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The Gleeble® NEWSLETTER

Spring 2003

DSI at the Shows

International Conference of Physical and Numerical Simulation of Materials Processing, Shanghai China, Postponed Due to SARS Concerns

The organizational committee of the 4th International Conference on Physical and Numerical Simulation of Materials Processing (ICPNS' 2003), after thorough evaluation and consultation, has decided to postpone the meeting, originally planned for May 26–29, 2003, for 6–12 months. The decision is based on concern over Severe Acute Respiratory Syndrome (SARS).

To date, 332 delegates from 32 countries and regions have registered for ICPNS' 2003 and 325 papers have been submitted. Preparation for ICPNS' 2003 will proceed, including the proceedings and the publication of academic papers in 3 journals this summer. The "publication cost" for journals is included in the registration fee. Meanwhile, organizers will keep participants updated monthly on preparations and will advise registrants three months in advance of the new date of the conference.

For the latest information, visit the conference website of http://nsmp.hit.edu.cn.

Thermec 2003 Scheduled for Madrid, Spain

The Thermec 2003 International Conference on Processing and Manufacturing of Advanced Materials is planned for July 7–11,

Continued on Page 3

Gleeble Application Profile

Wuhan Steel of China Develops New Steel Products Using the Gleeble® 2000

Part II

Dr. Qing Feng Wang
Technical Center, Wuhan Steel, Wuhan China
(Translated From Chinese)

3.2 Development of 3Cr2Mo and 3Cr2Ni1Mo Mold Steel for Plastic Molding

Demand for 3Cr2Mo and 3Cr2Ni1Mo mold steels has increased dramatically for molds producing plastic products with the rapid development of the Chinese plastics industry. In the past, these two steels were often produced by electric arc melting, or electric slag re-melting, and ingot casting, forging with quenching and tempering. The production efficiency was low and the cost was high. In 1999 a development team was formed at the R&D Center to develop mold steels, and soon the above two steels were successfully produced with BOF furnaces and continuous casting.

These two steels have pretty high percentage of alloying elements, and showed very high crack susceptibility during continuous casting. The challenge facing the team was how to control casting to avoid cracking.

Hot ductility tests were conducted using a 10 mm diameter × 120 mm long standard Gleeble hot tensile testing specimen. The specimens were cut from an ingot produced by a BOF steel making furnace and ingot casting. The test conditions, such as temperature distribution, thermal gradient, and tensile strain rate, were designed to cover the continuous casting conditions at Wuhan Steel (see Figure 3). The hot ductility and hot tensile strength were obtained as a function of temperature during continuous casting as shown in Figure 4. In order to keep the cast billet from cracking during casting, tensile stresses generated must be minimized during the low ductility region. The Gleeble hot ductility tests can develop for casting 3Cr2Mo and 3Cr2Ni1Mo steels a continuous casting castability map which provides a database for designing and controlling of the optimal casting speed, necessary cooling rate in the secondary cooling zone, and the temperature during unbending.

Based on the tests in the laboratory, the team conducted two successful plant trials in the rolling mills for the two steels in 1999. The BOF + Continuous casting processing routine simplified the production process, reduced the production costs, and increased the productivity significantly. The product rate was 17% higher than domestic competitors using the conventional process. By end of the 2001, more than 5000 tons of the two steels had been produced, which generated a significant economic benefit.

3.3 Development of TRIP Steels

Ductility of TRIP (Transformation Induced Plasticity) steels increases with a certain amount of retained austenite. It

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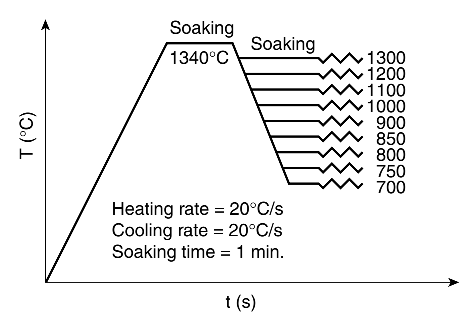

Figure 3. Test conditions of hot tensile mechanical property measurement.

Recent Gleeble Papers

406

Monitoring of Attenuation During Phase Transformations in Steel Using Laser-Ultrasonics

by M. Dubois, A. Moreau, M. Militzer, and J.F. Bussiere

Ferrite grain size strongly influences the mechanical properties of steels. In hot rolled steels, the ferrite grain size is determined by the austenite microstructure during the finish rolling, and by the rate of cooling though the transformation temperature range. A sensor to monitor phase transformations and grain sizes in strips during hot rolling would allow to control the process parameters, optimize the ferrite grain size, and better achieve the desired mechanical properties. Unfortunately, such a sensor is presently not available in hot strip mills. Currently, processing conditions in mills are set according to empirical knowledge, computer modeling, and laboratory simulations. In the laboratory, the standard technique to monitor phase transformations is dilatometry. This technique, however, provides only a quantitative measure of the overall phase decomposition and laborious metallographic techniques are required to determine further microstructural details. Ultrasound has been known for many years to be an excellent method to characterize steel microstructure. However, ultrasonic measurements at temperature of the austenite-to-ferrite transformations in low-carbon steels are not easily obtained using conventional ultrasonic transducers. Laser-ultrasonics, a technique based on the generation of ultrasonic waves by a pulsed laser and on their detection by a laser interferometer, is a truly remote technique (standoff distances of order 1 m) and works efficiently at high temperature. Papadakis et al. used conventional ultrasonic transducers and a momentary contact technique to measure ultrasonic attenuation and velocity during the ferrite-to-austenite phase transformation in an AISI 52100 steel. Scruby and Moss also measured ultrasonic attenuation and velocity during the same phase transformation in a low-carbon steel using laser-ultrasonics. However, the development of the laser-ultrasonics in recent years allows to obtain new ultrasonic data at high temperature with a significantly improved accuracy. This paper presents laser-ultrasonic measurements of ultrasonic attenuation in a hot rolled A36 steel at temperatures between 500°C and 1100°C. The sudden variations of ultrasonic attenuation observed in this temperature range are related to microstructural changes caused by the austenite-to-ferrite phase transformation.

410

Recrystallization Kinetics of Microalloyed Steels Determined by Two Mechanical Testing Techniques

by K. Airaksinen, L.P. Karjalainen, D. Porter, and J. Perttula

Data on the static and post-dynamic recrystallization have been determined in five Ti-microalloyed steels. Both the stress relaxation and interrupted deformation techniques have been employed. The effect of a strain rate change on the flow stress and the subsequent softening kinetics was also investigated. A reasonable agreement is obtained between the results of both the stress relaxation and double-compression methods, which further confirms the reliability of the stress relaxation technique. The results indicate that steels with plain Ti or with Ti-Ni-C or Ti-Ni-Cu alloying recrystallize at temperatures above 900°C (pass reduction ≥ 0.15) for interpass times characteristic of plate rolling, but Nb (ca. 0.03%) retards the recrystallization rate so that the final rolling temperature should be about 1000°C for full recrystallization between passes. The characteristics of static and metadynamic recrystallization are distinctly different. Softening becomes independent of strain and highly dependent on the strain rate even at strains leading to a small fraction of dynamic recrystallization. Nb has only a small retarding effect in metadynamic recrystallization. The flow stress level and softening kinetics are independent of the strain rate history only being dependent on the final strain rate.

417

Fabrication of Submicron Grained Titanium Alloy by Compressive Deformation

by X.J. Sun, J.L. Gu, B.Z. Bai, B. Dai, and N.P. Chen

This paper reviews various fabrication methods of ultrafine grained materials and their limitations briefly, and examines the possibility to produce ultrafine grained titanium alloy by compressive deformation preliminary. It has been shown that submicron-grained TC11 alloy can be obtained by compressive deformation below 725°C. During microstructure refinement, dynamic recrystallization occurs only in phases, and phases undergo a process of precipitation and growth. Compared with the situation of static annealing, deformation can not only enhance the precipitation and growth of phases but also change the morphology of precipitates.

422

Physical Simulation and Property Prediction in Heat Forming Process of 1Cr18Ni9Ti

by B. Guo, S. Wu, H. Dai, and R. Luo

Regarding heat forming process of 1Cr18Ni9Ti as typical forming process, this paper presents the study of the effect of various parameters on flow stress, grain size and hardness of formed specimen by means of Gleeble 1500 Thermo-simulation machine and metalloscope. On the basis of technical experiment this paper, data are proceeded by applying multilayer feed forward back-propagation neural network, a prediction model of technological parameters together with microstructure and property in the heat forming process is established, this forging property prediction in the heat forming process is realized.

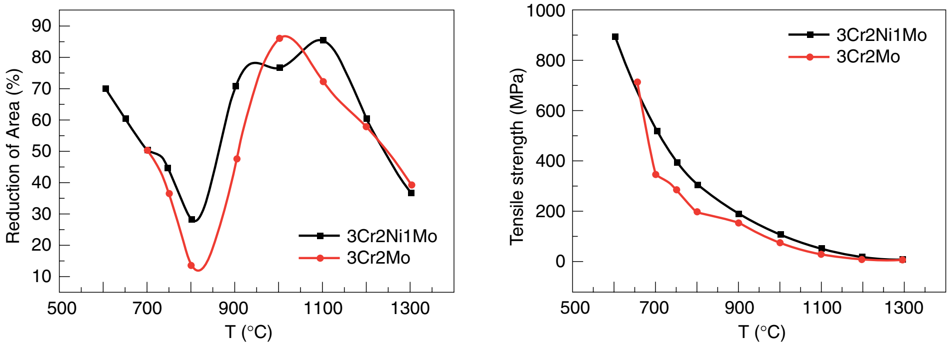

Figure 4. Typical hot tensile mechanical properties: (left) hot ductility as a function of temperature; (right) hot tensile strength as a function of temperature.

The Gleeble at Wuhan Steel

Continued from Page 1

can reach 25% elongation rate with the ultimate tensile strength of 800 Mpa. Thus, when TRIP steel is used for deep drawing, it meets the requirement of deep drawing ability, and reduces the weight of automotive vehicles. It will become a very attractive automotive steel.

Hot rolled TRIP steel has been studied in laboratories for many years, and it has lagged far behind the cold rolled strip TRIP steel due to the difficulties encountered in production, especially the difficulty to coil the hot rolled TRIP strips at relatively low temperatures.

Recently, the TRIP Steels Group at the R&D Center of Wuhan Steel has studied the effects of chemical composition, hot strip rolling schedule, and coiling temperature on the amount of retained austenite and hardness of the hot strip TRIP steel using the Gleeble system. The Gleeble specimens were cut from a rough rolled steel plate into the size of 10 mm × 10 mm × 80 mm. A typical thermomechanical processing routine simulated on the Gleeble is shown in Figure 5, where the slab re-heating temperature (SRT) was 1200°C, heating rate 10°C/s, soaking time at 1200°C for 10 minutes, and coiling temperature was 350°C, 400°C, and 450°C respectively. With the accurate control of the testing conditions on the Gleeble 2000, the laboratory test results apply well to plant production.

The following objectives have been achieved using the Gleeble thermal mechanical simulator:

1) The economic austenite stabilizing alloying elements needed in the TRIP steel have been chosen through Gleeble physical simulation on different rolling and coiling temperatures, hardness measurement, and microstructure analysis.

2) Readily controllable and easy to operate controlled rolling and controlled cooling process routine has been developed based on the results of Gleeble thermo-mechanical process simulation. All the controllable production parameters for hot rolling, coiling, and cooling have been determined.

3) The studies of effects of the amount of normal alloying elements such as C, Si, Mn, and Al and minor elements of Nb and Ti, finish rolling temperature, and coiling temperature have provided a database for development of the relationship between the property and the chemical composition, hot rolling schedule, and amount of retained austenite. The relationship is the basic input data for accurate prediction of properties using a mathematical model.

4. Concluding Remarks

The above cases are just a few of many examples of Gleeble applications in developing of new steel products at Wuhan Steel. The successful experience of the Gleeble application at Wuhan Steel has proven that the Gleeble system can significantly shorten the lead time of new products development, reduce the costs, and have a better control of product quality.

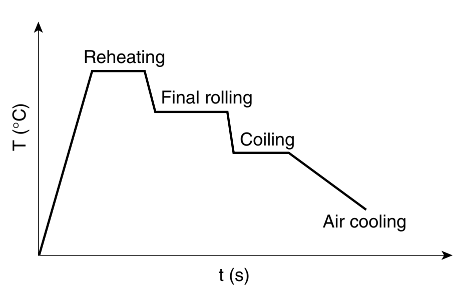

Figure 5. Thermo-mechanical processing simulation condition on the Gleeble 2000.

DSI at the Shows

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2003, in Madrid, Spain. Special sessions will be devoted to severe plastic deformation, surface engineering/coatings, modeling, texture, superplastic deformation, residual stresses, welding and joining, thin film technology and nanomaterials/nano tubes.

For more information, visit http://www.fundacion.uc3m.es/thermec/index.asp

ASM Materials Solutions Exposition—Pittsburgh, Pennsylvania

The ASM Materials Solutions Exposition will be held October 13–15, 2003, at Pittsburgh's David L. Lawrence Convention Center. Come see the state of the art in materials testing, materials characterization, metals, materials, processing, cutting-edge applications, and failure analysis.

Make it a point to stop by Booth 400. DSI application engineers will be standing by to answer your questions.

For additional information about the show, contact:

ASM International
Materials Park, OH 44073-0002
Tel: 440-338-5151
Fax: 440-338-4634
Web: www.asminternational.org

Materials Science & Technology 2003—Chicago, Illinois

Where theory meets application, where scientists meet engineers, where technology meets the future, Materials Science & Technology 2003 will be held November 9–12, at the Hyatt Regency Chicago.

DSI applications engineers will be available at Booth 214 to discuss your needs.

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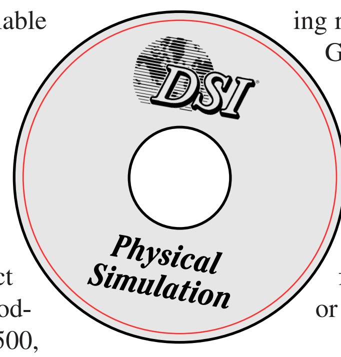
Free CD on Physical Simulation and Gleeble Systems Available from DSI

Did you know a free CD containing a library of information about physical simulation and Gleeble dynamic thermal-mechanical systems is available upon request?

The CD contains four major sections. The first is a nine-minute video introducing thermal-mechanical simulation systems.



The second section contains comprehensive product information about DSI's products, such as the Gleeble 3500, and 3800; Hot Torsion system; and MAXStrain® research system for making ultrafine-grain and nano materials. Brochures, specifications, and site preparation requirements are included.

The third section is a complete collection of technical application notes related to using DSI's systems, from "Axisymmetric Uniaxial Compression Testing Using ISO-T Anvils" to "Advanced QuikSim™ Configuration Techniques."

The fourth section covers the economics of Gleeble ownership and includes a wealth of information such as Gleeble application stories from more than two dozen of the world's leading industrial and academic research centers as well as white papers on "Why Physical Simulation?" and "Economic Justification of Gleeble Ownership."

Also included on the CD is a comprehensive bibliography of more than 400 scientific and technical papers involving research conducted using Gleeble systems.

To request a copy of the free CD, write DSI P.O. Box 1234, Route 355 Poestenkill, NY 12140 USA; tel: 518 283-5350, fax: 518 283-3160, or email: info@gleeble.com.

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