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The Gleeble® NEWSLETTER

Winter 2011

Come See Us at the Shows

THERMEC'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.

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. 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 will also deliver plenary/keynote lectures at THERMEC'2011.

Important Dates

- 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

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Gleeble Application Story

300th Gleeble Goes to CANMET Materials Technology Laboratory

An historic milestone—the 300th Gleeble—has been delivered and installed at the CANMET Materials Technology Laboratory (CANMET-MTL) in Ottawa, Ontario. CANMET-MTL, a materials research laboratory of the Government of Canada, is Canada's leading research centre dedicated to structural metals and alloys, materials design, pilot-scale processing and performance evaluation. Scientific and technical staff conduct research and development in casting, forming, and joining to provide materials solutions for Canadian industry in the energy, transportation and metals-manufacturing sectors.

CANMET-MTL purchased its Gleeble through major program funding for capital reinvestment as part of its relocation to new state-of-the-art research facilities in Hamilton, Ontario in the fall of 2010.

CANMET-MTL's new machine, a Gleeble 3800 with 20 tons maximum compression force and 10 tons maximum tension force, is equipped with a general purpose Mobile Conversion Unit with pocket jaws for general research and a 20-ton Hydrawedge II MCU for hot deformation studies and multi-hit rolling simulation. In addition, the Gleeble 3800 has a scanning laser dilatometer, among many other specialized testing accessories.

Dr. John Bowker, a former senior research scientist at the Materials Technology Laboratory, says, "CANMET enjoys a long and fruitful history with Gleebles. When I first arrived at the lab in 1982, we had just purchased a Gleeble 1500, which replaced a Gleeble 510 that had been used previously."

The Gleeble 1500 was used for 15

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Artist rendering shows CANMET-MTL's new state-of-the-art research facilities in Hamilton, Ontario.

Recent Gleeble Papers

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ASSET—The Advanced Semi-Solid Elongation Test for Determining Mechanical Properties of Alloys in the Mushy Zone

by J.D. James, J.A. Spittle, S.G.R. Brown, R.W. Evans, and M.E. Keeble

To provide accurate data for simulation of thermomechanical behaviour during casting and other solidification processes, a special testing method has been developed to measure the mechanical properties of alloys at temperatures between the solidus and liquidus. This involves rapidly re-heating cast material to the semi-solid state so that the test can be completed before the microstructure can degrade. A large alternating current, generated by a Gleeble simulator, is passed along the length of the specimen so that the electrical resistance of the material itself generates the heat. Thermocouples on the surface allow the temperature to be monitored and controlled accurately. Once the desired temperature has been attained a low force mechanical testing rig strains the specimen to failure. Strengths down to below 0.1 MPa have been measured for a variety of aluminium alloys with this technique. The fraction liquid present can be related to the temperature of the test by a thermodynamic software package.

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Tensile Properties of AA6061 and AA5083 above the Solidus Temperature

by M.R. Twite, J.A. Spittle and S.G.R. Brown

The tensile properties of aluminium alloys AA6061 and AA5083 have been measured over ranges extending from below the non-equilibrium solidus up to temperatures at which the measured strength is less than 1 MPa. Tests for each alloy were carried out at three different strain rates, representing the range thought to apply during direct-chill casting. It was found that differences exist in the way that tensile properties change with increasing temperatures for the two alloys. Most notably, a critical fraction liquid exists for the AA6061, above which the strength and ductility drop to very low values; no similar critical point seems to exist for the AA5083. The differences between the alloys are thought to be due to differences in solid/liquid morphology in the semi-solid temperature region.

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Joining of SiC Ceramic to Ni-based Superalloy with Cu/Ta/Cu Multiple Interlayer

by S. Li, X. Zang, H. Duan and Y. Zhang

In order to further increase the working temperature and decrease the weight of aeronautical turbines, new high temperature structure materials are being expected and investigated. Among them, SiC ceramic and SiC matrix composite are promising ones. The joining of SiC ceramic to Ni-based superalloy is a key technique for the application of the ceramic materials. Since the coefficient of linear thermal expansion (CTE) of SiC ceramic ($4.7 \times 10^{-6}C^{-1}$) is quite different from that of Ni-based superalloy ($16.29 \times 10^{-6}C^{-1}$), the direct joining of these two materials will generate concentration of thermal stress during welding and cooling, which may cause generation of microcracks. In order to solve this problem, diffusion welding using Cu/Ta/Cu multiple interlayer was experimentally studied.

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The Mathematical Modelling of Material Behavior at Extremely High Temperatures

by M. Glowacki and W. Zalecki

The possibilities of mathematical modelling of steel behaviour at temperatures between solidus and liquidus were discussed. Over the last few years, a coupled thermo-mechanical-microstructural model was developed by Glowacki for simulation of hot shape rolling of steel and bimetallic products in lower temperature range. In the current paper, the authors summarise the additional problems appearing while the material is rolled at temperature above the solidus temperature. The paper reports the results of experimental work leading to construction of an appropriate mathematical model describing the phenomena accompanying the deformation at temperatures, which are characteristic for rolling of continuously cast billets or slabs with "mushy" zone. The model should allow the prediction of density changes in the "mushy" zone, deformation of specimen with variable density, stress analysis and liquid phase movement simulation. The paper pays attention to physical aspects of the modelling.

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Interpretation of SICO Test for Rod Steels

by R. Kuziak and M. Pietrzyk

The SICO test (Strain Induced Crack Opening) is commonly used for an evaluation of ductility and workability of materials on the Gleeble thermomechanical simulators. Technical details of this test are given and an example of its application in metal forming processes is described. Interpretation of the results of this test is difficult, what can be ascribed to a significant inhomogeneity of deformation. Specific ways of heating the sample in the SICO test leads to concentration of deformations in a small area around the center of the sample. Proper interpretation of the results of the test requires information concerning states of strains and stresses in the regions where cracks appear. Thus, the objective of the work is an application of the finite element method to the simulation of the SICO test. The finite element code developed for the axisymmetric compression tests was adapted to the conditions of the SICO test. The results of the finite element simulation are used for an interpretation of this test. The predictions and measurements of loads during the tests are compared.

300th Gleeble at CANMET

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years before being replaced with an upgraded Gleeble 2000 that has served until the arrival of the new Gleeble 3800.

"The Gleeble is one of the most heavily used machines at our lab," Bowker says. "We have used and continue to use it for a broad range of thermo-mechanical simulation procedures. These include: welding applied to shipbuilding, marine materials, offshore structures and pipelines; compression testing to characterize the flow stress behavior of steels and aluminum alloys: and in situ melting and solidification to understand the effects of residuals on hot ductility."

A great deal of the work at CANMET-MTL is supported by and done in collaboration with industry sectors that include transportation, oil and gas pipelines, energy production and defense.

Jim Gianetto, Project Leader at the Materials Technology Laboratory, says, "Right now, we are heavily involved in research related to girth weld integrity for pipelines. In this major research program, we are using thermal simulation techniques to develop in-depth understanding of weld metal and HAZ structure-property relationships for application of high strength line pipe to construct large diameter, high pressure pipelines in remote Arctic regions. The proposed pipelines will be bringing natural gas from the Arctic to connect to the existing infrastructure in northern Alberta or be transported south to the US."

Hamilton, Ontario

The challenge presented by northern pipelines is formidable: construction of a buried pipeline over great distances (>750 miles (~1220 km)) across discontinuous permafrost. The lengths of pipe will be joined by welding and must withstand temperatures to -4°F (-20°C) and several percent longitudinal strain.

Among the new research efforts to be undertaken at CANMET-MTL with the new Gleeble are investigations of higher-strength sheet steels and magnesium alloys, including the joining of magnesium alloys. These projects are intended to assist in reducing weight for more fuel-efficient automobiles. Another research thrust will involve pushing the performance of materials for high-temperature use in Generation IV nuclear reactors as well as investigations of novel materials based on titanium alloys.

Gianetto says, "There is also a very great need for compression work, strip annealing simulation, and controlled cooling after annealing; all aimed at advanced high strength steels for automotive applications."

With the Gleeble 2000 reaching the end of its useful life, Gianetto is looking forward to working with the 3800. "There are substantial improvements in the hardware and software in the new machine, and it has become incredibly sophisticated."

CANMET-MTL is currently relocating to a new state-of-the-art facility in Hamilton, Ontario. The laboratory's relocation to the centre of Canada's automotive and metal manufacturing sector will enhance its ability to support industry by contributing to the development and commercialization of new materials and products. It will also create stronger synergies among the private sector, academia, and government.

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.

See Us at Shows

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For information about THERMEC' 2011, please visit the THERMEC' 2011 website: www.thermec2011.ca/

Quebec City, Canada

MEFORM 2011

MEFORM 2011 will be held March 30–April 1, 2011, at Technical University Bergakademie, Freiberg, Germany. International experts from industry and science will discuss all topics related to the forming of steels and non-ferrous materials. Sponsored by the Institute for Metal Forming, the conference is aimed at scientists from universities and research facilities as well as engineers from industry and students dealing with material characteristics for the simulation of forming processes, including:

- Physical characteristics
- State diagrams
- Forming behavior
- Microstructure development and mechanical properties
- Surface development of forming products
- Influence of several characteristic values on the result of numeric simulation

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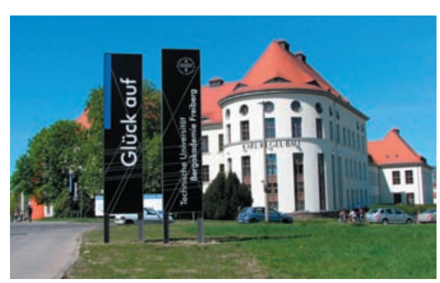
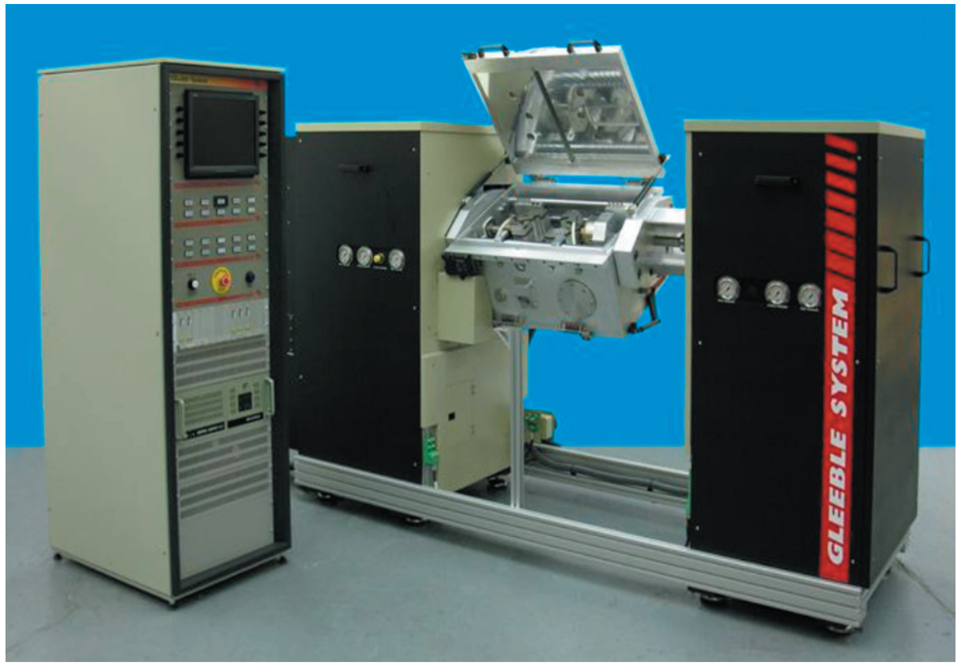


Freiberg, Germany

DSI Delivers Gleeble for Synchrotron Research



The Gleeble system will be used to perform advanced in-situ materials studies at the Brazilian Synchrotron Light Laboratory in Campinas, Brazil.

A new Gleeble physical simulation system, designed specifically for use in a synchrotron has been delivered to the Brazilian Synchrotron Light Laboratory (LNLS) in Campinas, Brazil.

At LNLS, the system will be used to perform advanced and unprecedented in-situ materials studies combining the power of high flux x-ray beam emanating from the Brazilian synchrotron source and the dynamic thermo-mechanical capabilities of a Gleeble simulator, which will make it possible to unveil the fundamentals of structural and functional materials behavior when subjected to specific thermo-mechanical conditions. The use of synchrotron generated x-rays to perform very fast diffraction experiments will allow LNLS to explore the complex interactions of temperature and/or stress on phenomena as phase transformations, residual stress evolution, corrosion, and oxidation, among others. The entire project was funded by Petrobras S.A., a Brazilian energy company (oil, gas, biofuels, and alternative energy sources).

This new system has a load frame designed specifically for work in the beam line. This allows the sample to be heated, cooled, and subjected to forces while in the path of a high flux synchrotron generated x-ray beam. The control system is designed for remote operation so the system operator can start, stop, and monitor experiments from outside the work cell where the load unit is located. Windows-based computer software, combined with an array of powerful processors, provides an extremely user-friendly interface to prepare physical simulation and thermal mechanical test programs, to provide digital closed-loop control of the thermal and mechanical systems, and to collect data.

Once the integration of the customized Gleeble simulator with the synchrotron experimental station has been completed and the installation commissioned, the scientific and technological use of this installation will start with the study of phase transformations on functional and structural materials including corrosion and high temperature resistant materials. The results of the research will be used by Petrobras S.A. to face the challenges to exploit, in a safe and environmentally responsible manner, the oil reserves in ultra-deep waters. Such scientific instrumentation has also been designed to help unveil the fundamentals of diffusion controlled and displasive martensitic and bainitic transformations in metallic alloys, among other phenomena. With the implementation of this advanced instrumentation the Brazilian Synchrotron Light Laboratory is moving forward the development and fruitful future use of its new 3rd generation source called Sirius.

The National Synchrotron Light Laboratory (LNLS) is a multidisciplinary institution, linked to the National Center for Research in Energy and Materials (CNPEM) and operated by the Brazilian Association of Synchrotron Light Technology (ABTLus) through a management contract with the Ministry of Science and Technology (MST). LNLS houses the only source of Synchrotron Light in Latin America. A set of scientific instrumentation allows the application of x-rays and ultraviolet Ray in studies of materials and the Centre of Nanosciences and Nanotechnology Cesar Lattes (C2Nano). Used by the scientific and technological community, this complex has contributed to the advancement of knowledge in strategic areas such as nanoscience, advanced materials, drugs and alternative energies, and to the training of scientific and technical personnel.

Planning a Visit to DSI? Plan Ahead!

If you are planning a visit to DSI and you will be coming from outside North America, be sure to plan ahead. Visitors to the US from abroad who need travel visas must apply at least eight weeks before visiting the USA.

All applications for travel visas are sent to Washington for review before final approval is granted. This significantly delays the process. In countries such as China or India, where a personal interview is required, you should apply at least 12 weeks before the planned travel date.

We are delighted to have visitors at DSI, but make sure you allow enough time for your request for a travel visa to be processed.