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The Gleeble® NEWSLETTER

Fall 2006

See Us at the Shows

Hot Cracking Phenomena in Welds, March 5–6, 2007, Berlin, Germany

Hot cracking problems have long been associated with welding, but its mechanisms have never been well understood or universally agreed upon. This sequel to the original two-day workshop held in 2004 will bring together international experts to discuss hot cracking from both a theoretical and practical standpoint. Topics will include:

- Cracking susceptibility of alloys
- Phenomena and mechanisms
- Ferrous and nonferrous metallurgy
- Testing and standardization
- Modeling and simulation
- Measurement and quantification.

For further information, visit http://www.bam.de/hotcracking.ht

For technical paper arrangements, contact Dr. Carl E. Cross, email: carl-edward.cross@bam.de

For organization/local arrangements, contact Alexandra Cichon, email alexandra.cichon@bam.de

Third International Conference on Recrystallization and Grain Growth (ReX & GG III), June 10–15, 2007, Jeju Island, Korea

ReX & GG III will provide a forum for materials scientists and engineers to discuss and exchange recent advances in recrystallization and grain growth during thermomechanical processing of materials and their industrial applications and will provide an opportunity to learn about the most up-to-date advances in the

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Gleeble Application Story

The Gleeble at Aichi Steel

by Chihiro Kasamatsu, Chief of Staff, Material Evaluation Department Aichi Steel Corporation

Aichi Steel Corporation, a member of the Toyota Group, is one of the major special steel producers in Japan. The headquarters and the main plant are in Aichi prefecture in central Japan. The EXPO was held in Aichi last year, and it is the production base of Toyota Motor Corporation.

Our company has not only a special steel production facility but also huge forging plants. About half of the sales are in the special steel business and the other half is the forging parts business. Aichi has the world's biggest forging plant. Most of our forging products are used in automobiles. We produce multiple parts including crankshafts, ring gears and shafts. We also launched forging plants in the USA, China and Southeast Asia.

Aichi Steel installed a Gleeble 1500 in 1982 for studying continuous casting process and hot rolling processes. The Gleeble 1500 gave us a lot of useful data. We purchased the Gleeble 3800 and a Hydrawedge unit last year in order to meet new research needs.

The main task of our department is research and development involving materials and production processes. We collect accurate data for casting processes, rolling

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Chihiro Kasamatsu (seated), Takeshi Matsuda (back), and Kazutaka Funaki use the Gleeble 3800 with Hydrawedge to perform research and development involving materials and production processes.

Recent Gleeble Papers

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Growth of Physical Simulation in Quality Production

by W.C. Chen

In the past 25 years, a quiet revolution has been taking place in the steel industry. During the quarter century, the world's most productive and profitable steel firms have increasingly turned to physical simulation to characterize materials, boost quality, and optimize their processes. Why physical simulation? The short answer is that, while all physical simulation involves physical testing, the key difference is that physical simulation attempts to replicate real-world processes on a laboratory scale in a way that the resultant data can be used to solve real-world problems. Physical simulation is used more as a predictive tool or for model development, whereas testing tends to be after-the-fact verification of results.

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A Method for Studying Weld Fusion Boundary Microstructure Evolution in Aluminum Alloys

by A. Kostrivas and J.C. Lippold

Aluminum alloys may exhibit a variety of microstructures within the fusion zone adjacent to the fusion boundary. Under conventional weld solidification conditions, epitaxial nucleation occurs off grains in the heat-affected zone (HAZ) and solidification proceeds along preferred growth directions. In some aluminum alloys, such as those containing Li and Zr, a nondendritic equiaxed grain zone (EQZ) has been observed along the fusion boundary that does not nucleate epitaxially from the HAZ substrate. The EQZ has been the subject of considerable study because of its susceptibility to cracking during initial fabrication and repair. The motivation of this investigation was to develop a technique that would allow the nature and evolution of the fusion boundary to be studied under controlled thermal conditions. A melting technique was developed to simulate the fusion boundary of aluminum alloys using the Gleeble® thermal simulator. Using a steel sleeve to contain the aluminum, samples were heated to incremental temperatures above the solidus temperature of a number of alloys. In Alloy 2195, a 4Cu-1Li alloy, an EQZ could be formed by heating in the temperature range approximately from 630–640°C. At temperatures above 640°C, solidification occurred by the normal epitaxial nucleation and growth mechanism. Fusion boundary behavior was also studied in Alloys 5454-H34, 6061-T6 and 2219-T8. Nucleation in these alloys was observed to be epitaxial. Details of the technique and its effectiveness for performing controlled melting experiments at incremental temperatures above the solidus are described.

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Development of Ultrafine Grain Steels Using the MAXStrain® Deformation Simulator

by W.C. Chen, D.E. Ferguson, and H.S. Ferguson

Several strengthening mechanisms have been used either separately or in combination to increase the strength of ferrite matrix steels, such as 1) solid solution hardening by substitute atoms of Mn and Si, or interstitial atoms of carbon, nitrogen, etc.; 2) dislocation hardening; 3) precipitates/multiphase hardening; and 4) grain refinement. Unfortunately, some of them have a negative effect on weldability, formability, as well as hot dip gavanizability. Grain refinement is one way that could increase the strength with no loss of ductility, and at some temperature may even exhibit superplasticity.

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An Institute for Steel Processing and Products

by R. Dippenaar and K. Enever

The pressing need after the Second World War for technical education in the Illawarra region of Australia, where BHP's Port Kembla Works is located, prompted the company to play a major role in the establishment of the University of Wollongong. The university eventually gained full autonomy in 1975. Building on this long history of collaboration and interaction, BHP established, in alliance with this university, the BHP Institute for Steel Processing and Products. This multidisciplinary institute within the university concentrates on focused academic research in support of BHP's strategic goals. Currently, three research programmes are in place in the areas of steel processing metallurgy (including primary processing, rolling technology, thermomechanical processing, and product development), coating technology, and management of innovation and organisational change. Established in 1995, the institute now collaborates with BHP on projects that cover a wide spectrum of activities and involves members of academic staff, postdoctoral research fellow, and graduate students. The operating funds of the institute are almost equally shared between the government in the form of competitive grants, BHP as the industrial partner, and the university.

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Experimental Procedure for Determining "True Stress–True Strain" Curves for Steels in the High Temperature Range and Under Controlled Deformation Rate

by M.A. Cavaliere, G. Gómez, J.I. Gazzarri, T. Pérez, and E.N. Dvorkin

In this paper we present an experimental procedure for determining "true stress–true strain" curves for steels in the high temperature range and under controlled deformation rate. The experimental procedure consists in the compression of cylindrical sample under controlled temperature and strain rate; only the compressive load and the sample axial shortening are measured. It is shown, using a finite element model of the test, that within a limited compression range the results are independent of the sample barreling, that is to say, they are independent of the friction between the sample and the machine plates.

Dual Hydraulic Valve System Allows Ultra-Precise Control of Low-Speed Tension or Compression in High-Speed Gleebles

A standard Gleeble 3500 has a 60 gpm hydraulic valve. It allows a maximum stroke rate of 1000 mm/sec in tension or compression with no load and a minimum stroke rate of 0.001 mm/sec. By contrast, a high-speed Gleeble 3500 has a 100 gpm valve that allows a maximum stroke of 1000 mm/sec with 4.5 tons of load. The downside of the bigger valve in the high speed Gleeble is that the minimum stroke rate is 0.01 mm/sec—ten times faster than a standard Gleeble.

For owners and users of high-speed Gleeble 3500s or 3800s who would like to maintain the high-speed capabilities of their systems, but would also like the minimum stroke rate available on a standard Gleeble 3500, there is a solution: the Dual Hydraulic Valve Kit.

The Dual Hydraulic Valve Kit for the Gleeble 3500 features two hydraulic servo valves, a 10 gpm valve and a 100 gpm valve. The 10 gpm allows low-speed, high accuracy performance under load with a minimum stroke rate of 0.001 mm per second while high-speed performance remains unchanged. The Dual Hydraulic Valve Kit for the Gleeble 3800 offers similar functionality, but features 20 gpm and 200 gpm valves.

Software that comes with either kit controls the two valves seamlessly, so that no special programming or intervention from the operator is required. Simply program the speed that you want, and the system takes care of the rest.

The Dual Hydraulic Valve Kit can be purchased as an option on a new machine, or retrofitted to an existing machine. For new Gleeble 3500s the part number is 35331; for the Gleeble 3800, part number 35332. When retrofitting existing machine, the part numbers are 35333 for the Gleeble 3500 and 35334 for the Gleeble 3800. For more information, contact us here at DSI.

The End is Near: Gleeble Newsletter Going "All Electronic" Next Issue

This is the last printed edition of the Gleeble Newsletter that you will receive. Starting with the Winter 2007 edition, the Gleeble Newsletter is going all electronic. Instead of a newsletter printed on paper, it will be delivered via email as a PDF file.

The content will still be the same as you have come to expect from the Gleeble Newsletter, but it will come to you via the Internet. As a result, you will receive the electronic version up to two weeks sooner than the paper version delivered through postal mail.

Be sure to sign up for the electronic version. To make sure you receive every single issue of the Gleeble Newsletter, sign up for the electronic edition today. It's easy. Just email info@gleeble.com and tell us you want to receive the electronic version of the Gleeble Newsletter, or sign up on our website, www.gleeble.com.

DSI Celebrates 50th Anniversary in 2007

In 2007, Dynamics Systems Inc. will be celebrating five decades of pioneering thermo-mechanical systems for process simulation, materials characterization and basic research. DSI systems are now in use in technical institutes, industrial laboratories, and universities throughout the world.

We hope you will join us in our celebration. Details will soon follow in the Gleeble Newsletter.

50 years 1957–2007

See Us at the Shows

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fundamental phenomena of microstructure evolution and their application with related properties.

For additional information, visit www.rex-gg-2007.org or email secretariat@rex-gg-2007.org.

The 5th International Conference on Physical and Numerical Simulation of Materials Processing, October 23–27, 2007, Zhengzhou, China

ICPNS' 2007 is supported by the National Natural Science Foundation of China (NSFC) and is co-sponsored by 17 societies and universities around the world, including those from Australia, Canada, China mainland, Croatia, Denmark, Finland, France, Germany, Hong Kong, India, Japan, Korea, Pakistan, Russia, Taiwan, UK and the USA.

This conference series, following the tradition of its four predecessors in Harbin (1990), Hainan (1997), Beijing (1999) and Shanghai (2004), provides a forum for researchers 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.

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For more about ICPNS' 2007, please visit the official website http://nsmp.hit.edu.cn

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The Gleeble at Aichi Steel Corporation

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processes and forging processes through Gleeble testing. We also need wide-ranging data for computer simulations for thermal analysis, stress and strength analysis of parts such as crankshafts, gears and shafts. The Gleeble 3800 is helping us very much.

Now we are concentrating on testing with the Gleeble to reduce costs in our forging production processes. Hot forging processes use a lot of dies. The dies are expensive because they are made of hot-die steel which contains a lot of expensive alloys and machining costs are also expensive. Therefore, the cost of dies affects the cost of forging processes.

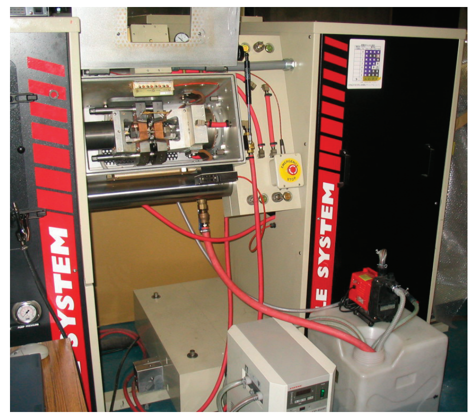
Our company uses many dies, and many of them are made at Aichi Steel. It means that we can experiment on site and gather information about the results of using different materials, heat treatments, die design, etc. Because of the current situation in the steel industry, there is increasing demand for laboratory studies to shorten the development period for improvements. We are using the Gleeble for three types of testing now.

One of them is about hot cracking resistance of hot-die steels, including our new materials. Mr. Matsuda is in charge of this testing in which heating and cooling are repeated every few seconds, and the test may last for more than a day. We use water for cooling. In order to continue the test for a long time, Mr. Matsuda set up a big water tank because the original water tank for quenching of the Gleeble was too small. Mr. Matsuda said that the design of new Gleeble, especially its chamber and the locations of valves are easy to use for liquid-use testing. The specimens for our hot cracking resistance tests are based on 10 mm diameter bar specimen but the center of them is our original design.

Before we started this study, we carefully observed the surface of many specimens of different shapes. We also spent considerable time deciding what the conditions of the testing—such as cycles of heating and cooling—would be. We need to get results which can be used for our intended application, therefore we use a uniquely shaped specimen for hot cracking resistance testing for hot forging dies.

We are also running melting tests. Mr. Funaki is in charge of this testing. "The accepted wisdom is that continuous casting in Japan is very good but there are some points we can make much better," said Mr. Funaki. "Tests that involve a combination of melting, tension, compression and heat treatment result in useful information. However, because of the complexity, these tests sometimes fail. Because the new Gleeble collects a lot of data digitally, that makes it easy for me to see what is going on and then revise the tests accordingly."

I am satisfied with the new Gleeble's performance. It has been running everyday since this January including weekends. Because of Toyota, which is the main customer of our company, we have to supply much higher quality steels and forging parts, and also we have to increase the productivity to meet our customers' demands. We also need to be more competitive in decreasing production costs. I look forward to further progress in meeting these goals with the Gleeble.



The Gleeble 3800 installation at Aichi Steel.

Copper Application Note Now Available

A Gleeble Application note, entitled "Method of performing controlled temperature uniaxial compression tests on CDA 110 copper" is now available.

The Application Note describes a method of using a Gleeble system to perform flow stress compression tests, at different temperatures, on CDA 110 copper (C11000) ASTM alloy B152.

For a copy of the Application Note ANP029, contact us here at DSI.