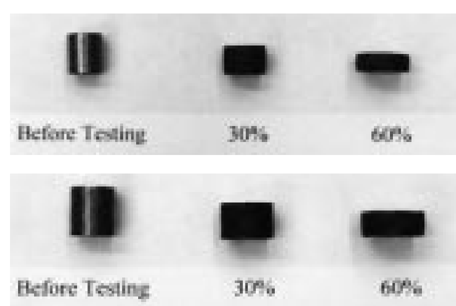
ASM INTERNATIONAL® The Materials Information Society

ASM/TMS Materials Exposition, September 14–18, Indianapolis, Indiana

Come see us at Booth 2101 at the Indianapolis Convention Center and RCA Dome, where applications engineers will be available to discuss your testing and simulation requirements.

This year, the Materials Expo will combine the Materials Expo, Thermal Spray Expositions, and the Heat Treating Society Exposition. For additional information, contact: ASM International, 9639 Kinsman Rd., Materials Park, OH 44073-0002; phone 216-338-5151; fax 216-338-4634; or visit their Web site at: www.asm-intl.org/ASMEvent.

Materials Week ’97 & Materials Exposition



Compressed specimens using ISO-T anvils are shown. (Top) 10 mm diameter × 12 mm specimen. (Bottom) 12.7 mm diameter × 14 mm specimen.

ISPS ’97 Proceedings

Continued from Page 1

The published proceedings of ISPS ’97 will be available soon. This publication will cover the physical simulation of casting, hot rolling, and welding by various experimental techniques such as Gleeble testing, torsion testing, bench scale forging, and so forth, with the aid of numerical modeling. Papers were presented by scientists from many countries, including Australia, Austria, Belgium, Canada, Denmark, Finland, Korea, Norway, People’s Republic of China, Russia, Slovakia, Slovenia, Taiwan, United Kingdom, and Japan.

A limited number of copies of the proceedings will be available from DSI. Please contact us if you would like to purchase one.

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., faxed to us at (518) 283-1360, or e-mailed via the Internet: info@gleeble.com.

Sino-American Symposium on Physical Simulation Set for April

The Sino-American Symposium on Physical Simulation, co-sponsored by China National Material Society and Dynamic Systems Inc., will be held at Haikou, on Hainan Island south of mainland China, on April 22–26, 1997.

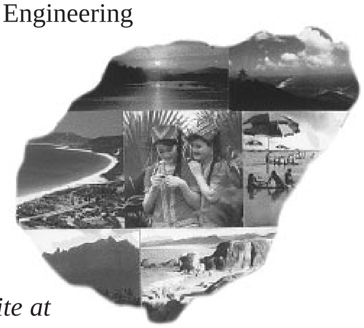
The symposium will provide a forum for exchange of information and presentation of papers dealing with physical simulation and computer simulation as well as their application to materials and hot working, including welding, forging, rolling, casting, and heat treatment. Official proceedings containing full papers will be published.

The Conference Committee has asked APIS Travel to put together a post conference tour package scheduled for April 24–26 for symposium delegates and companions.

So far, about 100 participants have registered. If you would like to register, please see below.

Sino-American Symposium Information

Haikou, Host City	The capital city of Hainan Island, the second largest island in China, is situated in the tropical zone with average temperatures of 20° C (68° F) in the daytime and of 15° C (59° F) in the evening.
Visas	Visitors are granted visas upon landing at Haikou Airport. The process takes about 5 minutes.
Registration Fee	US $200
Payment	Bank of China, Heilongjiang Branch 19, Hongjun Street, Nangang District, Harbin 150001, China A/C No: 4246502-0114-09362468 Name: Niu Jitai or to be paid upon check-in on April 21, 1997
Further Contact	Professor Niu Jitai, Chairman School of Material Science and Engineering Harbin Institute of Technology Harbin 150001, China Tel: 86-451-6221000 ext 3373 Fax: 86-451-6221048 E-mail: jtniu@hitnet.hit.edu.cn



The outline of Hainan Island—from the island’s Web site at http://www.ihep.ac.cn/cw/hainan/hainan.html.

Dynamic Systems Inc.
P.O. Box 1234, Route 355
Poestenkill, NY 12140 USA