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The Gleeble® NEWSLETTER

Summer 2001

See Us at the Shows

43rd Mechanical Working and Steel Processing Conference—Adams Mark Hotel, Charlotte, NC, October 28–31, 2001

Learn about the latest developments in bar products and forgings, flat products, process technology, roll technology, and more. Make it a point to stop by Booth 28. DSI application engineers will be standing by to answer your questions.

For additional information about the conference, contact:

The Iron & Steel Society
186 Thorn Hill Road
Warrendale, PA 15086
Tel: (724) 776-1535
Fax: (724) 776-0430

ASM Heat Treat Show, ASM Materials Solutions Exposition—Indianapolis Convention Center, November 6–7, 2001.

This unique event provides opportunities for cross-networking, learning, and problem solving. Technical programs of the accompanying conference are organized by industry, including aerospace, automotive, energy, heavy equipment, machinery, and durable goods. DSI will be there to discuss physical simulation, process optimization, and materials characterization.

Be sure to stop by Booth 901 to speak with DSI applications engineers.

For additional information about the conference, contact:

ASM International
9639 Kinsman Road
Materials Park, OH 44073-0002
Tel: (440) 338-5151
Fax: (440) 338-4634

Gleeble Application Profile

The Gleeble at The Timken Company in Canton, Ohio

The Timken Company is unique in the steel industry because not only does the company make alloy steel and specialty steel for a variety of customers, but it also makes precision components, including its world famous tapered roller bearings, out of Timken steel.

At Timken's Material Research and Development Department in North Canton, Ohio, investigators are constantly studying ways of optimizing the processing of steel with an eye toward improving the final product. Around Christmas of 1999, the company installed a Gleeble 3500C with high-speed servo hydraulics and hot torsion simulation capability.

E. Buddy Damm, principal materials engineer, works with a team of colleagues using the Gleeble to understand the high temperature processing of steel such as hot ductility, recrystallization, flow-stress, and high temperature strength. There is also a large effort in phase transformation and dilatometry, using the laser dilatometer on the Gleeble.

All of this work is related to a project from the Department of Energy's (DOE) Office of Industrial Technologies entitled "Controlled Thermo-Mechanical Processing (CTMP) of Tubes and Pipes for Enhanced Manufacturing and Performance." The objective is to improve the process for manufacturing seamless mechanical tubing. The idea is to try to provide a product that will meet the customer's needs in the as-

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Al Hummel (right), Materials Analyst and principal operator of the Gleeble, and E. Buddy Damm, Principal Materials Engineer, prepared for a test at The Timken Company's Material Research and Development Department.

Recent Gleeble Papers

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Influence of Constraining on the Toughness Behavior of Multi-Layer Weldments

by S. Kleber, J. Reiss, B. Buchmayr, H. Cerjak, and E. Perteneder

In multi-layer weldments the toughness decreases from the cap pass to the root pass under unconstraint conditions during the cooling period. There is some practical evidence that multi-layer welds with clamped steel plates reveal a higher toughness when all other parameters are kept constant. To understand and simulate this phenomenon under controlled conditions, three different Gleeble welding procedures were applied to simulate the toughness response under free contraction, contraction compensation during the cooling phase, and plastic deformation at aging temperature. The compensation of contraction in the cross section by plastic deformation simulates a volume element in the cap pass, whereas in the third testing type, an element of the root layer was simulated, which is affected by compression at lower temperatures. A comparison of the toughness values, between simulated specimens and real weldments showed a reasonable good agreement, so that the result of the physical simulation can be directly applied to large scale multi-layer weldments.

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Weldability Study of a Thermomechanically Controlled Processed Steel of Grade 50 kg/mm^2 under Higher Heat Input

by J.N. Aoh, C.D. Lin, and F.H. Kuo

Weldability of TMCP steel of grade 50 kg/mm2 was studied using welding simulation. Nil-strength tests and nil-ductility tests were carried out to evaluate the hot crack susceptibility of the TMCP steel near the fusion line in the HAZ. Different welding thermal cycles corresponding to different amounts of heat input were simulated on TMCP steel. The results provided a better understanding of how far the toughness and hardness in the HAZ were influenced by heat input and peak temperature welding. Microstructure analysis revealed that the degradation of toughness might be attributed to the existence of M/A constituents and grain coarsening in the HAZ. Study on weld simulated TMCP steel and a submerged-arc welded specimens showed that microstructures obtained by simulation under different thermal cycles were in good agreement with those of a real weld HAZ.

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Toughness of Single and Multi-Pass Weld HAZs of SQV-2A Pressure Vessel Steel

by Fukuhisa Matsuda, Kenji Ikeuchi, and Jinsun Liao

The influence of weld heat input and multi-pass weld thermal cycle on weld HAZ toughness of low alloy steel SQV-2A have been metallographically investigated. The weld HAZs were simulated with a Gleeble 1500 test machine. The toughness of the simulated weld HAZs was evaluated with the absorbed energy of the Charpy impact test. As the weld heat input was increased and cooling time Δ8/5 from 1073 to 773 K became longer than 20 s, serious embrittlement in CGHAZ (Coarse Grained HAZ) occurred, and the amount of M-A constituents increased, which suggested that the CGHAZs were embrittled owing to the formation of the M-A constituent. Post weld heat treatments 893 K could improve considerably the toughness of the embrittled CGHAZs mainly by decomposing the M-A constituent. Serious embrittlement was also observed in ICCGHAZs (Intercritically Reheated CGHAZ), when coarse necklace-like M-A constituents formed in the grain boundary region and finer M-A constituents of elongated type in the bulk region. Temper bead thermal cycles with a peak temperature of 673 K could improve significantly the toughness of embrittled ICCGHAZs by decomposing the M-A constituents. However, when the weld heat input was high, the toughness of the embrittled ICCGHAZs became difficult to improve by the temper bead thermal cycles.

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Susceptibility of Ferritic Low Alloy Steel Weld Metal To Stress-Relief Embrittlement

by Stan T. Mandziej and W.C. Chen

Post weld heat treatment of some low-alloy ferritic steels causes decrease in ductility and cracking in the weld metal or the heat affected zone. The stress-relief embrittled weld metal is characterized with a substantial amount of intergranular fractures along columnar grains of primary austenite. The grain boundary ferrite of the weld metal microstructure after stress-relief shows a much higher dislocation density than in the as-welded condition. The dislocations are generated tremendously during the stress-relieving to accommodate substantial shrinkage of acicular ferrite—the strongest component of microstructure. Identification of dislocation configurations and their behavior during further annealing and their influences on fracture behavior lead to physical simulation tests to study the susceptibility of the weld metals to the stress-relief embrittlement. Simulation tests were carried out on a Gleeble system using samples taken from purposely-made two-bead weld metals. The samples were heated to a certain temperature, held for stress-relieving and then cooled. During these cycles, the diameter of the sample was constantly monitored by a laser system. Three thermal cycles were applied to stimulate movement of dislocations and their reactions in order to achieve the sequence of changes in substructure which is characteristic of the embrittling process. The laser dilatometer allows the measurement of the contraction of the diameter of the sample which appears in weld metals prone to the embrittlement and does not appear in non-embrittling weld metals.

The Gleeble at The Timken Company

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rolled condition. DOE estimates that $400 million in cost savings could be realized if CTMP were applied to the 15 million tons of tube and pipe consumed in the U.S. annually.

At present, the process of producing seamless mechanical steel tubing involves heating a bar of steel, six inches in diameter and six feet long, and forcing it over a plug on the end of a mandrill. The process jams the piercing point through the bar and makes a hole down the middle. It is a tremendously violent process that involves several steps afterward: running it through an elongator and reducing mill to control the wall thickness and diameters, and then cooling it through controlled slow cooling or air cooling. After that, there is heat treatment to make sure that the steel tubing has the hardness and structure specifications that the customer wants.

Timken would rather not heat treat, soak, cool, temper or otherwise perform additional processing on the tubing because it takes time, money, and consumes energy. The company is working with various customers in the automotive industry as partners to develop steel tubing that has the right attributes for downstream processes. Much of the tubing is being machined into bearing races or gears.

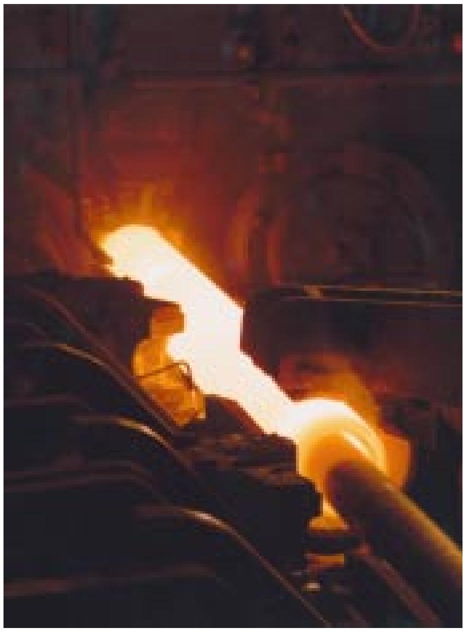
Damm says, "We're using the Gleeble to figure out how to process our tubing so that its characteristics are particularly well suited to whatever the customer will do to it. So we have to understand heat treatment and hardening processes in bearing factories, how to improve those processes, and a lot of that relates to phase transformation and dilatometry. Since Timken also makes bearings, we have a wonderful partner in that regard, and the same skillset applies."

He adds, "Part of our work with the Gleeble involves looking at the forgeability of bars that we sell to people who make crankshafts. Our Gleeble is in use constantly. Some of the steels we're investigating include alloy steels for carburized applications, such as 4120, 8620 and 5130; alloys steels through hardening grades 52100; and induction hardening grades, such as 1060 and 5060."

Damm says, "With the Gleeble, we're able to study phase transformation, which is critical to understanding how to control our design processes, and we are also able to create mathematical models necessary to feed simulation tools."

He concludes, "The Gleeble is a fantastic tool because of its extended capabilities compared to previous models and because of its wide range of applications. It delivers faster ROI because of its flexibility."

The Timken Company makes precision components, including its world famous tapered roller bearings.



The objective of the Gleeble research is to help improve the process for manufacturing seamless mechanical tubing.

Check Out www.gleeble.com!

If you haven't visited www.gleeble.com, you're in for a treat. It's the official website of Dynamic Systems, and there you will find a collection of useful and interesting information, including:

- Information on all DSI products, such as the Gleeble 3200, 3500, 3800, MAXStrain Multi Axis, Hot Torsion, and others
- Upcoming events
- Back issues of the Gleeble Newsletter in downloadable PDF format
- Background information on physical simulation
- Dozens of Gleeble application stories
- Press releases
- Application notes
- A brief company history, and much more

While you are visiting www.gleeble.com, you can also sign up to receive the electronic version of the Gleeble newsletter via email.

If you are already a Gleeble user, be sure to register for the users-only DSI Technical Support Website. You can do so by visiting www.gleeble.com, clicking on the login link at the top of the page, and filling out the registration form. Your registration information will be emailed back to you.

In the Technical Support Website, you will find a wealth of information, including a Frequently Asked Questions section that covers general Gleeble information, heating and cooling, hydraulic system, and torsion. You'll also find downloadable application notes, a discussion section where you can post messages that can be read by other Gleeble users, Gleeble system site plans, and catalogs and product information.

Be sure to visit both these sites frequently. We expect them to change often and to become "information central" for Gleeble systems.

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ESAFORM Conference to be held in Kraków, Poland

The European Scientific Association for Material Forming, the Akademia Górniczo-Hutnicza, and the University of Wroclaw have announced the 5th Conference on Material Forming to be held in Kraków, Poland, April 14–17, 2002.

ESAFORM 2002 will bring together scientists working on all material forming processes (rolling, extrusion, drawing, casting, stamping, forging, injection moulding, sheet forming, etc.) involving all types of materials (metal, polymer, glass, ceramic, composite, wood). The conference aims to encourage communication between specialists of different scientific disciplines.

Six plenary lectures, giving state of the art and perspectives in the main areas of materials forming, will be delivered by recognized scientists.

The conference will also feature a number of mini-symposia with lectures by leading scientists in various fields of materials forming at the beginning of each session. The mini-symposia organizers will select the invited speakers.

ESAFORM 2002 Conference—mini-symposia

1. Optimization of forming processes
2. Applications of inverse analysis
3. Numerical methods and tools for testing products of industrial casting
4. Modelling of microstructure and thermomechanical processing
5. Solidification and solid state forming of polymers
6. Innovative powder forming processes
7. Extrusion and drawing of materials
8. Recycling of materials
9. Thixoforming/semi solid processing
10. Processing of superalloys
11. Composites forming processes
12. Material characterization and computational methods in cutting
13. Damage modelling in metal forming
14. Numerical and physical investigation of forging
15. Computational methods in contact mechanics
16. Hydroforming simulation
17. Sheet metal forming

Presentations concerning all the steps of material forming processes are welcome. Prospective authors are invited to submit an abstract of one page maximum and 200 words minimum. It should contain the title, the author's affiliation, outline the main features, results and conclusions of the paper, and provide relevant references. If the authors are interested in joining a mini-symposium, they should indicate which one. All abstracts are to be sent to the local committee who will forward them to the mini-symposium coordinators if appropriate.

The Selection Committee and mini-symposia coordinators will review the abstracts and all authors will be notified of the decision. Final manuscripts, four pages long, should be prepared in camera-ready form. Proceedings will be available at the conference. Extended versions of selected papers will be published in the International Journal of Forming Processes.

For further information contact:

Conference Secretary
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Akademia Górniczo-Hutnicza
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Important Dates and Deadlines

Submitting of abstracts	September 30, 2001
Notification of acceptance of abstracts	November 15, 2001
Receipt of final manuscripts	January 31, 2002
Notification of acceptance of papers	March 1, 2002