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

The Gleeble® NEWSLETTER

Fall 1999

Come See Us at the Shows & Conferences

Materials Solutions Exposition & Conference, Cincinnati, Ohio, November 2–4, 1999

DSI will be exhibiting the latest in Gleeble Systems technology at Booth 801, at the Cincinnati Convention Center. Stop by to see what's new.

The Materials Information Society

11th Annual Aeromat Conference & Exposition, Bellevue (Seattle), Washington, June 26–29, 2000

AeroMat is widely recognized as the premiere event for anyone interested in technology advances in aerospace materials, processes and designs. Without exception, AeroMat 2000 will offer a broad spectrum of distinctive aerospace related symposia. The technical conference and exposition will focus on the technology drivers that will influence the aerospace industry's performance and productivity in the 21st century.

Stop by Booth 504 at the Meydenbauer Convention Center to speak with DSI applications engineers.

For additional information about either conference, contact:

ASM International
9838 Kinsman Rd.
Materials Park, OH 44073 USA
Phone: (440) 338-5151
Fax: (440) 338-4634
Web: www.asm-intl.org

Gleeble Application Profiles:

The Gleeble at USX Corporation's U. S. Steel Group

The U.S. Steel Technical Center at Monroeville, Pennsylvania, has a two-pronged mission to fulfill for USX Corporation's U. S. Steel Group:

- to provide technical support for U. S. Steel's manufacturing capabilities and
- to develop new products.

For Matthew Merwin, Senior Research Engineer, and Kalyan Khan, Associate Research Consultant, a Gleeble physical simulation system has become an essential tool in achieving that mission. The Gleeble 3500, equipped with laser dilatometer and low-force load cell, was installed in June of 1998. It's the latest in a series of Gleebles at the Technical Center.

For Merwin and Kalyan, the new Gleeble 3500 has already produced significant paybacks. They have been doing extensive hot ductility work on steels—some on new grades, some on grades that show cracking problems in continuous casting. Their goal is to determine ductility behavior to avoid bending and straightening of the slab at temperatures where ductility is low and thus to reduce the cracking.

"If it cracks, we have to condition the slab by scarfing or grinding. Either way, it's a significant productivity hit," Merwin says. "We've been pretty successful at curing the cracking problems, and that means we save money and energy."

Kalyan adds, "When we are going to a new grade, we use the Gleeble to assess its castability. We know before hand what cooling to impose on the material when we are casting it."

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Matthew Merwin (right), Senior Research Engineer, and Kalyan Khan, Associate Research Consultant, prepare to run a simulation on U. S. Steel Group's Gleeble 3500.

Recent Gleeble Papers

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Recrystallization in Nb and Nb-Ti Microalloyed Steels Investigated by the Stress Relaxation Method

by L.P. Karjalainen

The stress relaxation method was employed to investigate the static recrystallization kinetics in Nb and Nb-Ti bearing HSLA steels with variable microalloying (0.01–0.04%Nb, 0.015–0.14%Ti). The accumulation of strain in multipass deformation was also studied briefly. The results show that this technique is suitable even to a quantitative determination of softening behavior, and the values of the softening rate as well as the observed influence of strain, strain rate, and temperature on it are in agreement with the published data. Ti (≤ 0.02%) causes a very small extra solute drag in addition to a pronounced effect of Nb, which bring about the same recrystallization rate for Nb and Nb-Ti bearing steels. A high Ti content (0.14%) together with 0.04%Nb exerts a marked retarding effect on recrystallization even at temperatures above 1000°C. The results from two-pass deformation tests indicate that recrystallization proceeds inhomogeneously in accordance with the law of mixtures approach.

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Recovery Kinetics and Recrystallization of Low Alloy Steels During Warm Working

by Z. Husain

The objective of this work was to establish quantitative knowledge of the recovery and recrystallization during warm working of medium carbon low alloy steels with a view to facilitating the prediction of microstructure and properties. Thermomechanical simulations were carried out in the temperature range 600–900°C using six steels relevant to commercial warm forging. When the deformation was in austenite, above Ar_3, rapid recrystallization of the austenite was observed in all steels. Lowering the deformation temperature and increasing the cooling rate led to finer recrystallized austenite grains, which in turn produced finer ferrite grains upon transformation. When deformation was in the ferrite/ pearlite region, below Ac_1, only recovery was observed, the extent of which increased with decreasing cooling rate after deformation and increasing the deformation temperature. When deformation was in the intercritical region, a reduction in cooling rate promoted ferrite/ pearlite formation. Microalloyed steels were also studied to assess their feasibility for warm working applications. Niobium retarded the recrystallization kinetics after deformation at 900°C and vanadium had a smaller effect. Lowering the solution temperature reduced the inhibiting effect of niobium due to incomplete dissolution. Equations were developed for the kinetics of recovery, recrystallization, recrystallized grain size, recrystallization of niobium steel, tensile strength and phase fractions, showing reasonable agreement with experimental results.

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Anisotropy in Superplastic Deformation of Ti-6AL-4V

by Bai Bingzhe and Chen Nanping

Experimental research is made to explore the anisotropy in superplastic tension (SPT) and superplastic compression (SPC) of Ti-6Al-4V thick plate. After certain amount of deformation, the cross section of the specimen becomes elliptical shape. The major axis of the ellipse is parallel to the major-fiber direction after SPT, and vertical to it after SPC. Other behaviors of the anisotropy of superplasticity are also examined. The anisotropy becomes weakened as strain rate goes up. A constitutive equation is put forward to depict anisotropic superplastic deformation (SPD), in which microstructural morphology and distribution are considered and different micro-mechanisms of deformation are involved.

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The Characteristics of SP for Commercial Alloys in Supplied State

by B. Bai, Y. Wang, L. Yang, and N. Chen

Superplastic forming with commercial alloys in supplied state (CASS) is of economic importance. But these alloys usually possess complex characteristics of superplastic deformation (SPD). Three aspects of these characteristics and their regulation are examined in this paper, which include anisotropy, heterogeneity of SPD, and dynamic change of microstructure. It is believed that the more regulations are mastered by people, the more CASS can be formed through superplastic technology, and the finer parts of CASS can be developed.

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Influence of Steel Composition on Impact Toughness of Simulated High Energy Welds

by L.P. Karjalainen, D. Porter, Zuze Xu, and Yuqin Guo

The Charpy V impact toughness of simulated high heat input coarse grained zones of two normalized and five thermomechanically processed steels (yield strength ≥ 355 MPa) has been studied. Multiparameter, non-linear regression analysis showed that the toughness behavior can be explained on the basis of carbon equivalent, Nb content, Ti/N ratio and the cooling rate between 800 and 500°C. Low carbon equivalent (0.33) and low Nb content (≤ 0.02%) together with Ti/N ration between 3 and 5 are beneficial at cooling times $t_{8/5}$ of 80 to 200 s, due to the influence of these factors on the amount of polygonal ferrite and minor phases in the microstructure and, to some extent, the prior austenite grain size. Thermomechanical processing with accelerated cooling is an effective method for producing high yield strength steels suitable for high energy welding.

Gleeble at U. S. Steel Group

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Merwin says, "We got useful information from the Gleeble right off the bat."

Kalyan adds, "One of the long-term goals is to use the Gleeble to develop 'caster-friendly' compositions."

Merwin and Kalyan have used the Gleeble 3500's laser dilatometer as part of their work on development of new steel grades for U. S. Steel. These range from sheet materials to heavy-gauge plate.

Merwin says, "The laser dilatometer gives us extremely precise measurements of the expansion and contraction of specimens as they are heating and cooling, and that gives us a good handle on phase transformations that occur during processing."

"That allows us to determine a material's hardenability, as well as proper temperatures for rolling and, to some degree, coiling and annealing. This has had an impact on new materials development, and there have been some commercial applications of the results," Merwin adds.

They have also used the Gleeble's compression capabilities for hot deformation testing that has had an impact on optimizing the rolling schedules for some of the grades currently in production.

U. S. Steel has also used the Gleeble to do a bit of detective work. A production facility was having problems with edge cracking in one of their grades. They knew that the cracking was occurring, but it was difficult to pinpoint where it was happening. Without knowing where, they couldn't find out the reason for the cracking

As a result, they used the Gleeble to pinpoint the exact temperature at which the cracking was taking place. Once the rolling stand was identified by backtracking, some additional sleuthing led to the discovery of damaged side guides that were causing the cracking.

"The guides were repaired, and the problem was solved," Kalyan says, "but it was the Gleeble that told us where to look."

The U.S. Steel Technical Center also looked at post-weld heat treatment cracking in 11 different compositions of ASTM A514 low-alloy steel. The results of this research will soon be published at the upcoming ASM International Symposium on Steel for Fabricated Structures.

Both Merwin and Kalyan were first exposed to the Gleeble during their undergraduate and graduate studies. Merwin says, "One of the great advantages of the Gleeble is that it is really applicable to every stage of our production—from casting to heat treatment after the steel has been rolled and even welded. That provides a variety of research opportunities in areas that can produce return on investment."

DSI Chairman Named AWS Fellow

Dr. Hugo Ferguson, one of the original founders of DSI and current Chairman of the Board, has been inducted as a Fellow of the American Welding Society at its 80th Annual Convention in St. Louis. The honor of Fellow is conferred upon distinguished individuals who have made extraordinary contributions to welding and allied sciences.

In announcing the honor, AWS said: "Dr. Ferguson's work led to the development of the first functional Gleeble System. His work also aided the understanding of welding metallurgy and the development of the first commercial high-current meter for measuring secondary current in resistance welding applications. Dr. Ferguson earned his Ph.D. in physical metallurgy from the Rensselaer Polytechnic Institute."

Celebrating 80 years of service, the American Welding Society is the largest organization in the world dedicated to advancing the science, technology and application of welding. AWS, headquartered in Miami, Florida, serves over 49,000 national and international members. Additional information about the Society can be found on the AWS website at www.aws.org.

DSI founder Hugo Ferguson.

DSI Co-Sponsors THERMEC 2000

International Conference on Processing & Manufacturing of Advanced Materials

DSI is a proud co-sponsor of THERMEC 2000, planned for December 4–8, 2000 in Las Vegas, Nevada, USA. The objective of the conference is to focus on recent advances in science and technology of fabrication/manufacturing, structure/property, and applications of both ferrous and non-ferrous materials, including Fe-C, Fe-C-Ni, Al, Ti, Cu and Mg.

Emphasis will also be given to other advanced materials such as metal/matrix composites, intermetallics & bulk amorphous materials, and superalloys. Special sessions will be devoted to the superplastic deformation/DB, texture, modeling, net shaper forming, impact engineering, intelligent/smart materials/processes and coatings. A mini symposium is also planned on high-temperature superconducting materials.

The first THERMEC '88 was held in Tokyo in 1988. THERMEC '97 was held in Australia in July, 1997.

Co-operating Organizations

The Minerals, Metals, Materials Society (TMS), USA.
The Japan Institute of Metals, Japan.
The Iron & Steel Institute of Japan
The Japan Institute of Light Metals
The Society of Materials Science of Japan
The Japan Society for Technology for Plasticity
The Korean Institute of Metals & Materials (KIMM), Korea
Chinese Society for Metals (CSM), P.R. China
Verein Deutscher Eisenhuttenwesen (VDEh.), Germany
Societe Francaise de Metallurgie et de Materiaux, France
Indian Institute of Metals (IIM), India

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

DSI Co-Sponsors THERMEC 2000

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Important Dates

March 25, 2000 – Abstracts due
April 25, 2000 – Notification of acceptance of abstracts
August 25, 2000 – Manuscript due & authors registration mandatory
September 25, 2000 – Early registration with discount
October 5, 2000 – Hotel reservation
December 4-8, 2000 – THERMEC '2000 Meeting

Contacts by Country

USA, Canada, South America

Prof. A.J. DeArdo
Department of Materials Science & Engineering
University of Pittsburgh
848 Benedum Hall
Pittsburgh, PA 15261 USA
Fax: (412) 624-1543

Dr. U. Balachandran
Argonne National Laboaratory
Ceramic Section – Materials & Component Technology Division
9700 South Cass Ave.
Argonne, IL 60439-4838 USA
Fax: (630) 252-3604
E-mail: balu@anl.gov

Prof. Isaac Weiss
College of Engineering & Computer Science
Wright State University
Dayton, OH 45435-0001 USA
Tel: (937) 775-5094
Fax: (937) 775-5009
E-mail: iweiss@cs.wright.edu

Japan

Prof. K.Higashi
College of Engineering
Osaka Prefecture University
1-1 Gakuen- Cho, Sakai
Osaka 593, Japan
Fax: +81 722-58-6858
E-mail: higashi@mtl.osakafu-u.ac.jp

Prof. M. Yamaguchi
Department of Materials Science & Engineering
Kyoto University
Kyoto 606-8501, Japan
Fax: +81 75-753-5461
E-mail: masaharu@karma.mtl.kyoto-u.ac.jp

Professor C. Ouchi
Department of Metallurgy
Tohoku University
Sendai 980, Japan
Fax: +81 22-217-7294
E-mail: couchi@material.tohoku.ac.jp

Korea

Professor C.G. Kang
Director, Engineering Research Center
Net Shape & Die Manufacturing Div.
School of Mechanical Engineering, Pusan
Pusan National University
Pusan 609-735, Korea
Fax: +82 51-512-1722

Europe

Prof. R.P. Wahi
Hahn- Meitner Institut-Berlin
Glienicker Str. 100
D-14109 Berlin, Germany
Fax: +49 30-8062-2824
E-mail: wahi@hmi.de

Australia

Professor T. Chandra
Unicentre Conference Unit
University of Wollongong
Wollongong 2522, NSW, Australia
Fax: +61 2-4221 4921, +61 2-4285 6445
E-mail: tara_chandra@uow.edu.au

For additional information about THERMEC 2000, contact any of the individuals above or visit the THERMEC 2000 website at www.thermec2000.conf.au.