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The Gleeble® NEWSLETTER
Summer 2010

THERMEC' 2011 to be held in Quebec, August 1–5, 2011

THERMEC' 2011, the international conference on processing and manufacturing advanced materials, will be held at the Quebec City Convention Center in Quebec City, Canada, August 1–5, 2011.

Continuing the tradition of its six predecessors—Japan (1988), Australia (1997), USA (2000), Spain (2003) Canada (2006) and Berlin (2009)—THERMEC' 2011 will provide a forum for researchers around the globe to present papers on recent advances in the overall field of science and technology of processing and manufacturing of advanced materials.

The Conference will cover all aspects of processing, fabrication, structure/property evaluation and applications of both ferrous and non-ferrous materials including biomaterials, aerospace and other advanced materials. Oral and poster presentations will be included in the conference program. In addition to the contributed papers, the conference committee will include invited papers by eminent researchers in key areas of materials science and materials processing/manufacturing. Internationally known experts from various countries will also deliver plenary/keynote lectures at THERMEC' 2011.

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Gleeble Application Story

The Gleeble at INSA de Lyon

The Institut National des Sciences Appliquées (National Institute of Applied Science) de Lyon, Villeurbanne, France—also known as INSA de Lyon—is an elite university with the mission of training highly qualified engineers, supporting continuing education, and conducting research and testing.

For Assistant Professor Damien Fabrègue, a Gleeble 3500 physical simulation system installed in 2008 is a critical tool for accomplishing that mission. Damien is in charge of the Gleeble facility within the Materials Science and Engineering Laboratory (MATEIS lab).

"We use the Gleeble extensively for research work," Damien says. "Often it is used by Ph.D. candidates and post-doctoral students in materials science, but sometimes by undergraduates within the framework of research projects. Typically, we have a lot of research efforts underway in cooperation with industry."

Many of the Gleeble-related research projects at INSA de Lyon involve investigations of steel. One involves reproducing welding cycles to investigate the mechanical properties of steel at high temperature. "We need to know the HAZ properties of each zone so that we can feed the data to finite element computer simulations to predict the mechanical strength of the weld," Damien says. "We also use finite element simulations to reproduce the welding."

He adds, "In particular, we're looking at liquid metal embrittlement during high temperature processes. For example, if you have a zinc coated steel for automotive use, during welding, the zinc can melt and flow into the steel, greatly weaken-

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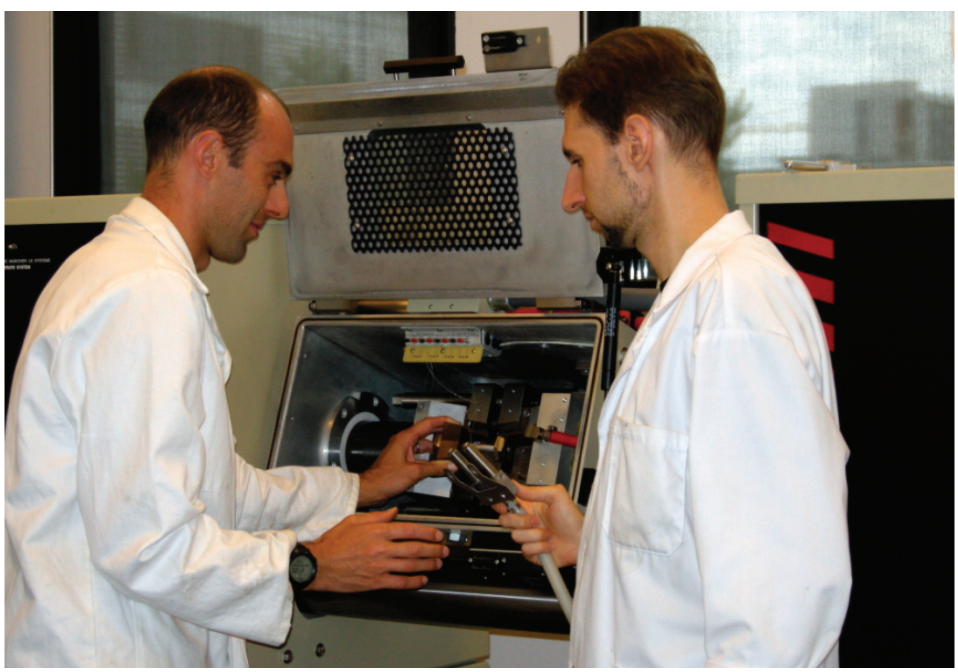

Damien Fabrègue (left), responsible for the Gleeble, and Florian Mercier, technician.

Recent Gleeble Papers

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A Precipitation Model for Predicting Hot Ductility Behaviour in Microalloyed Steels

by K.M. Banks, A.P. Bentley, and A. Koursaris

Hot ductility in the austenite of microalloyed steels is associated with carbonitride precipitation at grain boundaries and dislocations within the matrix. Although investigations into the hot ductility behaviour of microalloyed steels are extensive, precipitation models for predicting hot ductility during continuous casting are rare. Mathematical modeling has been used with some success in describing caronitride precipitation in both underformed and deformed austenite. However, most precipitation models have focused on simple alloying systems such as Nb-microalloyed steels. Precipitation start-time-temperature (PTT) diagrams for multi-component microalloying systems are scarce. In this work, the mutual solubility of complex carbonitrides in austenite, together with the classic nucleation theory, are used to establish relationships between precipitation and hot ductility in V-, Nb- and V-Nb microalloyed steels. The model is used to explain hot ductility behaviour during thin slab casting of low C-V-Nb steels.

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Effect of Thermomechanical History on the High Temperature Mechanical Properties of a Microalloyed Steel and a Low Carbon Steel

by S. Akhlaghi, F. Hassani, and S. Yue

The low ductility of steels at elevated temperatures is one of the main causes of surface cracking in continuous casting. Much work has been conducted to study the hot ductility behavior of various steels using simple isothermal tests in laboratories. However, there are several considerable differences between the thermomechanical history of such tests and the complex history that occurs during continuous casting. Previous work at McGill has shown that the thermal history can strongly control the hot ductility of steel. The present work concentrates on the effect of strains imposed during thermal cycles representative of continuous casting. In the casting machine, such strains could be generated by friction, ferrostatic pressure or thermal gradients. It is observed that imposing such strains markedly improves or deteriorates hot ductility at the unbending point of the thermal history in a Nb-Ti microalloyed steel, depending largely on the temperature at which the strains are executed. On the other hand, applying identical thermomechanical histories to a low carbon steel has little effect on the hot ductility. The metallurgy and consequences of these results are discussed in this paper.

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The Stress-Relief Cracking Susceptibility of a New Ferritic Steel—Part 2: Multiple-Pass Heat-Affected Zone Simulations

by J.G. Nawrocki, J.N. Dupont, C.V. Robino, and A.R. Marder

The stress-relief cracking susceptibility of multiple-pass welds in HCM2S, a new ferritic steel, and standard 2.25Cr-1Mo steel has been evaluated and compared to single-pass weld results using Gleeble techniques. Simulated coarse-grained heat-affected zones (CGHAZ) were produced using two-and three-pass thermal cycle simulations and tested at various postweld heat treatment (PWHT) temperatures. Light optical and scanning electron microscopy were used to characterize the CGHAZ microstrutures. The multipass samples of each material failed along grain boundaries (prior austenite or packet) normal to the tensile axis and exhibited extensive plastic deformation, indicating that stress-relief cracking was avoided with the use of multipass simulations. The times to failure, when considering CGHAZ simulations, were longer than those of the single-pass samples at each PWHT temperature. The ductility increased with increasing PWHT temperature for each alloy and increased relative to the single-pass samples at each PWHT temperature. The differences in stress-relief cracking response between the single- and multiple-pass samples are discussed in terms of the microstructual changes that take place during the multiple-pass procedure and subsequent PWHT.

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Gleeble Machine Determination of Creep Law Parameters for Thermally Induced Deformations in Aluminium DC Casting

by I. Farup, J-M Drezet, A. Mo, and T. Iveland

By means of a Gleeble machine, the flow stress at steady state creep in an AA3103 aluminium alloy has been measured for temperatures and strain rates relevant for thermally induced deformations in DC casting. The strain rate has been determined by measuring the global radial strain rate at the specimen centre by an extensometer, and the stress has been set equal to the force in the axial direction divided by the cross section area. The parameters of Garofalo's equation have been fitted to the resulting steady state stress and strain rate. Such a method is based upon the assumption of homogeneous stress and strain rate fields. In the Gleeble machine, the specimens are heated by the Joule effect leading to axial temperature gradients, and the specimen geometry is non-cylindrical. The resulting inhomogeneities in the stress and strain rate fields are studied by finite element modeling, and it is shown that although they can be significant, the global radial strain rate and the axial force divided by the cross section area at the specimen centre can be relatively close to what the respective strain rate and stress values would have been if the conditions actually were homogenous.

Water Cooling Options for Gleeble Simulation Systems

Gleebles are highly precise thermal-mechanical physical simulation systems that are used in laboratories throughout the world in highly variable environments, from Norway to Brazil, from the United States to China. To generate reproducible test results, insure the consistent performance of the hydraulic system, and maintain accurate measurements, each Gleeble system must be maintained at a consistent temperature that is steady with no more than one degree of variation, regardless of the environment in which the Gleeble is operating. To do this, all Gleeble systems require water cooling.

The vast majority of Gleebles are maintained at constant temperature through a closed loop cooling water system. The advantage of a closed loop system is that the quality of the water can be controlled to prevent corrosion within the Gleeble. Most of these closed loop systems have a water-to-air heat exchanger that rejects heat from the water loop into the room or outdoor air maintains the Gleeble at a constant temperature level. Gleeble water-to-air-based cooling systems are engineered on the basis of the size of the Gleeble, the locale, and the operating environment.

Another option for Gleeble cooling is available for facilities that have a building water loop. In those cases, the Gleeble is still fitted with a closed water loop, but a water-to-water heat exchanger is used to reject heat from the Gleeble cooling loop into the building water loop. If the building water loop is not sufficiently cool, the Gleeble cooling system may be fitted with a refrigeration unit to keep operating temperatures within the proper range.

When properly maintained closed loop cooling systems provide corrosion protection and assure a longer life for Gleeble components. When planning for a new Gleeble system our engineers work with each customer to assure the cooling requirements are considered in the installation and operation.

The Gleeble at INSA de Lyon

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ing it, which is something you obviously don't want in an automotive application. We're looking at ways to do the welding and avoid the embrittlement." The work is being done in collaboration with ArcelorMittal.

One of the key investigations in the MATEIS laboratory is using the Gleeble to study optimization of microstructure. "We want to gain in mechanical properties, to make the material tougher and more impact resistant," he says.

Toward this end, in collaboration with Tohoku University in Japan, Damien and his colleagues are doing high speed compression testing on titanium and cobalt alloys to simulate forging of these materials for biomedical applications.

Damien is not shy about his desire and need to push the Gleeble to the limits of what can be done with the physical simulation system. For example, some of the work in his laboratory involves doing heat treatment on aluminum in the semi-solid state. Other investigations—in collaboration with the SIMAP laboratory in Grenoble, France—encompass heat treatment on bulk metallic glasses. "They have some very interesting properties," Damien says.

Probably the most difficult line of inquiry in the Gleeble laboratory at INSA de Lyon involves sintering. "We're trying to sinter some very special materials, but I can't even reveal what they are," Damien says.

The Gleeble is an absolutely essential piece of equipment for Damien, his colleagues, and his students.

He says, "Everything I am doing with a Gleeble, I might possibly be able to do with some other equipment, but this is the only piece of equipment that I can do everything with. I can always do what I want. It may take some time to optimize the work, but in the end, you can always run the experiment or do the simulation that you wanted to do."

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Important Dates

- July 1, 2010—First call for abstract
- November 4, 2010—Abstracts due
- December 14, 2010—Notification to authors of abstract acceptance
- March 4, 2011—Manuscripts due (strict due date)
- March 4, 2011—Advance registration for speakers (strict due date)
- May 4, 2011—Final Program on Website
- August 1–5, 2011—THERMEC' 2011 in Quebec City, Canada

For information about conference topics and coordinators, keynote speakers, abstract submission, cooperating and sponsoring organizations, and much more, please visit the THERMEC' 2011 website: http://www.thermec2011.ca/

Quebec City, Canada

We Want Your Papers

If you're doing research with a Gleeble physical simulation system and have published or presented papers on your work, we want to hear from you. We would like a copy of your paper so that an abstract can be published in the "Recent Gleeble Papers" section of the Gleeble Newsletter.

Over the years, well over 500 papers have been featured in the Gleeble Newsletter. To make sure your paper is included, mail it to Dynamic Systems Inc., P.O. Box 1234, Route 355, Poestenkill, NY 12140 USA; Fax it to 518 283-3160 or email it to info@gleeble.com.

The 6th ICPNS set for Nov. 16–19 in Guilin City, China

ICPNS' 2010, the 6th International Conference on Physical & Numerical Simulation of Materials Processing, will be held on November 16–19, 2010 in Guilin City, Guangxi Province, China.

The conference is supported by the National Natural Science Foundation of China (NSFC) and is co-sponsored by 20 societies and universities around the world. It provides a forum for researchers around the world to present papers on recent advances in the overall field of physical and numerical methods and their applications in thermo-mechanical processing of advanced materials.

Both oral and poster presentations will be included. Internationally known experts from various countries will deliver keynote/lead lectures. About 600 delegates from 40 countries are expected to attend.

Conference Scope and Topics

The conference will cover all aspects of Physical and Numerical Simulation of Materials Processing. It will focus on, but is not restricted to, the following topics:

1. Physical simulation and numerical modeling of materials and thermo-mechanical processing; Development and applications of numerical simulation software.
2. The industrial processes of welding, bonding, heat treatment, stamping, rolling, casting/continuous-casting, forging, extrusion, super plasticity, self-propagating, powder metallurgy, high energy beam processing and other advanced technologies.
3. The materials of subject including HSLA steels, TMCP steels, stainless steels, super alloy, aluminum alloys, titanium alloys, magnesium alloys, composites, intermetallics, ceramics, polymer, shape memory alloy, opto-electronic materials, gradient materials, semiconductor materials and other advanced materials.
4. Surface engineering and coating.
5. The ultra-fine grain materials; Nanomaterials and technology.
6. Amorphous materials and alloy.
7. New-style energy materials and technology.
8. Green materials manufacture.
9. Materials recycling technology.
10. Materials behavior in extreme condition.
11. Conjugation between materials and environment.
12. Electronic encapsulating of advanced materials.
13. Nondestructive examination of materials.
14. Computation materials science and molecular dynamics simulation.
15. Application of artificial neural network and expert system on material processing.
16. Prediction and evaluation on structure and performance of materials.
17. Prospects of physical simulation and numerical modeling on materials and thermo-mechanical processing in the 21st century.
18. Advanced materials developing and technology.

Paper and Publication

All accepted papers will be printed in the proceedings of ICPNS' 2010. Each selected paper will be published in one of the leading journals indexed as SCI or EI.

Important Dates

- Abstract (250 words) Submission due: July 20, 2010
- Notification of Acceptance: July 31, 2010
- Deadline for Full Manuscripts: August 31, 2010
- Final Program on website: September 30, 2010
- Date of the conference: November 16–19, 2010

Conference Venue

ICPNS' 2010 will be held at the Conference Center of the Waterfall Hotel (five-star), Guilin City, Guangxi Province, China.

Guilin City, located in the south of China and well known for its unique Karst landscape, is easily accessible by air from the major Chinese cities of Beijing, Shanghai, Guangzhou and Hong Kong. The temperature at Guilin is 15–25 °C in November.

Contacts

For manuscript/abstract submission, please contact our academic secretary, Dr. Guangtao Zhou at ICPNS2010@gmail.com.

For programs and other enquiries, please contact our chairman, Professor Jitai Niu at ICPNS2010@gmail.com or niujitai@163.com.

Website: http://www.icpns.org/index.html

ICPNS' 2010 will be held at the five-star Waterfall Hotel in Guilin City.