Dynamic Systems Inc.
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The Gleeble® NEWSLETTER

Spring 1996

Registration for ISPS Now Open

Anyone who wishes to attend ISPS may now register.

Registration Fees

Standard registration includes lunch and coffee breaks each day, one copy of the abstracts, and one copy of the published proceedings.

- Standard Registration (includes one copy of the published proceedings) US$300
- Student Registration US$50
- Banquet Tickets (not included in the registration fee) US$40

Proceedings

Additional copies of the proceedings can be purchased for US$60 if ordered before end of conference, US$100 if ordered after the conference.

Accommodations

The conference hotel is the Ramada University Hotel and Conference Center, 3110 Olentangy River Road, Columbus, Ohio 43202. The Ramada's telephone number is (614) 267-7461 or (800) 228-2828. Fax number is (614) 263-5299. ISPS attendees are responsible for securing their own accommodations. A block of rooms has been reserved for the conference attendees at a discounted rate of US$65.00 per night, plus applicable taxes. Reservations must be received by the hotel three weeks prior to your arrival date. Please mention Dynamic Systems and the conference name (ISPS '96) when making your reservations.

Airline Reservations

USAir and Delta Airlines, in cooperation with Dynamic Systems Inc., are offering special discount fares for attendees traveling to ISPS.

The special offer for conference attendees allows for a 10% discount off regular coach fare. Travel to and from Columbus, Ohio, must be between June 1 and 8, 1996. Reservations must be made and tickets issued at least 7 days prior to departure. These special fares are available only through the number listed below.

Reservations for any other USAir or Delta published fare can be made with a 5% discount savings (all fare tariff rules apply as published). These discounts only apply to attendees from the continental USA and Canada. For reservations and information call (800) 666-2929 or (518) 783-8861 from anywhere in the USA and Canada, 5 days a week from 8:00 a.m. to 5:00 p.m. Eastern Time. Please identify yourself as an ISPS '96 attendee.

ISPS '96

For a complete ISPS registration kit, contact:

ISPS Director
c/o Dynamic Systems Inc.
PO Box 1234
Poestenkill, NY 12140 USA
Phone: (518) 283-5350
Fax: (518) 283-3160
E-mail: ISPS@Gleeble.com

More information is also available at the DSI Internet web site:

www.Gleeble.com/gleeble

Sixty Papers to be Presented at First United States ISPS

The first International Symposium on Physical Simulation (ISPS) to be held in the United States has drawn 60 papers from researchers around the world.

The symposium—scheduled for Columbus, Ohio, June 3–5, 1996—is jointly sponsored by Dynamic Systems Inc., Edison Welding Institute, ASM International, and the Forging Industry Education and Research Foundation. As the sixth ISPS, the Columbus meeting will provide a forum for the exchange of information on physical simulation, including:

- 18 papers on hot working processes,
- 18 papers on welding,
- 6 papers on casting,
- 8 papers on heat treatment, and
- 10 papers on computer simulation as it relates to physical simulation.

The complete conference listing is published on pages 3 and 4 of this newsletter.

The ISPS is held every two years and allows metallurgists and materials research scientists, product and process development engineers, and managers an opportunity to meet to discuss and observe the latest physical simulation techniques and results. Past symposia have been held in the Pacific Rim, Europe, and Canada.

Gleeble Newsletter

The Gleeble Newsletter is intended to be a forum for Gleeble users worldwide to exchange ideas and information. We welcome your comments and suggestions. Letters, comments, and articles for the newsletter may be addressed to David Ferguson at Dynamic Systems Inc., faxed to us at (518) 283-3160, or e-mailed via the Internet: info@gleeble.com.

Recent Gleeble Papers

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HAZ Hot Cracking Behavior of HD 556 and INCONEL 617

by C.D. Lundin, C.Y.P. Qiao, and R.W. Swindeman

The weldability of HD 556 and Inconel 617 alloys was evaluated using the Gleeble Hot Ductility Test and the Varestraint Hot Cracking Test. The results from the metallographic examination indicate that the rare earth element La has a beneficial influence on HAZ liquation cracking resistance and Ti rich carbides or Ti rich carbonitrides enhance the HAZ liquation cracking propensity. A qualitative characterization of the particles in the HAZs was performed. The HAZ liquation cracking tendencies for both materials are addressed from the hot cracking theory standpoint. The correlative criteria are technologically based and are directly related to hot cracking and solidification theory.

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Copper-Precipitation Strengthened HSLA Steels: Designing for Base Plate and HAZ Toughness

by M.R. Krishnadev, W.L. Zhang, and J.T. Bowker

The study deals with the development of an understanding of the relation between the microstructure and toughness of the HAZ and that of the base plate in copper strengthened HSLA steels containing varying levels of manganese (0.5 to 1.3 percent) and nickel (1 to 2.5 percent). To isolate the effect of a copper, a copper free composition has also been used. A Gleeble thermal/mechanical simulator has been used to simulate the coarse grained HAZ region and to determine its transformation kinetics. SEM and TEM have been used to characterize the fracture behavior and microstucture respectively. Instrumented Charpy testing has been used to evaluate crack initiation and propagation behavior. Toughness variations have been related to the variations in the nature of transformation microstructures. Based on the results, guidelines for designing Cu-HSLA steels for achieving good toughness in both the base plate and the HAZ are outlined.

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Progress in Material Properties and Weldability of Modern HSLA Steels

by M. Mayrhofer, H. Schültz, R. Rauch, H. Cerjak, and H. Kammerstetter

A short historical review shows the essential motives which led to the development of thermomechanically processed (TM) high strength low alloy (HSLA) steels. The "state of the art" of TM-steel production has been summarized. The weldability of TM-steels with yield-strengths ranging from 355 MPa up to 690 MPa has been quantified by the investigation of real welded joints and welding simulation technique. In this paper the results of the roughness testing task have been reported. Toughness has been characterized by ISO-V testing. The reported results allow the direct comparison of welding simulation technique with real welded joints. The toughness behaviour of simulated heat affected zone (HAZ) microstructure of TM-steels has been compared to that of equivalent grades of normalized (N) or quenched and tempered (QT) type of steels. The introduction of new technologies mostly presupposes the availability of materials with new specific properties. The reason why steel is of paramount importance in industrial development no doubt lies in the fact that, unlike other materials, it may exhibit a variety of characteristics adjusted to the intended use, and that it is possible, again and again, to find new potentials for further and new developments. The essential motives of development can be summarized as follows: (a) Safety, with special emphasis on behaviour under complex processing stresses and on the structural component; (b) Economic efficiency, including the utilization of high strength, the simple processing in forming and welding; (c) Competitiveness, as compared to alternative materials.

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Augmented Sintering of Steel Powder

by Q. Qiong, J. Allen, G.R. Rogers, and D.W. Walsh

The effects of a thermally cycled sintering process (vis-a-vis an isothermal sintering process) were examined in a low carbon steel powder. Several thermal processes were used, among them (1) an isothermal process similar to traditional methods, (2) a thermally cycled process imposing periodic free cooling from the traditional sintering temperature to a minimum temperature below the lower critical temperature, (3) a low temperature cycled process with a maximum temperature slightly in excess of the upper critical temperature, (4) a thermally cycled process imposing periodic free cooling from the traditional sintering temperature to a minimum temperature slightly in excess of the upper critical temperature, and (5) an isothermal sintering process with a peak temperature slightly in excess of the upper critical temperature. The duration for all tests was one-half hour. Sintering was done under argon in the Gleeble HAZ 1000—a computer-controlled, thermomechanical testing device in which heat is supplied to the specimen by electric resistance heating. The extent of sintering was measured using a quantitative image analysis system. Several parameters were measured and recorded; these included pore area fraction, pore area, maximum linear pore dimension, pore roughness and pore roundness. Thermal cycling appears to accelerate the sintering process, the changing thermal gradient drives diffusion, grain growth, nucleation, recrystallization, and many other processes. Of particular interest is the cyclic grain refinement caused by repeated nucleations during the equilibrium phase transformations.

Conference Sessions

WELDING I

Accessing Material Weldability: Review of Recent Progress
Dr. J.C. Lippold, Ohio State University, USA

Weldability Study of a Thermomechanically Controlled Processed Steel of Grade 50 kg/mm^2 Under Higher Heat Input
Jong-Ning Aoh, Cheng-Der Lin, National Chung Cheng University, Taiwan, ROC
Fei-Hu Kuo, Chung-Shan Institute of Science & Technology, Taiwan, ROC

Optimization of Solid-State Weld Microstructure and Properties Through Simulation Studies
S.L. West, M.J. Morgan, K.J. Imrich, Westinghouse Savannah River Company, USA

A Study of Gleeble Hot Ductility Test Procedure
Wangen Lin, Edison Welding Institute, USA

The Influence of Heat Input on the Microstructure and Heat-Affected Zone Behaviour of W-Containing Modern 9-10% Cr-Steels
H. Cerjak, E. Letofsky, Graz University of Technology, Austria

WELDING II

The Effect of M-A Constituent on Notch Toughness of Heat Affected Zone of the Vessel Steel DG50
Ao Lie-ge, Institute of Iron & Steel Research Ansan, China

Influence of Constraining on the Toughness Behaviour of Multi-Layer Weldments
S. Kleber, J. Reiss, B. Buchmayr, H. Cerjak, Graz University of Technology, Austria

Susceptibility of Ferritic Low-Alloy Steel Weld Metal to Stress-Relief Embrittlement
S.T. Mandziej, Advanced Materials Analysis, The Netherlands
W.C. Chen, Dynamic Systems Inc., USA

Ductility-Dip Cracking of Inconel Filler Metal 52
M.J. Cola, Westinghouse Electric Corporation, USA

Test Method to Evaluate Braze Joints
R.E. Sundell, H.A. Nied, GE Corporate Research & Development, USA

Heat-Affected Zone Liquation Cracking Susceptibility of Al-Zn-Mg Alloys
T. Ma, G. den Ouden, Delft University of Technology, The Netherlands

Physical Simulation of Melting and Metal Transfer Processes in Adaptive Pulsed Arc Welding in Carbon Dioxide
Saraev Yu.N., Shpigunova O.I., Russian Academy of Sciences, Russia

WELDING III

Microstructure of Ni_3Al and Interfaces Between Ni_3Al and Metal Ti or Ni-Based Superalloy During SHS In-Situ Welding
Guo Shi-ju, Dang Zi-jiou, Lai Ho-yi, University of Science and Technology, China

A Research of Diffusion Welding of Titanium Alloys
Niu Jitai, Zhang Jei, Zhao Yan, Zai Jinfan, Harbin Institute of Technology, China

Effect of the M-A Constituent on the HAZ Toughness of the TMCP+AcC Steels at High Energy Welding
Zuze Xu, Yuqin Guo, Central Iron & Steel Research Institute, China
L. Pentti Karjalainen, University of Oulu, Finland
D. Porter, Research Center of Rautaruukki Oy, Finland

Reheating Cracking in HSLA Steels
Qian Bainian, Li Jinli, Yu Dehua, Chinese Academy of Sciences, China

Relationship Between Bonded Joining Quality and Diffusion Bonding Process for Structural Joining
H. Guo, E. Steinhauer, Prof. J.-J. Chene, Ecole Polytechnique Federale de Lausanne, Switzerland

HEAT TREATMENT

Rapid Heat Treatment of Titanium Alloys
S.L. Semiatin, I.M. Sukonnik, Wright-Patterson AFB, USA

Physical Simulation of Quench Cracking for P/M Superalloy Turbine Disks
Keh-Minn Chang, West Virginia University, USA

Thermomechanical Simulation for Small Scale Specimens
D.E. Clark, E.W. Reutzel, Idaho National Engineering Laboratory, USA

Effects of Thermal Cycling on the Microstructure and Properties of SiCw/Al Composite
P. Zhang, Harbin Welding Company, China
J. Zhang, Q.C. Meng, L. Geng, H.T. Tian, Harbin Institute of Technology, China

Simulation of Various Heat Treatments During the Production of Deep-Drawing Steels
S. Claessens, J. Dilewijns, University of Gent, Belgium
D. Vanderschueren, OCAS N.V.-Research Centre, Belgium

Simulation of Heat Treatment Process Car Stabilizers
L. Kosec, S. Javoric, M. Dretnik, University of Ljubljana, Slovenia

A New Criterion for Thermal Fatigue Damage
Yang Ruifang, Li Shuqi, Xiao Pinghui, Ding Guoqing, Central Iron & Steel Research Institute, China

HOT WORKING I

Stress Relaxation, A Novel Technique for Measuring the Softening Kinetics on Hot Deformed Austenite
L.P. Karjalainen, J. Perttula, University of Oulu, Finland
J. Niu, Harbin Institute of Technology, China

The Hot Deformation Behaviour at Various Strain Rates and Modelling of Flow Stress Considering Residual Strain Containing Ti Steel
Yourong Xu, Dahua Hou, Deying Wang, W-ping Xu, Shanghai University (Jiading Campus), China

Stress Relaxation Behavior of Different Microalloyed Steels
J. Asensio-Lozano, University of Oviedo, Spain

An Investigation on Physical Simulation of Hot Continuous Rolling and Multi-pass Hot Rolling of Sheet and Plate Steels
Yourong Xu, Deying Wang, W-ping Xu, Yong Qin, Shanghai University, China

Flow Curve Measurement to Simulate Hot Rolling of HSLA Steels
S. Kleber, K. Kerschbaumer, B. Buchmayer, Graz University of Technology, Austria

HOT WORKING II

Torsion Simulation of the Hot Strip Rolling Process
J. Worobec, D. Hall, Dofasco, Inc., Canada

A Method to Determine the Stored Energy During Deformation of Nb-Bearing Steels by Torsion Test
X.D. Liu, L.P. Karjalainen, J. Perttula, University of Oulu, Finland

Hot Compression Behavior of Ti-25Al-10Nb-3V-1Mo Alloys After Hydrogenation Treatment
Zhang Yong, Zhang Shaoqing, Institute of Aeronautical Materials, China

Experimental Examination of Anisotropy for Ti-6Al-4V Thick Plate by Gleeble 1500
Bai Bingzhe, Beijing Research Institute of Mechanical & Electrical Technology, China

Mechanical Testing of SiC Fibers in Torsion
R. Scholz, Joint Research Center of European Community, Italy
H. Pasic, Ohio University, USA

Modelling of Rolling Processes by Torsion Plastometer with Prediction of Hardening and Softening Processes
I. Schindler, J. Kliber, Technical University of Ostrava, Czech Republic
J. Boruta, Vitkovice Steel Works, Czech Republic

Determining Strain and Strain Rate of the Torsion Test at Simulation of the Metal Forming Processes
J. Kliber, I. Schindler, Technical University of Ostrava, Czech Republic

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HOT WORKING III

Microstructural Evolution During Isothermal Deformation of a Ti-Alloy
Bai Bingzhe, Beijing Research Institute, China

Laboratory Testing of Wear
R. Turk, V. Nardin, M. Trcelj, T. Rodic, University of Ljubljana, Slovenia

Determination of the Warm Forging Behavior of Ferrite-Cementite and Austenite Microstructures in 8620 Steel
M.R. Blankenau, D.K. Matlock, C.J. VanTyne, Colorado School of Mines, USA

Deformation Resistance of Titanium Under Condition of Hot Plate Rolling
Z. Ladislav, Research and Testing Institute, Nova Hut, Czech Republic

The Effect of Hot-Working Conditions on the Austenite Decomposition in SAE 4120 Steel
E.B. Damm, Dynamic Systems Inc., USA
C.J. VanTyne, S.W. Thompson, D.K. Matlock, Colorado School of Mines, USA

COMPUTER SIMULATION I

A Computational Simulation of the Transverse Varestraint Test
Zhili Feng, Wangen Lin, Edison Welding Institute, USA

Simulation of Tensile Tests in the Regime of Dynamic Strain Aging
K.J. Draheim, J. Schlipf (deceased 8/95), Institut fur Metallkunde und Metallphysik, Germany

Simulation of Grain Boundary Motion During High Temperature Cyclic Deformation
K.J. Draheim, G. Gottstein, Institut fur Metallkunde und Metallphysik, Germany

Simulation of Microstructure Evolution During Directional Solidification of Al-Cu-Si Alloys
X. Wang, J. Illerich, A. Ludwig, M. Fackelday, T. Kraft, P.R. Sahm, Foundry-Institute, Germany

Simulation of Recrystallization and Recovery During Annealing of Cold Rolled BCC and FCC Metals Using a 3D-Cellular Automation
V. Marx, D. Raabe, G. Gottstein, Institut fur Metallkunde und Metallphysik, Germany

COMPUTER SIMULATION II

Use of Physical Simulation Data to Predict Metal Flow and Product Properties in Forging
V. Vazquez, B. Painter, T. Altan, The Ohio State University, USA

Analyzing the Meshomechanic Effects on Ultimate Tensile Stress of Nodular Cast Iron with Finite Element Methods
Leilei Zhang, Jiangbo Han, Lemmy Meekisho, Oregon Graduate Institute of Science and Technology, USA

Modelling of the Influence of Additional Types of Slip Systems on the Texture Evolution at Elevated Temperatures
D. Raabe, Institute fur Metallkunde und Metallphysik, Germany

Physical Modelling of Dislocation Dynamics at Elevated Temperatures
D. Raabe, Institute fur Metallkunde und Metallphysik, Germany

Constitutive Modelling and Analysis of Hot Flat Rolling
Dr. Eng. T.A. El-Bitar, Central Metallurgical R&D Institute, Egypt

CASTING

Physical Simulation of Continuous Casting and Direct Hot Rolling of Steels
H.G. Suzuki, National Research Institute for Metals, Japan

The Hot Tensile Test as a Means of Assessing the Susceptibility of Steel to Cracking During Continuous Casting
B. Mintz, R. Abu-Shosha, S. Ayyod, O.G. Comineli, City University, England

Determination of Mechanical Properties of Partially Molten Microstructures Associated with the Casting Process: Development of a Physical Technique and its Numerical Simulation
J.A. Spittle, S.G.R. Brown, J.D. James, R.W. Evans, University of Wales Swansea, United Kingdom

Physical Modeling of the Refining Hearth in the Plasma Arc Melting Process
X. Huang, J.S. Chou, D.J. Tilly, K.O. Yu, V. Suri, Concurrent Technologies Corporation, USA

Analysis of Flow Nature in a Cast Pouring System of an Automotive Part
J.E. Araujo-Osorio, J.F. Chavez-Alcala, B.U. Sanchez, Instituto Politecnico Nacional, Mexico
J. Zuniga-Solis, Autometales, S.A., Mexico

High Temperature Compressive Testing and Characterization of Hot Ductility Behaviour of Directionally Solidified Superalloys
H. Guo, E. Steinhauer, Prof. J.-J. Chene, Swiss Federal Institute of Technology, Switzerland