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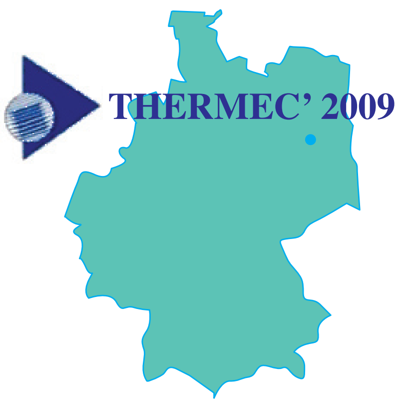
The Gleeble® NEWSLETTER

Winter 2009

See Us at the Shows

THERMEC' 2009, August 25–29, 2009, Berlin, Germany

THERMEC' 2009, Sixth International Conference on Processing and Manufacturing of Advanced Materials will be held August 25–29, 2009, in Berlin, Germany. The Conference will cover all aspects of processing, fabrication, structure/property evaluation and applications of both ferrous and non-ferrous materials including hydrogen and fuel cell technologies, metallic glasses, thin films, ecomaterials, nanocrystalline materials, biomaterials and other advanced materials.



The last THERMEC was held in Vancouver, British Columbia, Canada, in 2006 and attracted over 1,250 delegates from 35 countries who presented more than 700 papers.

For further information, visit http://thermec.uow.edu.au or contact:

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Gleeble Application Story

The Gleeble at the University of Alabama

Visit the home page of the Department of Metallurgical and Materials Engineering at the University of Alabama, and you'll quickly discover that the Department's vision is "To provide a high quality education in Metallurgical and Materials Engineering, with emphasis on student-centered research and scholarly activities, service to community and industry, and professional practice in Metallurgical and Materials Engineering, all conducted in an environment that celebrates discovery and diversity."

Poke around a little further, and you'll find that the Department's mission includes conducting "world class research in the field of metallurgical and materials engineering. The research will encompass both fundamental and applied knowledge in the areas of synthesis, processing, structure, properties, and performance of materials."

For Associate Professor Srinath Viswanathan, PhD, a Gleeble 1500 retro-fitted with a Series 3 Control System is an indispensable tool in helping to achieve the Department's vision and mission.

Currently the Gleeble is instrumental in two research projects. In one of them, Dr. Viswanathan and his graduate students are using it to simulate certain heat treating schedules and, in combination with dilatometry, to investigate phase transfor-

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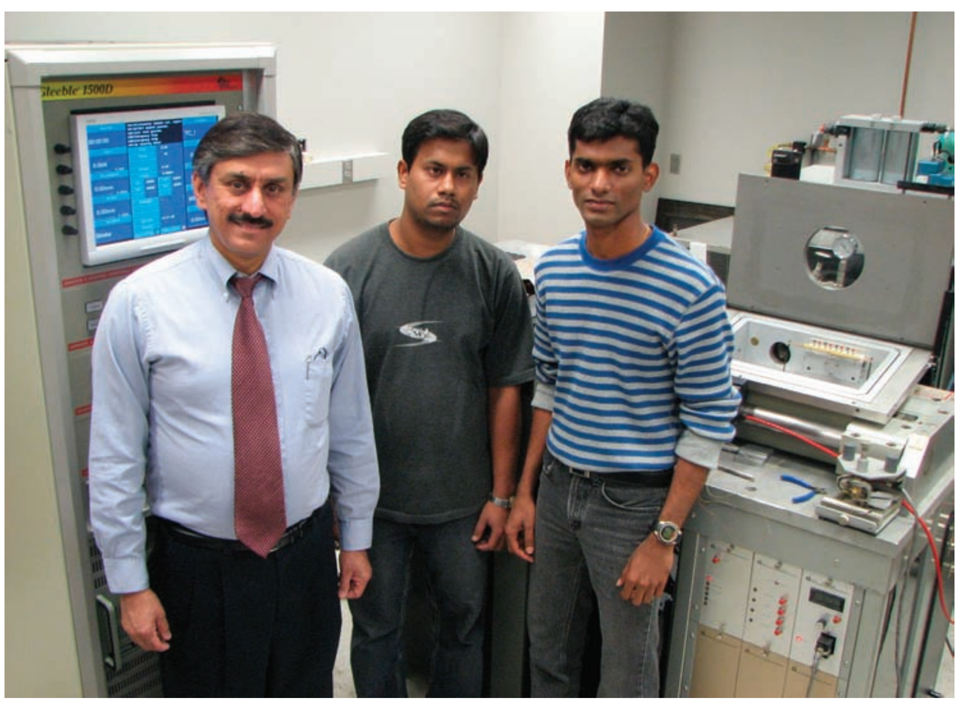

Dr. Srinath Viswanathan and two graduate students, Partha Saha and Chris Samuel, in the Gleeble lab at the University of Alabama.

Recent Gleeble Papers

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Mechanical Properties of Partially Molten Aluminium Alloys

by J.A. Spittle, S.G.R. Brown, J.D. James, and R.W. Evans

A technique has been developed for measuring the mechanical properties of aluminium alloys at temperatures between the solidus and liquidus. Such measurements were carried out by re-heating specimens cut from cast ingots to the temperature of interest. A Gleeble 1500 was linked to a low-force mechanical testing machine, enabling rapid heating to minimize the effects of solid state diffusion on the cored dendritic structure, together with the ability to minimise the warm-up forces encountered by the specimen as it expands. Tests on as-cast aluminium 2024 revealed strength in the range 20–0.03 N/mm^2, and these were compared to strengths of homogenized 2024 at the same temperatures where the specimens were heated by a conventional furnace. In both cases the temperatures were related to the fraction liquid present predited by *Thermo-Calc*. A number of tests were also preformed at temperatures just below the solidus.

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Hot Torsion Testing Determines Metals Workability

by W. Chen and D. Ferguson

Metals workability generally is defined as the ability to form a metal into a particular shape by means of applying a load to the metal via some type of equipment or tooling without causing the metal to fracture or to have an undesirable microstructure. Workability of a material is determined from several factors including strain, strain rate, temperature, failure behavior, and others. Mechanical tests, such as tension and compression tests alone are not capable of providing all of this information. However, the torsion test can provide flow stress data and failure and microstructural response to deformation processing. Gleeble systems offer dynamic thermal-mechanical test capabilities, such as hot torsion testing, simulating thermal and mechanical parameters under very precisely controlled conditions.

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A Study on the Edge Cracking of Low Carbon Steel Sheets Manufactured by Mini-Mill Process

by J-H Kwak, J-H Chung, and K.M. Cho

Thin slab-direct hot rolling, called mini-mill process, is expected to become a future process for production of low carbon steel sheets. Mini-mill has some strong points compared to integrated mill in terms of low capital costs as well as low energy and labor costs per unit of output. The facilities of mini-mills have been improved in terms of better quality and productivity since the first generation mini-mill for hot strip production in 1989. Recently, mini-mill processes have adopted not only a thicker slab caster to increase the productivity and reduce surface defects of slabs, but also a roughing mill for a thinner gauge of hot strip production. All of these efforts culminate into a competitive advantage over the integrated hot strip mill. However, there are several problems to be solved in the processing, one of which is edge cracking in low carbon steel sheet. The edge cracking of low carbon steels is regarded as a kind of embrittlement at high temperature. Even though there are several different opinions about the causes of embrittlement in the temperature range of 900 to 1200°C, it is well known that the super cooling and low deformation temperature close to 900°C causes ductility of plain low carbon steel to deteriorate. Since the thickness of cast slab produced in mini-mill processes is thinner than that in integrated mill, the cooling rate at the surface of slab edge must be higher. Compared to integrated mill, these characteristics put mini-mill at a disadvantage. Even though some mini-mill processes attach tunnel furnaces or reheating furnaces prior to roughing, the major functions of these furnaces are to obtain the rolling temperature, to act as a buffer for thin slabs, and to homogenize the segregated elements. If optimum conditions of preheat treatment to prevent the edge cracking in mini-mill process were obtained, the furnace could be applied as an edge cracking inhibitor prior to roughing. The present study tackles the metallurgical subjects involving the thin slab-direct hot rolling process, i.e., mini-mill process. In order to clarify the effect of chemical composition of steel and MnS precipitation behavior on the development of edge cracking during hot rolling, the content of manganese and sulfur in low carbon steel was varied and the isothermal treatment was applied prior to roughing. In addition, this study proposes the concept of an edge index for more accurate estimation of the total amount of edge cracking as a function of Mn/S ratio.

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Crain Size Prediction of Alloy 718 Billet Forged by Radial Forging Machine Using Numerical and Physical Simulation

by M. Yamaguchi, S. Kubota, T. Ohno, T. Nonomura, and T. Fukui

Fine grains are required for Alloy 718 to obtain its high strength. Since grain size is strongly affected by forging conditions, many trial forgings are generally needed. On the other hand, grain size predictions by several simulations have been tried to reduce trial forgings. The purpose of this study is to predict grain size of Alloy 718 by combining a numerical simulation and a physical simulation. Firstly the transitions of temperature and strain of the forged material during hot forging were calculated by the 3-dimensional FEM. Secondly multi-stage plane strain compression tests using small test pieces were carried out by means of the Gleeble system according to the temperature and strain programs obtained by the numerical simulation, then the grain size was observed. These simulations were applied for predicting and refining the grain size of Alloy 718 billet forged by hydraulic 4-ram radial forging machine.

Inaugural Indian Gleeble Users Group a Great Success

On September 30, 2008, the Indian Gleeble Users Group held its first meeting at the Intercontinental Grand Hotel in Mumbai, India. The purpose of the Indian Gleeble Users Group is to provide a forum where Gleeble users and potential Gleeble users can discuss the Gleeble and physical simulation technologies. Sponsored by Dynamic Systems Inc. and organized by Dynamic Technology Systems of India, the gathering marked the beginning of what is hoped will be a long series of collaborative get-togethers among Gleeble users in India. The objective of the Gleeble User Forum, India was explained to the participants by Mr. Suyash Nadkarni.

About 25 people attended, including representatives of Bharat Heavy Electricals Ltd., TATA Steel Ltd., JSW Steels Ltd., Essar Steel Ltd., Indian Institute of Technology—Roorkee, and Bhabha Atomic Research Center, to name a few.

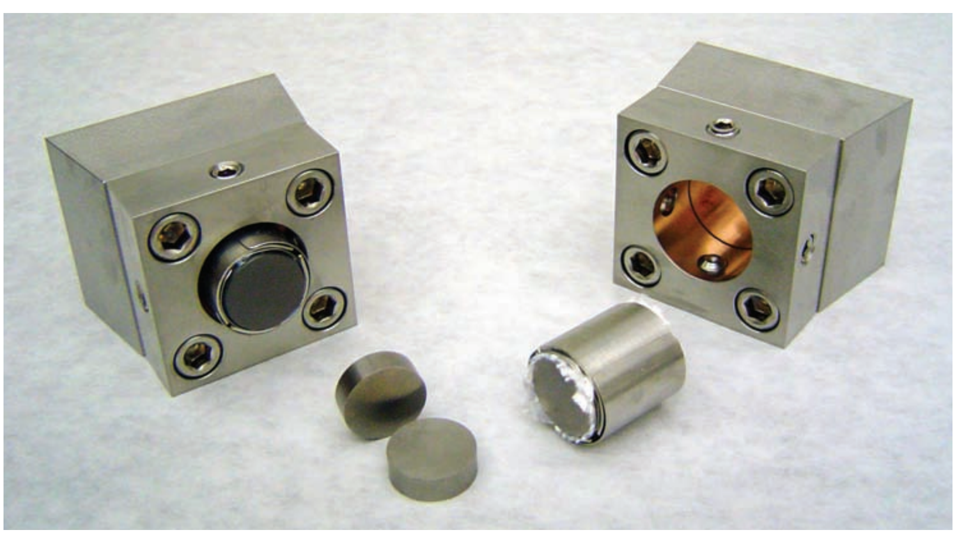
Dr. S. Suresh of Bharat Heavy Electricals gave the opening address in which he spoke about the importance of physical simulation. Dr. A.K. Verna of TATA Iron and Steel discussed how his company had used a Gleeble to optimize their casting and rolling processes and to optimize the 'Galvannealing Cycle' for IFGA steels. His conclusion: "Do not think of developing any steel product without a Gleeble."

Mr. Manimozhi of the Welding Research Institute, part of Bharat Heavy Electricals Ltd., addressed how they are planning to use the Gleeble to optimize the welding processes of a new steel grade to be used in power plant operations.

Intercontinental Grand Hotel in Mumbai, India.

After each presentation, there were free-flowing group discussions. These covered wide-ranging topics, including using the Gleeble to optimize the formability and weldability of various steels for such applications as automobile panels and structural members, as well as for appliances such as dishwashers, refrigerators, and washing machines.

Todd Bonesteel, Director of Sales and Marketing for DSI, said, "By the end of the meeting, it was pretty clear that everyone thought it was a huge success, and discussions had already started on when and where to hold the next meeting of the Indian Gleeble Users Group."



DSI's new compression tungsten anvils are a direct replacement for the standard flow stress anvils.

Planning a Visit to DSI? Plan Ahead!

If you are planning a visit to DSI and you will be coming from outside North America, be sure to plan ahead. Visitors to the US from abroad who need travel visas must apply at least eight weeks before visiting the USA.

All applications for travel visas are sent to Washington for review before final approval is granted. This significantly delays the process. In countries such as China or India, where a personal interview is required, you should apply at least 12 weeks before the planned travel date.

We are delighted to have visitors at DSI, but make sure you allow enough time for your request for a travel visa to be processed.

High Temperature Flow Stress Compression Studies? Get Tungsten Anvils!

DSI's standard flow stress compression anvils (DSI part #9219-062) are tungsten carbide with a binder used to reduce the chance of cracking at elevated temperatures. Typically, these standard anvils can be used up to 1,250°C for short periods of time. But at elevated temperatures, the binder can soften significantly, and the anvils can deform after extended use at high temperatures and high loads.

If you want to conduct flow stress compression studies above 1,250°C, order DSI's new pure tungsten anvils (DSI part #9219-066). These anvils are a direct replacement for the standard flow stress compression anvils and are rated to 2,300°C. For more information about these new anvils, contact us here at DSI.

First Gleeble System Installed in Hungary

For the first time ever, a Gleeble system has been installed in Hungary.

A new Gleeble 3800 with both a Pocket Jaw Mobile Conversion Unit and a Hydrawedge Mobile Conversion Unit has been installed at the College of Dunaújváros (Dunaújvárosi Főiskola) in Dunaújváros, Hungary. The machine belongs to a special science center (DuRATT *Dunaújvárosi Regionális Anyagtudományi Tudásközpont*) that was organized out of the mechanical engineering and material science departments. Dr. Verő Balázs is the Science Director, Dr. Zsámbók Dénes is the DuRATT Manager, and Valenta László is the Deputy Manager. The system features 20-ton maximum compression force, 10-ton maximum tension force, 2 meter/sec maximum stroke rate and a high speed hydraulic servo valve system. The system was installed in January 2008.

Dunaferr Steel Works is the primary sponsor of work being done on the Gleeble at Dunaújváros, and a majority of the research focuses on plate rolling to optimize operations at the Dunaferr steel mill. Péter Illés is the leader of the technology management at Dunaferr. Dr. Zsolt Csepeli and Dr. Jenei István are two professors at the college who are working closely with Dunaferr to simulate continuous casting and hot rolling. Dr. István is the leader of the Gleeble laboratory and Dr. Csepeli is a member of innovation management at Dunaferr. Tibor "Figura" Dobján is the Lead Gleeble Operator.

For hot rolling physical simulation they are using a Hydrawedge II system, which allows for separate control of strain and strain rate and is optimized for performing rapid multiple deformation hits. They are using the standard Gleeble plane strain anvils for physical simulation of hot plate rolling. With this Gleeble configuration, complex heating and cooling cycles can be dynamically controlled during the multiple hit deformation schedule for accurate physical simulation of the plate rolling process.

The College of Dunaújváros, Hungary.

The Gleeble at the University of Alabama

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mation as it relates to the heat treatment of ductile iron.

"The research is supported by a consortium of companies, and the goal is to look at the effects of trace elements on the ferrite-pearlite ratio in ductile iron," Dr. Viswanathan says.

The key issue is that one of the raw materials for making ductile iron is steel. Currently a lot of the steel is micro-alloyed. It contains trace elements such as niobium, vanadium, and boron.

Dr. Viswanathan says, "When this steel is used as the feedstock for the ductile iron, the trace elements get into the iron, and the iron was never designed to have these elements. Our work will look at the effects of the trace elements on the final microstructure, the phase transformations, and the dimension."

"The bottom line is that changes in the feedstock are forcing the industry to deal with the effects of the trace elements. We're going to characterize those effects so that the industry can deal with them more successfully," he adds.

The work on the ductile iron project is still in the preliminary stages. Dr. Viswanathan and his colleagues are working out the CCT curves for unalloyed ductile iron with the intent of using that as a baseline for the rest of the research.

In another project, they are using the Gleeble to measure the mechanical properties in the mushy zone of magnesium alloys. This research is funded by the Department of Energy through the US Automotive Materials Partnership.

Dr. Viswanathan says, "When you make a casting, you melt the alloy and pour it into a mold. First it is liquid, then partly liquid and partly solid—the mushy zone—and the material can crack while it is in the mushy condition."

He adds, "Casting process design engineers who are working with magnesium alloys need to know the properties of the materials in the mushy zone, and right now there is no data on it. If we can understand the mechanical properties in the mushy zone, then we can design casting processes and molds so the magnesium alloys don't crack when they are being cast."

One of the advantages of the Gleeble for Dr. Viswanathan is that he can use smaller samples because an external furnace is not required. With the Gleeble, he can heat the sample while precisely controlling the temperature at around 500°C and then apply a tensile test, all within a controlled atmosphere of CO_2 and SF_6.

"The Gleeble is a very versatile system that can simulate a number of materials processes, and our students get a lot of experience with it," he says. "It definitely fits the mission of our department to educate students and do world class research."