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The Gleeble® NEWSLETTER

Summer 2003

DSI at the Shows

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
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.

For additional information contact:

The Iron & Steel Society
186 Thorn Hill Rd.
Warrendale, PA 15086
Tel: 724-776-1535
Email: info@matscitech.org
www.matscitech.org

Gleeble Application Profile

The Gleeble at USIMINAS

USIMINAS is a major steel producer in Brazil, leading a group with the capacity of manufacturing some 10 million tons of steel per year. The company produces flat steel, including heavy plate, hot rolled strips, and cold rolled strips and sheets.

The biggest customer for flat steel in Brazil is the automotive industry, comprising about 25% of the market. There are some 13 car manufacturers in Brazil, including companies from Europe, Asia, and North America, which manufacture not just for the local market but also for export to other countries. Other large customers for flat steel include the construction industry, pipeline industry, and companies that manufacture electrical appliances.

According to Dr. Túlio Magno Füzessy de Melo, research engineer in USIMINAS' Products Research Laboratory at its plant in Ipatinga, Brazil, the global market is one of the driving forces behind their research efforts. "Because of the global market, demands for quality are very stringent," he says. "As a result, we have to make steel that is as good for a particular application as steel made anywhere in the world."

In the mid-1990s, USIMINAS decided to increase its production capacity. The company already had a batch annealing process, but now it decided to add a continuous annealing line.

"As a result, we were faced with the

Continued on Page 4

Marcelo Souza, Dr. Túlio Melo and Altamiro Pinheiro (left to right) perform tests using the Gleeble at USIMINAS' Products Research Laboratory.

Recent Gleeble Papers

411

Hot Ductility of Certain Microalloyed Steels under Simulated Continuous Casting Conditions

by L.P. Karjalainen, H. Kinnunen, and D. Porter

The hot ductility of steels containing 0.014–0.017%Ti, 0.34–0.72%Ni and various combinations of Nb, V and Cu has been investigated by tensile testing over the temperature range of 600–1050°C. The in-situ melting procedure was employed, followed by subsequent cooling at three different rates to the selected testing temperature. Two strain rates, 0.005 and 0.05 s^{-1}, were used. The results show that a ductility trough exists in all the steels in the temperature range of 700–950°C, and the lowest ductility in terms of reduction of area (RA) is at 750°C. Markedly lower RA and elongation to fracture values were obtained at the lower strain rate. The ductility trough was quite similar in Nb bearing and V or Cu containing steels, especially at the high cooling rate of 4°C/s and with a Ti/N ratio of about 2.8. Reducing the cooling rate from 4 to 1°C/s makes the ductility trough narrower and shallower in the Nb-bearing steels, but has little effect in the Nb-free steels. Increasing Ca/S ratios in the range 0 to 1.25 improve the ductility minimum especially at the lower cooling rate of 1°C/s. Low N and high Ti/N ratio may also improve the minimum ductility at lower cooling rates.

412

Recrystallisation Rates in Austenite Measured by Double Compression and Stress Relaxation Methods

by J.S. Perttula and L.P. Karjalainen

The feasibility of two mechanical testing methods, double compression and stress relaxation, for measuring the static recrystallization rate in hot deformed austenite was studied. The results were verified by metallographic observations. The effect of recovery on the softening data in an interrupted compression test is eliminated when the reloading flow stresses are analyzed at a total strain of 5% instead of 0.2% offset strain used conventionally. A stress relaxation test provides consistent data on the recrystallization event. In most instances, the stress present in the course of softening has no effect at all or only slightly enhances the recrystallization rate. The accelerating effect is most pronounced, about 50–70%, at small strains and fine grain sizes.

413

Optimizing Recrystallization Controlled Rolling by Physical Simulation

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

Physical simulation can provide an effective tool for designing forming schedules. In this work, recrystallization controlled rolling with accelerated cooling has been simulated using a Gleeble 1500. The investigation included grain growth during reheating, the recrystallization kinetics of hot-worked austenite as a function of chemistry, temperature and strain, the tendency to grain growth after recrystallization and the effect of accelerated cooling on the final ferritic microstructure and grain size. All the steels studied were Ti microalloyed, two were C-Mn based and three contained Ni together with additions of Cu, V or Nb. Ti was effective in preventing grain growth after recrystallization in all of the steels. Equations describing the recrystallization kinetics and grain size development are given.

414

Recrystallization of Ti-Microalloyed Steels under Constant and Varying Deformation Conditions

by L.P. Karjalainen, D. Porter, and P. Peura

The effects of an instantaneous strain rate change on the flow stress and the rate of subsequent static and metadynamic recrystallization have been investigated using Ti and Ti-Nb microalloyed steels. A distinct transient stage has been found during which the flow stress changes towards that characteristic of the new strain rate, with pronounced under and overshootings in dynamic recrystallization regime. Static recrystallization rates are only slightly affected by the previous strain rate history during the transition stage. Following dynamic recrystallization a strain rate change leads to very rapid dynamic softening which can completely eliminate subsequent recrystallization. The average strain rate is a poor parameter to characterize metadynamic recrystallization rates in the transition stage.

408

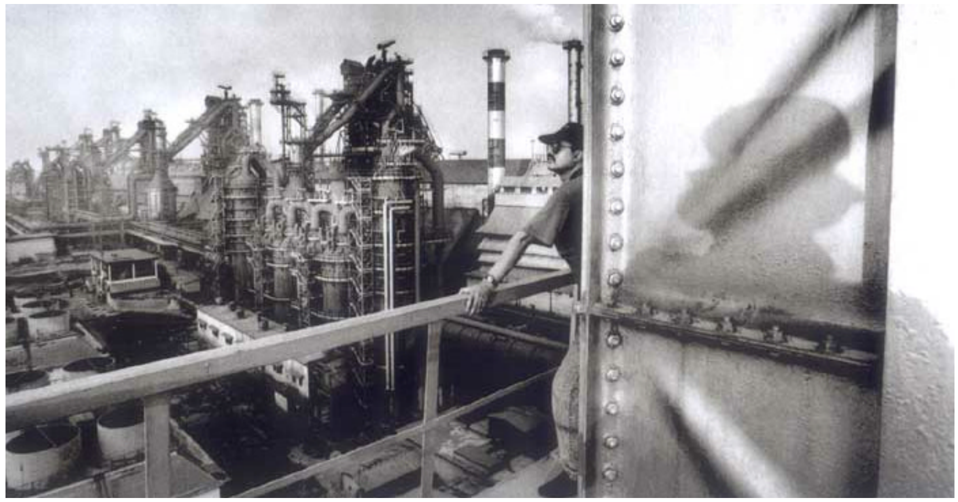
Laser Ultrasonic Measurement of Microstructure Evolution during Metals Processing

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

Laser-ultrasonics, a technique based on the generation of ultrasonic waves by a pulsed laser and on their detection by a laser interferometer, was used to monitor microstructure evolution during austenitization and phase transformations of A36 and IF steels, and during the sintering of a green powder metal iron compact. Ultrasonic attenuation measurements allowed the observation of grain growth during austenitization and of nucleation and growth during phase transformations. A calibration based on the metallographic evaluation of austenite grain sizes on quenched steel samples was obtained to quantitatively relate ultrasonic attenuation to austenite grain sizes. Ultrasonic velocity measurements also allowed the monitoring of the first two stages of the sintering process in a green powder metal iron compact. The laser-ultrasonic technique provided, in real-time, microstructural information that could only have been obtained laboriously using traditional metallographic techniques. The results presented in this paper establish laser-ultrasonics as a powerful laboratory tool to study microstructural evolution at high temperatures.

Call for Papers: SimPro'04 in Ranchi, India

An International Conference on Thermo-Mechanical Simulations and Processing of Steels—SimPro '04—is scheduled for Ranchi, India, September 21–23, 2004. The conference, organized by the R&D Centre for Iron and Steel and the Indian Institute for Metals, is sponsored by the Ministry of Steel and DSI and is co-sponsored by CBMM Asia Co., Ltd. and Concast India Limited.



A view of the blast furances at Bhilai Steel Plant, Steel Authority of India, Ltd.

Conference Scope

Steel research in the last two decades has been driven chiefly by the desire to develop high strength steels with tailor made microstructure and properties suited for diverse applications. In this respect, significant progress has been made in understanding the influence of alloying elements, hot deformation of austenite and its controlled decomposition during cooling, resulting in generation of a wide array of microstructures and mechanical properties in hot rolled steels. In the cold rolling arena, the major thrust has predominantly focused towards production of stronger and superior formable quality cold rolled and coated steel sheets. These developments are aimed at meeting ever increasing demands for steel with higher performance and reliability in service.

Today, physical simulation studies have proven highly beneficial in improving metallurgical processes, developing new products, understanding various mechanisms operating during processing of materials and also for investigating materials failure. Such techniques have provided many cost effective solutions for hot rolling and cold rolling mills and metallic coating lines. This has led to the development of numerous new generation steels catering to a wide variety of critical applications.

The conference will focus on the latest advances in thermo-mechanical processing and various simulation techniques and their applications related to steel products. It will provide an opportunity for scientists and technologists from research and academic institutes, as well as steel manufacturers, to share their experiences and find new means of producing cost effective high value steel products.

The conference will focus on:

- Simulation of continuous casting, hot rolling, strip annealing, forging, extrusion, heat-treatment, and welding/HAZ
- Phase transformations
- Modeling of metallurgical processes
- Advances in thermo-mechanical processing for hot rolled, cold rolled, and coated steels
- Emerging steel products, processes and applications for the 21st century.

Call for Papers

Technical papers are invited for presentation at the conference per the following schedule. Authors are requested to submit the abstract of 300 to 500 words in duplicate to the conference secretariat for review. Authors of the accepted papers will submit their full paper as per the provided guidelines. At least one author should be registered as a delegate.

- Receipt of Abstract—31st December, 2003
- Acceptance of paper—15th February, 2004
- Full text of paper—30th June, 2004

Language

All communication will be made in English.

Proceedings

Proceedings will be published and distributed to all registered delegates at the conference. All papers received according to schedule will be published in the proceedings.

Venue

The conference will be held at the Auditorium of Research & Development Centre for Iron & Steel (RDCIS)—a Corporate R&D Centre of SAIL which is the largest steel producer in India. The R&D Centre is equipped with state-of-the-art testing and diagnostic facilities, including pilot scale laboratories, to carry out comprehensive research and developmental activities for various units of SAIL.

Secretariat Address

All correspondence related to this conference should be made at the following address:

Conference Secretariat
c/o Dr. S.K. Chaudhuri
Dy. General Manager, Product Development Division
Research & Development Centre for Iron & Steel
Steel Authority of India Limited
Ranchi (Jharkhand) 834 002 India
Tel: +91-651-2411148 (office),
+91-651-2441188 (residence),
+91-651-2411 070/087 x2331
Fax: +91-651-2411103/2411090
Email: simpro@rdcis.bih.nic.in

Concurrent Event—Gleeble Demonstration

Experts from Dynamic Systems Inc., USA, manufacturers of the Gleeble thermo-mechanical physical simulation system, will be available for interaction and discussions with the participants. A live demonstration of the Gleeble 3500C will also be organized during the conference.

Dynamic Systems Inc.

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Poestenkill, NY 12140 USA

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The Gleeble at USIMINAS

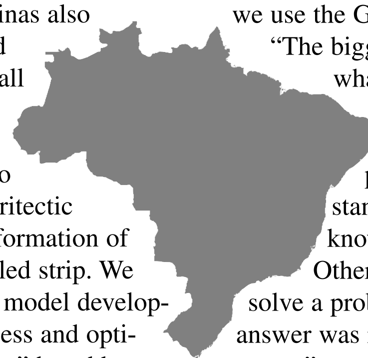
Continued from Page 1

need to adapt some of our steels which were batch annealed to the continuous annealing line," Dr. Melo says. "To do that we needed a simulator, so we purchased a Gleeble 3500."

The Gleeble is located in the Research and Development Department, which employs approximately 130 people and is comprised of three divisions: Product Research and Development, Process Research and Development, and Laboratories.

"The Gleeble was commissioned in 1997," he says, "and since then we have adapted a great number of products from batch annealing to continuous annealing. The transition was very smooth because of the ability to physically simulate the process on the Gleeble," Dr. Melo says.

The Gleeble at Usiminas also has the Hydrawedge and Torsion MCUs. "Using all these capabilities, we have also been simulating continuous casting to study hot ductility of peritectic steels, as well as hot deformation of heavy plates and hot rolled strip. We also use the Gleeble for model development to control the process and optimize the rolling schedule," he adds.



Dr. Melo notes that there are two apparently conflicting trends in the automotive industry. One is toward lighter, thinner auto bodies that require less fuel because there is less weight to move around. The second trend is that safety is very important—people don't want to be at greater risk if they have a collision in a car with a lighter body.

USIMINAS is working toward the development of high-strength steels that will allow the construction of cars that are both lighter and safer. The Gleeble is being used to help the development of these steels with the right chemistry and processing. This development assures the position of steel as the first choice material for automotive applications.

"The Gleeble is always very busy," Dr. Melo says. "In addition to our research and development work, people in other production and technical departments want to know the properties of steel, how to roll and heat treat it, and so forth, and we use the Gleeble to get the answers."

"The biggest challenge is to know if what you want to simulate represents the real-world process," he adds. "There are many people here trying to understand our processes better to know what to simulate. Otherwise, you can attempt to solve a problem only to find out that the answer was right, but the question was wrong."

"The Gleeble is literally running around the clock. It's very versatile. Once you know how to use it well, the Gleeble has a thousand and one applications," he says.