The Gleeble® NEWSLETTER

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Thermec 2003 Set for Spain

The Thermec 2003 International Conference on Processing and Manufacturing of Advanced Materials is planned for July 7–11, 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 www.uc3m.es/thermec

DSI Receives International Trade Award

DSI received an "Excellence in International Trade" award from the Capital Region World Trade Center and the Global Business Network.

The Excellence in International Trade Awards recognize those companies in the Capital Region of New York State that have succeeded in making a sustained effort to increase their export sales. DSI received the award for demonstrating a commitment to exporting and international trade.

Continued on Page 3

Gleeble Application Profile

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

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

1. Introduction

The Gleeble 2000 system at Wuhan Steel consists of two mobile conversion units (MCU). One is the general-purpose unit and the other is the Hydrawedge unit. It has been playing a significant role in the development of new steel products at Wuhan Steel.

When the supply of the domestic steel market was greater than the demand in 1995, most of the steel companies took a strategy of reducing production and cutting prices in order to survive. Facing such a fiercely competitive market and learning that the supply of value added steel products was in short supply in the domestic market, Wuhan Steel took a very active strategy to explore new technology to sharpen their competitive edge. They formed a high spirit, cross-functional team in a division within the R&D Center to develop new products. With a total of 50 members, the New Product Development Division was divided into 10 groups to develop steels in applications of pipe-line, ship building, machinery manufacturing, bridge construction, pressure vessels, buildings, hot and cold rolled automotive sheets, coated steels, and electrode steels. With this mission in mind, they put heavy investment into R&D facilities including

Continued on Page 3

Mr. Han Xiong Dong, Dr. Qing Feng Wang, and Ms. Gui Lian Yuan (left to right) conduct a test using the Gleeble 2000 system at Wuhan Steel.

Recent Gleeble Papers

407

Laser-Ultrasonic Monitoring of Phase Transformations in Steels

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

For most steel products, a controlled cooling through the temperature range of austenite decomposition is the least expensive way to increase strength. Unfortunately, no technique presently exists to monitor phase transformations in steel products during in-plant processing. Consequently, cooling conditions are set according to knowledge based on previous results, computer modeling, and laboratory simulations. Even in the laboratory, dilatometry, the standard technique to monitor austenite-ferrite phase transformations, provides only a quantitative measure of the overall phase decomposition, and laborious metallographic techniques are required to determine further microstructural details. Ultrasonics has been for many years an excellent method to characterize steel microstructure . However, ultrasonic measurements at the austenite-ferrite transformation temperatures 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 of 1 m) and works well at high temperatures. Ultrasonic attenuation has already been measured during heating and cooling of carbon samples through the austenite-ferrite transformation using laser-ultrasonics, conventional piezoelectric transducers, and electromagnetic transducers. Unfortunately, the accuracy of the data obtained did not allow a reliable identification of the transformation temperatures, and no comparison with a conventional technique to monitor phase transformation was presented. This article presents laser-ultrasonic attenuation measurements in hot-rolled A36 and interstitial free (IF) steels at temperatures between 500 to 1100°C. The development of laser-ultrasonics in recent years has allowed new attenuation measurements with significantly improved accuracy at these temperatures. The sudden variations of ultrasonic attenuation observed in this temperature range are related to microstructural changes caused by the austenite-ferrite phase transformation. These attenuation variations are also compared to dilatometry measurements.

409

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.

419

Simulation of Hot Forming Procession in Mn18Cr18N Steel

by M. Guan, J. Song, and H. Guo

In the hot forming of Mn18Cr18N steel, such problems as easy cracking, difficult controlling of forming parameters often occur. In this paper, the variation rule of the plasticity of the steel, the starting mechanism of micro-crack and its generating characteristics were studied with the combination of thermodynamic simulation test, micro-simulation and FEM, the related data of microstructure change and hot forming parameters were produced. The hot forming process of 600MW generator retaining ring was analyzed as an example.

488

Modeling the Microstructural Evolution During Hot Strip Rolling

by Gonzalo Gomez, Teresa Pérez, and Jorge Moriconi

Due to the increasingly severe specifications being imposed by end users, an accurate knowledge of the microstructural evolution during hot rolling and its effect on the final mechanical properties is needed for many as-rolled products. Metallurgical models that describe in detail different aspects of the microstructural evolution in the hot strip mill have already been published. The aim of this paper is to present a model that comprises the whole microstructural evolution of plain carbon and microalloyed steels during hot rolling, including hot deformation, cooling and coiling. Several theoretical and empirical expressions proposed in the literature were used. Attention was paid to the interaction between the following metallurgical phenomena: dislocation density evolution, microalloy precipitation, recrystallization and grain growth. It also covered the phase transformation during cooling (austenite decomposition into ferrite, perlite and/or bainite) and the precipitation of microalloys in the ferritic range. The main goal of this model is to make an accurate prediction of the yield strength (YS) and the ultimate tensile strength (UTS) of the as-rolled material based on the steel chemistry and processing conditions. The model parameters were adjusted with data obtained from bibliography and from experiments performed in a thermomechanical simulator. A first comparison between mill data and calculated YS and UTS values is presented showing a good agreement.

The Gleeble at Wuhan Steel

Continued from Page 1

purchasing a world famous Gleeble 2000 thermal mechanical simulator.

Over the past five years using the Gleeble 2000 system Wuhan Steel has shortened significantly the development time of a new product. The number of new products developed has increased gradually every year and the increase in sales of new products developed using the Gleeble systems has reached 70% every year. In 2001 alone, the R&D Center had a total of 65 projects in new product development, and it developed more than a hundred new products. The sale of new products has increased to 10–20% of the total revenue of Wuhan Steel.

2. Use of the Gleeble 2000 in New Product Development at Wuhan Steel

In the New Product Development Division the Gleeble 2000 system is open to every group. Every group uses the unique features of the Gleeble 2000 system to conduct many different thermal and mechanical simulations and materials studies. Applications include, but are not limited to, continuous casting, materials processing, heat treatment, welding, etc. They have hosted several seminars by the Gleeble experts from Dynamic Systems Inc. (DSI) and their own Gleeble System Group of the R&D Center on possible applications of the Gleeble systems to the engineers within the R&D Center. This stimulates the engineers' enthusiasm to develop new products and technologies. The engineers of the Gleeble System Group participate in research and development of other groups to help them use the Gleeble to design material composition, develop processing schedule, and characterize materials properties.

To the engineers at the R&D Center, the Gleeble thermal mechanical simulator is not just an ordinary physical simulator. Rather, it has become a platform they cannot be without for their research and development, just like those platforms similar to VC and VB that the software developers need to develop all kinds of computer software.

The research engineers normally follow the procedure shown in Figure 1 to develop new products until they reach production stage.

The quality of the new alloy developed is controlled in plant trials using the procedure shown in Figure 2.

Continued on Page 4

DSI Receives Award

Continued from Page 1

DSI has been exporting for 40 years. During the past two years, DSI has made export sales to Germany, Italy, Spain, France, Austria, Poland, Canada, China, Japan, Korea and India.

The Global Business Network is a member-supported, not-for-profit association of businesses, organizations and individuals pursuing global business opportunities. The Capital Region World Trade Center is one of more than 300 World Trade Centers located in approximately 100 countries worldwide. The mission of the Capital Region World Trade Center is to promote, educate and assist companies in developing opportunities in international trade and investment in order to grow their businesses and enhance the Region's economic base.

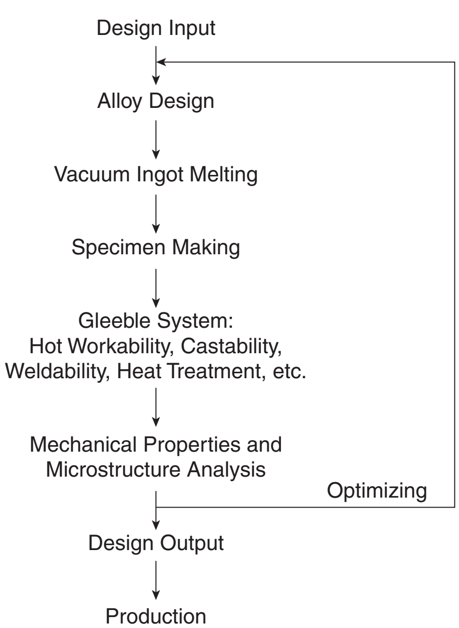

Figure 1. Flow chart of new alloy development using the Gleeble system.

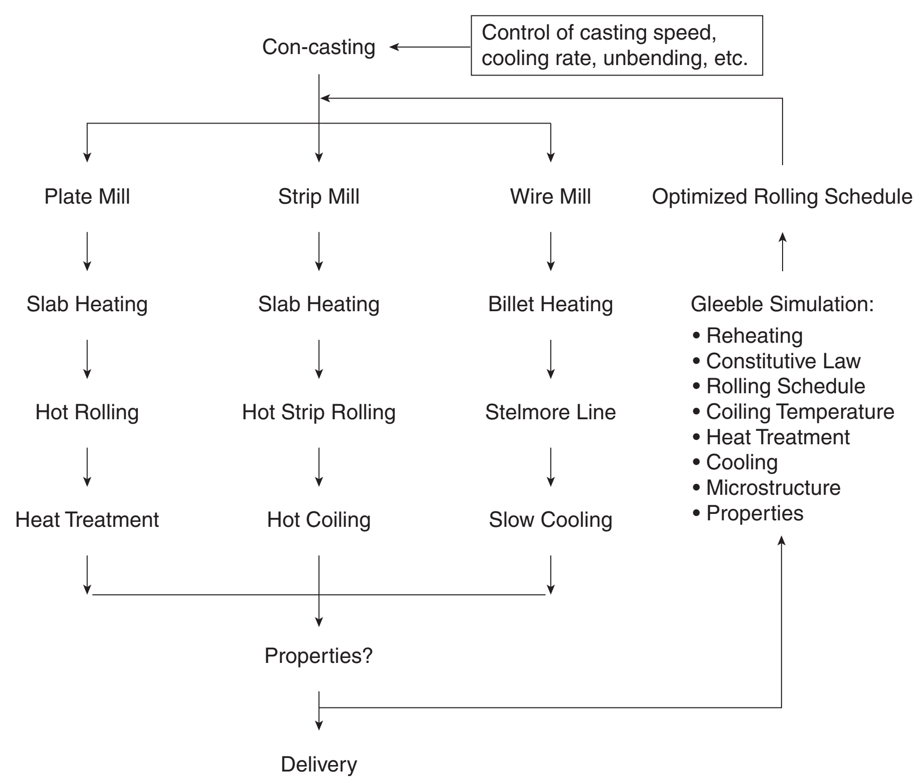

Figure 2. Flow chart of quality control of new products using the Gleeble system at Wuhan Steel.

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The Gleeble at Wuhan Steel of China

Continued from Page 3

3. Cases of Gleeble Applications in New Product Development at Wuhan Steel

3.1 Development of Series High Heat-Input Welding Steels

In 1996, Wuhan Steel learned that Beijing Yanshan Petroleum Chemical Industry Co. Ltd. needed a batch of steel plates in a very short time. The steel plate would be used to manufacture thick wall raw oil storage vessels. The requirements for the steel plates were: the yield strength must be greater than 490 MPa, and they must be capable of being welded with the heat input (line energy) greater than 100 kJ/cm. No Chinese steel producer has ever been able to produce these types of steel plates before. The development of the new steels must be complete by the Pressure Vessel Steels Group of the Technical Center within six months according to the contract.

For conventional low alloy steels, grains grow rapidly in the heat-affected zone during high heat input welding, and some undesirable M-A microstructure forms, which reduces the toughness of the HAZ significantly. The challenges facing the researchers were how to produce the steel (including design and control of the composition, steel making, and hot processing) to achieve the designed weldability under high heat input during welding. In order to design the right composition of the steel, the effect of alloying elements and non-metallic inclusions formed on weldability were studied using the Gleeble system. It was finally found that enough needle-like ferrite must be formed within grains to meet the weldability of the steel under the control of chemical composition.

With a conventional development practice without a Gleeble system for such a project, a substantial number (between 10 and 100) of 50 kg ingots must be produced in a vacuum melting furnace first, and then rolled into welding plates. The total number of welding plates can be more than one hundred. The development time with repeated cycles, from ingot melting to welding to property measurement, could be increased by six additional months. Moreover, there was no welding facility that could supply such a high heat (line energy) input at the Technical Center, and it would cost more than hundreds of thousands of yuans RMB to contract out the welding work. Without the welding facility in-house, an additional three months must be added on to the delivery time. In one word, there was no way that the new alloy could be developed in less than six months without a Gleeble system.

Fortunately, a Gleeble 2000 system was just installed at the R&D Center at Wuhan Steel. On the Gleeble system, a small sample can be used to simulate a thermal cycle seen in the heat-affected zone during welding of steel plates. As a result, the number of steels with different chemical composition was reduced by more than 50%. Moreover, properties of the heat-affected zone under given welding conditions can be subsequently measured with the small Gleeble sample. The high flow quenching system supplied with the Gleeble system can freeze high temperature microstructure of the steel using rapid water quenching at any stage of welding thermal cycle. This, however, cannot easily be achieved in real welding practice.

The engineers from the Pressure Vessel Steel Group used the HAZ software developed by DSI to simulate many different thermal cycles in the heat-affected zone of the steel plate under high heat input from 20 kJ/cm to 120 kJ/cm. High temperature microstructure was frozen with rapid water quenching during welding simulation. The microstructure was examined and effect of different non-metallic inclusions and second phase particles on growth of austenite grains and evolution of microstructure at different welding stages were studied. This work on the Gleeble was completed in less than two months.

With the aid of the Gleeble system, the time of developing the new steel was reduced by seven months comparing to the conventional practice. This project alone has saved more than a million yuans of RMB in R&D for Wuhan Steel. Because the project was well planned and designed using the Gleeble system, the high heat input steel WH610D2 developed was easily processed with current hot rolling facilities available in Wuhan Steel. More importantly, the steel produced met the specifications required by the customer. So far, the customer has built four raw oil storage vessels each with a capacity of 100,000 m^3 using the WH610D2 steel plate.

To be continued in the next issue of the Gleeble Newsletter.