

TUESDAY, AUGUST 24, 2004, A.M.

SESSION 19: INTERNATIONAL SYMPOSIUM ON MATERIALS FOR FUEL EFFICIENT AUTOMOBILES

MECHANICAL BEHAVIOUR

Sponsor: Iron and Steel, The Metallurgical Society of CIM

Room: ALBION C

Chairmen: D. WILKINSON, T. PETRIC and M. JAIN, McMaster University, Hamilton, Ontario, Canada

PAPER 19.1 — 8:30 (KEYNOTE)

TRANSIENT EFFECTS IN DEFORMATION OF METAL SHEET. (KEYNOTE SPEAKER)

A. BEAUDOIN, Dept. of Mechanical and Industrial Engineering, University of Illinois at Urbana-Champaign, Urbana, Illinois, U.S.A.

Increasing demands for the performance of metal sheet in automotive applications fosters need for improved predictive capability in design of stamping operations. Central to success in simulation of sheet forming processes are the constitutive relations adopted in (production) finite element codes. This talk will focus on transient plasticity developed in loading and unloading. Implications for springback, stress relaxation and plastic localization will be noted. Insight into critical aspects of constitutive relations, needed to reflect such transient plasticity, will be identified through application of detailed multiscale models. The extension of results from such multiscale simulations to the modification of existing constitutive models -- appropriate for engineering design -- will be demonstrated.

PAPER 19.2 — 9:00

INVESTIGATION OF MECHANICAL BEHAVIOUR OF STRIP CAST AA5754 ALUMINUM.

Y. LIU, J. KANG, M. JAIN and D.S. WILKINSON, McMaster University, Hamilton, Ontario, Canada

Control of the impurity level, especially iron content in AA5754 aluminum alloy is critical to optimizing the mechanical properties of the alloy. This has generated considerable interest in understanding the fundamentals of materials behavior and how this affects materials recycling and energy conservation. In the current investigation, an O-temper continuous cast (CC) AA5754 aluminum alloy of different iron contents was cold rolled to different reductions. Various measurements including hardness test, tensile tests and cantilever bending were performed to determine mechanical properties. Microstructural and texture distributions were also collected. Reduction of area in tension (RA) has been measured for a range of pre-strain. Results indicated that iron content has a significant detrimental effect on fracture and therefore on the bendability of these materials.

PAPER 19.3 — 9:25

CREEP AND MICROSTRUCTURE OF HYBRID REINFORCED MAGNESIUM ALLOY AE42.

H. DIERINGA, I.M. PEREIRA, N. HORT, A. BOWLES and K.U. KAINER, GKSS Research Center, Geesthacht, Germany

Magnesium alloys are gaining increasing interest especially in automotive applications due to the alloys low density. Weight saving plays an important role when green house gases should be reduced. One obstacle is the poor creep resistance of magnesium alloys at elevated temperatures. Alloy development as well as development of magnesium based metal matrix composites are possible solutions. In this paper, hybrid reinforced composites based on magnesium alloy AE42 produced by squeeze casting are investigated. Compression creep properties at different loads and temperatures are investigated as well as microstructural changes during creep by optical microscopy and SEM.

PAPER 19.4 — 9:50

SHEAR BANDING IN STRIP CAST AUTOMOTIVE ALUMINUM AA5754 SHEETS.

J. KANG, M. JAIN, D.S. WILKINSON and J.D. EMBURY, McMaster University, Hamilton, Ontario, Canada

In-situ field emission SEM observation on uniaxial tensile samples reveals that in-grain slip lines develop into sample scale macroscopic shear bands by local shear between grains. The results also indicate that grain orientation distribution or texture is important in the development of shear bands. Several other factors influencing the shear banding will be discussed. Full field strain measurement by digital speckle correlation method has been applied to standard tensile samples and double-edge-notch samples. The results show that dynamic strain aging is harmful to the ductility of AA5754 at room temperature. Based on the above conclusions, a model for tensile instability of strip cast AA5754 will be proposed.

COFFEE BREAK — 10:15 – 10:30

PAPER 19.5 — 10:30

THE EFFECTS OF ALUMINUM ADDITION ON MICROSTRUCTURE AND TENSILE PROPERTIES OF HIGH STRENGTH LOW ALLOY TRIP-AIDED FERROUS STEELS WITH ANNEALED MARTENSITE MATRIX.

K-I. SUGIMOTO, B. YU, A. NAGASAKA, Shinshu University, Nganano, Japan,
S-I. HASHIMOTO, CBMM Asia Co., Ltd., Minato-ku, Tokyo, Japan, and
T. KASHIMA, Kobe Steel, Ltd., Kakogawa, Hyogo Prefecture, Japan

The effects of aluminum content on microstructure and tensile properties of high strength low alloy TRIP-aided ferrous steel with annealed martensite matrix were investigated to realize in-line galvanization. When chemical composition of the steel was based on 0.2C-1.5Si-1.5Mn-0.04Al (mass%), aluminum addition of 0.5-1.0 mass% and silicon removal of 1.0-0.5 mass% brought on excellent ductility due to highly stabilized retained austenite. Also, the aluminum addition rose optimum austempering temperature up to 450°C. It was expected that these findings realize in-line galvanization after continuous intercritical annealing.

PAPER 19.6 — 10:55

ON THE STRENGTHENING BEHAVIOUR OF TRIP-AIDED MICROALLOYED LOW CARBON FERRITE-BAINITE STEEL.

N.R. BANDYOPADHYAY, K.P. DAS and S. DATTA, B.E. College, Howrah, West Bengal, India

Transformation-Induced-Plasticity (TRIP) behavior of microalloyed low carbon (0.06-0.07 wt%) Si-Mn ferrite-bainite steels have been studied. Optimization of process parameter has been attempted to maximize TRIP effect and achieving high strength to weight ratio with higher fabricability. Study revealed that the primary condition of inducing TRIP is not only the volume fraction of austenite but also the distribution of second phase constituents and the retained austenite within it. The steels also exhibit strain-induced transformation of γ to α in spite of relatively low volume fraction, which is observed under TEM with straining insitu. TRIP amenable stable austenite is also seen to be formed by manganese partitioning through competitive process.

PAPER 19.7 — 11:20

THE HIGH SPEED DEFORMATION BEHAVIOUR OF DP600 SHEET STEEL.

J. QU and S. YUE, McGill University, Montréal, Québec, Canada

By means of dynamic Hopkinson bar with shear punch version, the high-speed deformation behaviour of DP600 sheet steel was studied with an emphasis on the influence of microstructure. Dual phase microstructure with different fractions of martensite, acicular ferrite, and bainitic microstructure were obtained by changing heat-treating parameters during intercritical annealing, accelerated cooling, and over-aging. For all the heat-treated specimens, quasi-static shear punch properties were also measured by MTS hydraulic machine and compared with dynamic results. Additionally, standard tensile tests for some specimens were conducted for verification.

PAPER 19.8 — 11:45

CONTROL OPTIMIZATION OF SHEAR PUNCH TEST FOR MECHANICAL PROPERTIES: EFFECT OF THICKNESS AND PUNCH DIAMETER.

A. ELWAZRI, R. VARANO and S. YUE, McGill University, Montréal, Québec, Canada

A good method of directly measuring mechanical properties of a material deformed in compression or torsion is through the shear punch test. Unlike tensile testing the shear punch test is not limited by specimen size or shape. However, it is unclear whether an appropriate test thickness and punch diameter is required in order to attain realistic tensile properties. Thus, the focus of this work is to determine the effect of thickness and punch diameter on the mechanical properties of the punch specimens in relation to tensile data. The aim of this work is to determine a standard thickness and punch diameter for shear punch.