MONDAY, AUGUST 25, 2003, P.M.

SESSION 8: LIGHT METALS 2003
MÉTAUX LÉGERS

REDUCTION TECHNOLOGIES

Sponsor: Light Metals Section, The Metallurgical Society of CIM
Room: Port McNeill
Chairmen: G. DUFOUR, Alcoa, Canada,
A. BOLDUC, Alcan Inc., Montréal, Québec, Canada

PAPER 8.1 — 14:00
DEMONSTRATION THERMO-ELECTRIC AND MHD MATHEMATICAL MODELS OF A 500 KA L ELECTROLYSIS CELL.
M. DUPUIS, V. BOJAREVICS, School of Computing and Mathematics, University of Greenwich, London, United Kingdom, and
J. FREIBERGS, Institute of Physics, University of Latvia, Salaspils, Latvia

In the present study, a 3D full cell quarter thermo-electric model of a 500 kA demonstration cell has been developed and solved. In parallel, a non-linear wave MHD model of the same 500 kA demonstration cell has been developed and solved. A preliminary study of the impact of the interactions between the cell thermo-electric and MHD models will be presented.

PAPER 8.2 — 14:25
FLUORIDES EMISSIONS MANAGEMENT IN AN ALUMINUM SMELTER.
C. GAUTHIER and A. MORAS, Alcoa Aluminerie d'Deschambault, Deschambault, Québec, Canada

From year to year, environment is increasingly present in plant operation. Long-term strategic development requires always to get the state-of-the-art operation but also the best available environmental technology and the best environmental practices. For an aluminum smelter like Alcoa Deschambault, the major environmental topic is for sure fluorides emissions from pot rooms. While Deschambault had already very good technology (dry scrubbers, effectives ventilation at 2.0 Nm3/s pot, good tightness from hoods, etc., new improvements were looked at when a load increase project was identified. This was especially important since it was also planned to expand the plant eventually.

- The goal — more production but less fluorides emissions.
- The solutions — increased captation, specific pot captation, operation review, anode tray lids, bath bin lids and improved follow-up.
- The results — roof vent fluoride emissions six months average reduced by close to 50%.
- The benefits — better environment protection but, more important, new benchmark for the future.

PAPER 8.3 — 14:50
MODELLING THE GAS COLLECTION SYSTEM OF VERTICAL STUD SODERBERG CELLS.
E. DERNEDDE, Consultant, Kroll International, Brossard, Québec, Canada

Vertical stud Soderberg (VSS) cells are equipped with gas skirts, which collect most of the fluorides and hydrocarbons generated under the crust. However, with more stringent environmental regulations under restrained economic conditions, efforts are made to improve the gas collection efficiency of these cells. Experience and plant trials usually guide the design of gas collection systems of vertical stud Soderberg cells. In order to enhance such design work, a model of the gas collection system from the gas skirt to the header duct was developed. Calculated gas collection efficiencies compared favourably with published data from a VSS cell with a single burner. The effect of operations on the gas collection efficiency was also demonstrated.

COFFEE BREAK — 15:15 – 15:40

PAPER 8.4 — 15:40
CALCULATING TEMPERATURES UNDER HOOD OF A PREBAKE ANODE CELL
M. DUPUIS, GéniSim Inc., Jonquière, Québec, Canada
W. HAUPIN *Lower Burrell, PA, USA*

In computer modeling of a prebaked anode Hall Héroult cell, one needs to know the temperature of the mixture of air and cell gas (Tairin) that cools the top of the cell crust and the anode rods under the cell hoods. This temperature can be measured, of course, if a similar operating cell is available, but not if the model is of a distinctly new design. However, it is also possible to estimate the temperature. This is the aim of the present work.

First we must calculate the air drawn in under the hoods at potroom temperature, and combine it with the CO_2 and CO escaping at electrolyte temperature to produce a gas blend at temperature, Tblend. The CO of the mixture burns, generates heat, forms more CO_2, and consumes O_2 from the air drawn in. Also, heat is generated by air burning of the anode forming additional CO_2 and consuming O_2. The heats of combustion of CO and air burning of anode carbon plus the heat from the cover and anode stubs raise the temperature of the mixture of gases to temperature, Tmix.

This gas mixture then extracts heat from the anode rods and rises to the exhaust temperature, Texh. In order to compute Tblend, Tmix and Texh, the heat capacities of the gas mixtures is needed. Finally, Tairin is calculated as the log mean of Tmix and Texh, just as the log mean of inlet and outlet temperatures are used to calculate heat transfer in heat exchangers.

PAPER 8.5 — 16:05
MASS TRANSFER OF IMPURITY ELEMENTS TO THE CATHODE DURING ALUMINUM ELECTROLYSIS.
G.M. HAARBERG, E. THISTED, Department of Materials Technology,
Norwegian University of Science and Technology, Trondheim, Norway, and
S. ROLSETH, Department of Materials Technology, SINTEF, Trondheim, Norway

The presence of dissolved impurity species in the electrolyte may influence key parameters such as current efficiency and metal quality during electrowinning of aluminum. The mass transfer of several impurity elements (Mn, Ti, Fe, P) from electrolyte to cathode was studied. Impurities were added to the cells, mainly as oxides. Analyses of samples taken from the electrolyte and cathode metal were made to study the mass transfer of impurities to the cathode. Mass transfer coefficients for metallic impurities were found to be of the order of 10-6 m/s.

PAPER 8.6 — 16:30
THE POSSIBILITIES OF ELECTROWINNING AL FROM AL^2S^3.
S.C. LANS, J. BOHTE, Resources Engineering, Delft University of Technology, Delft, The Netherlands,
D. VAN DER PLAS, Research and Development Technology – Process Kinetics Reactor Design, CORUS, Ljmuiden, The Netherlands,
A. VAN SANDWIJK and M.A. REUTER, Resources Engineering, Delft University of Technology, Delft, The Netherlands

The objective of this research is to investigate the possibilities for an alternative process for the production of primary aluminum via a sulphide intermediate. By the proposed route, it is expected that the electrical energy consumption can be reduced by almost 60%. The results of an experimental investigation into the possibilities of Al_2S_3 electrolysis in a molten chloride electrolyte will be discussed.

PAPER 8.7 — 16:55
INTENSIVE SIDEWALL COOLING IN HALL HEROULT CELLS.
P.W. BAKER, J. SARVINIS, R. HAYWOOD and A. MONAGHAN, Light Metals, Hatch Associates, Brisbane, Queensland, Australia

One major process difficulty facing the operators of Hall-Heroult reduction cells for primary aluminum production has been maintaining ledge stability throughout the life of the cell. Operational measures taken to manage sidewall overheating typically involve local cooling of the problem regions using a forced air manifold, or a reduction in the cell production rate. In this paper, the application of patented Hatch furnace cooler technology, originally developed in the non-ferrous smelting industry, has been investigated as a potentially promising means of enhancing and controlling sidewall cooling to provide superior process control, increased throughput, and robust containment for the Hall-Heroult cell in primary aluminum production.

TUESDAY, AUGUST 26, 2003, A.M.

SESSION 19: LIGHT METALS 2003
MÉTAUX LÉGERS

REDUCTION TECHNOLOGIES (CONTINUED)

Sponsor: Light Metals Section, The Metallurgical Society of CIM
Room: Port McNeill
Chairmen: G. DUFOUR, Alcoa, Canada,
A. BOLDUC, Alcan Inc., Montréal, Québec, Canada

PAPER 19.1 — 8:30
REDUCTION IN AE-MINUTES AND GHGS AT THE ALCOA BAIE-COMEAU SMELTER
A.TABEREAUX, Alcoa Inc, Alcoa, TN, USA, alton.tabereaux@alcoa.com
C. LESSARD, M. THIBOUTOT and É. LAVOIE, Alcoa-Aluminerie de Baie-Comeau, Baie-Comeau, Québec Canada

Historically the VS Soderberg cells at the Alcoa Baie-Comeau smelter have operated with a side-break and batch alumina feed operation that resulted in a high anode effect rate. A new AE-minute reduction program developed at Baie-Comeau has been implemented in the majority of the pots and subsequently has been successful in achieving a 35% reduction in AE-minutes and PFC emissions during 2002. The various steps of the anode effect reduction program are discussed and plant results are presented.

PAPER 19.2 — 9:00
THE PRODUCTION OF AL_2S_3 AS AN INTERMEDIATE FOR AN ALTERNATIVE PRIMARY ALUMINUM PROCESS.
Y. XIAO, J.J. SOONS, Resources Engineering, Delft University of Technology, Delft, The Netherlands,
D. VAN DER PLAS, Research and Development Technology – Process Kinetics Reactor Design, CORUS, Ljmuiden, The Netherlands,
A. VAN SANDWIJK and M.A. REUTER, Resources Engineering, Delft University of Technology, Delft, The Netherlands

The objective of this research is to investigate the possibilities for an alternative process for the production of primary aluminum via a sulphide intermediate. By the proposed route, it is expected that the electrical energy consumption can be reduced by almost 60%. The results of an experimental investigation into the possibilities of the conversion of Al_2O_3 to Al_2S_3 will be discussed.

ENVIRONMENT, GREENHOUSE GAS EFFECT

Chairmen: L. SYLVAIN, Alcoa, Canada, and T. LEWIS, Alcan International, Kingston, Ontario, Canada

PAPER 19.3 — 9:30
VOLUNTARY CONTRIBUTION OF GREENHOUSE GASES BY ALCOA.
G. PROULX, Alcoa Primary Metal, Deschambault, Québec, Canada

The warming up of the planet and its impact on environment is a major concern of our modern societies. It becomes essential that everyone joins the effort to face this challenge by adopting new attitudes. In June 2002, Alcoa signed a voluntary agreement with the Quebec government to reduce GHG emissions. The agreement calls for a reduction of about 200 000 tons/year of the average emissions for 2002-2003 and 2004, compared to 2001. Although all GHGs are covered by the agreement, Alcoa's first priority is the reduction of PFCs emitted during the anode effects, given the important global warming potential of the perfluorocarbons and the firm's capabilities for improvement. Alcoa is involved in the operation of three smelters in Quebec: ABI, which is also partly owned by Pechiney, Baie-Comeau, and Deschambault. Each smelter faced a different situation in relation to PFCs emissions, having different technologies and operating philosophies. So to share the best practices and ensure Alcoa would meet its commitment with the government, the three smelters formed a group where they can exchange on: anode effect killing routine; floor operation practices; pots feeding; and prediction of anode effect.

This paper will present 2002 results, the methodology, and how best practices were developed and implemented. Alcoa's action plan will also be discussed.

COFFEE BREAK — 10:00 — 10:30

PAPER 19.4 — 11:00
RECYCLING.
O. BALLON, M. PAGET and M. LEFEBVRE, Recyclage d'Aluminum Québec Inc., Bécancour, Québec, Canada

For almost twenty years, Recyclage d'Aluminum Québec Inc. (RAQ) has operated aluminum dross processing plants in Baie-Comeau, on the north shore of the St. Laurent River, and in Bécancour, Québec. Due to constant research for technological improvement and in order to satisfy its main client, ALCOA, to reduce the elimination of residues by land filling, RAQ has built a plant capable of treating black and white dross in a closed circuit process; without air, water or soil emissions. The technology selected, developed over a period of ten years by ALSA, a German company, allows for the treatment of all dross and for the marketing of the commercial by-products. This technology has been labelled the "Best Available Technology" by the European Union.

PAPER 19.5 — 11:30
IMPACT OF ALUMINA CHANGES FOR ALCAN SIDE BROKEN PLANTS IN QUÉBEC.
A. GOSSELIN, Reduction Technology Service, Alcan International Limited, Jonquière, Québec, Canada

Actually, there are good opportunities to purchase alumina from multiple suppliers. On the other hand, alumina changes have been historically suspected to have negative impacts on the process. Many plants that have never undergone any alumina changes for years or decades must now adapt to many changes in a single year. The objective of this work was to document and to understand the different phenomena related to alumina changes in order to keep a steady level of environmental and process performance during those events. This work covers alumina changes in two HS Soderberg plants in Quebec. Alumina changes have been extensively documented as a function of the process performance indicators such as anode effect frequency and duration. Other parameters have also been followed (bath temperature, AlF_3 excess, etc.). A special attention has been paid to alumina feeding and crust formation.

PAPER 19.6 — 12:00
ANODE PASTE PLANT IMPROVEMENTS IN KITIMAT, BRITISH COLUMBIA
S. YOUNG, Alcan Primary Metal – British Columbia, Kitimat, British Columbia, Canada

Over a period of about 5 years, there have been many improvements in the manufacturing of anode paste for the soderberg anodes in Kitimat, BC. Sparked in part due to an "anode crisis" in the Potrooms, many initiatives were started not only in the Anode Paste Plant but also in the Potrooms.

Through this "journey of improvements", both areas have greatly improved as seen by reviewing the parameters that are normally measured and by some new ones that had not been monitored before within Alcan. The improvements in the Anode Paste Plant (APP) required some significant investment of resources.

Coupled with this work in the APP, was the development of a strong network with the customer from Potrooms through regular meetings to review issues, targets and process parameters statistical behavior.

This paper will describe just some of the many improvements done to date to reduce variation and some of the work to follow.

SESSION 20: LIGHT METALS 2003
MÉTAUX LÉGERS

ALLOYS DEVELOPMENT

Sponsor: Light Metals Section, The Metallurgical Society of CIM
Room: Port Hardy
Chairmen: J.P. MARTIN, CNRC, Ottawa, Ontario, Canada, and
C. BICKERT, Pechiney

PAPER 20.1 — 9:00
ALTISI INTERMETALLICS IN A356 AL-SI FOUNDRY ALLOY.
H.R. HABIBI, University of Manitoba, Winnipeg, Manitoba, Canada
X.G. CHEN, Alcan Research and Development Centre, and
R. GHOMASHCHI, Centre for University Research on Aluminum, CURAL, University of Quebec at Chicoutimi, Chicoutimi, Québec, Canada

The presence of impurity and alloying elements such as Fe, Mn, Cu, Zn, Mg, and Ti brings about some complications in the microstructure of Al-Si alloys due to the formation of intermetallic phases. Each impurity element, in combination with others, may promote the formation of a particular intermetallic microconstituent provided that its relative concentration is compatible with the expected intermetallic compound. Among the many intermetallics, the application of grain refiners may result in the formation of Al-Ti-based intermetallics such as Al_3Ti. Although there are ample information on the mechanism of grain refining and the morphologies of Al_3Ti phase, there is limited information available in open literature on the formation of Ti-based intermetallics and their growth mechanism and orientation when small amount of Ti is added to Al-Si alloys. The morphology of TiAlSi intermetallics has been reported to be plate-like or blocky, polygonal, but there are not reports as on the favoured conditions under which either of these morphologies would prevail. It is further observed that once the plate-like morphology is formed, it tends to grow to such extent to even disturbs the flow of molten alloy. This paper discusses the preliminary findings on these intermetallics with the intention of exploring the mechanism responsible for the formation of both morphologies and their interrelationships with aluminum matrix.

PAPER 20.2 — 9:30
EFFECT OF RARE-EARTH ELEMENTS ON THE PROPERTIES OF AL-CU ALLOY A201.
K. SADAYAPPAN, M. SAHOO, CANMET, Natural Resources Canada, Ottawa, Ontario, Canada, and
R.W. SMITH, Department of Mechanical Engineering, Queen's University, Kingston, Ontario, Canada

A201 is one of the high-strength cast aluminum alloys used in aerospace applications. Despite its high strength, this alloy, along with other members of Al-Cu alloy family, suffers from poor hot tearing resistance, making casting process difficult. In this investigation, the effect of rare earth elements when added as mischmetal to Al-Cu alloy on the hot tearing resistance was evaluated. The rare earths seem to improve the performance of the alloy. The miscrostuctural examination revealed a modified eutectic structure. However, the strength of the alloys is not improved by the addition of mischmetal after heat treatment. The findings are presented and discussed in this paper.

COFFEE BREAK — 10:00 – 10:30

PAPER 20.3 — 10:30
X-RAY TOMOGRAPHY STUDY OF ATOMIZED AL-CU DROPLETS.
A. PRASAD, H. HENEIN, University of Alberta, Edmonton, Alberta, Canada,
E. MAIRE, GEMPPM, INSA, Villeurbanne, France, and
C.-A. GANDIN, LSGMM, École des Mines de Nancy, Nancy, France

Atomization of metals and alloys results in the rapid solidification of droplets that yields a complex interplay of nucleation undercooling, recalescence, microsegregation, etc. Characterization of the solidified microstructure has been studied using conventional optical and SEM microscopy. These techniques provide limited information as only a finite number of sections of the powder can be examined. X-Ray tomography using Synchrotron radiation with 1 µm beam resolution was used to generate a 3D image for the entire volume of a particle and was compared to microscopic images. The tomography experiments were carried out on Al5%Cu and Al17%Cu atomized droplets of 500 µm in diameter. Microstructural features of solidification such as shrinkage, nucleation, recalescence, etc. that are apparent in the 3D images will be discussed and contrasted with characterization from microscopic techniques.

PAPER 20.4 — 11:00
DEVELOPMENT OF LIGHTWEIGHT AL ALLOY TECHNIQUE.
S. GNYLOSKURENKO, Institute of Industrial Science, The University of Tokyo, Tokyo, Japan,
T. NAKAMURA, Institute of Multidisciplinary Research for Advanced Material, Tohoku University, Sendai, Japan,
K. SAKAMOTO, Training Welfare Center, KEIHIN Corporation, Kakuta-shi, Japan,
A. BYAKOVA, National Technical University of Kiev, Ukraine, and
M. MAEDA, Institute of Industrial Science, The University of Tokyo, Tokyo, Japan

Cellular metal is one of the most prospective lightweight materials due to its interesting combination of properties. A new foaming agent, calcium carbonate, and appropriate techniques are suggested to improve metal structure and control of the foaming process. A coating procedure was applied to enhance wetting of the agent particles and control homogeneity of the foam. Results showed that coated carbonate ensured aluminum foam with comparable density and smaller pores than when the conventional foaming agent, titanium hydride, is used. The present study shows that calcium carbonate and techniques are highly applicable to foamed metal production.

TUESDAY, AUGUST 26, 2003, P.M.

SESSION 29: LIGHT METALS 2003 MÉTAUX LÉGERS

CASTING AND SOLIDIFICATION

Sponsor: Light Metals Section, The Metallurgical Society of CIM

Room: Port McNeill

Chairmen: R. GHOMASHCHI, UQAC, Canada, and
R.I.L. GUTHRIE, McGill Metals Processing Centre, McGill University, Montréal, Québec, Canada

PAPER 29.1 — 14:00
ALUMINUM DROPLETS IMPINGING ON METALLIC SUBSTRATES: A DYNAMIC WETTING AND HEAT TRANSFER STUDY.
S. LEBOEUF, D. BOUCHARD, Industrial Materials Institute, Boucherville,Québec, Canada,
R.I.L. GUTHRIE, M. ISAC, McGill Metals Processing Centre, McGill University, Montréal, Québec, Canada, and J.-P. NADEAU, Industrial Materials Institute, Boucherville, Québec, Canada

The present work describes an experimental set-up built to simulate the dynamic wetting and heat transfer behaviour occurring in many rapid solidification processes. Tests were performed with molten aluminum droplets falling from a crucible and hitting a metallic substrate. A high-speed camera captured the evolution of the contact angles while thermocouples, inserted inside the metallic substrate, allowed heat transfer analysis to be performed. The selection of optimum process parameters for carrying out these tests are presented and discussed.

PAPER 29.2 — 14:25
EXPERIMENTAL STUDY AND NUMERICAL ANALYSIS FOR THE PREDICTION OF TEMPERATURE EVOLUTION AND SOLID FRACTION IN SEMI-SOLID BILLETS PRODUCED WITH THE SWIRL ENTHALPY EQUILIBRATION DEVICE.
D. BOUCHARD, F. PINEAU, Industrial Materials Institue, Aluminum Technology Centre, National Research Council, Boucherville, Québec, Canada,
J. LANGLAIS, Arvida Research and Development Centre, Alcan International Limited, Jonquière, Québec, Canada,
P. WALES and D. DOUTRE, Kingston Research Centre, Alcan International Limited, Kingston, Ontario, Canada

An inverse technique coupled to a mathematical model was used to characterize the heat transfer of semi-solid billets produced with the Swirl Enthalpy Equilibration Device (SEED). Temperature measurements were carried out in the billets and on their crucibles. The data enabled the heat transfer boundary conditions to be calculated as well as the evolution of temperature and solid fraction in the billets. The mathematical model along with the numerical and experimental results are presented and discussed.

PAPER 29.3 — 14:50
EFFECTS OF DIFFERENT MODIFIERS ON THE MICROSTRUCTURES AND POROSITY OF A356 ALLOY.
A. ABDOLLAHI, S. KHAN and A. WANG, Research and Development Centre, Shellcast Foundries Inc., Montréal, Québec, Canada

Modification of silicon in Al-Si alloys can be performed by adding a very small amount of such elements as Na, Sr, and Ca to alter the forms of silicon from an acicular shape to a fine fibrous. This modification results in a considerable improvement in mechanical properties, especially elongation. Metallographic observations in A356 alloy indicated the degree of the modification with Na, Sr, and Ca. They showed that the effect of Ca as a modifier is not as strong as Na or Sr while Na is the most effective modifier. Although modifiers improve mechanical properties, they also increase porosity in castings. The reduced pressure test (RPT) and Tatur test showed that the increasing porosity with Na is the most and with Sr the least.

COFFE BREAK — 15:15 – 15:45

PAPER 29.4 — 15:45
INDUSTRIAL APPLICATIONS OF HEAT PIPE TECHNOLOGY TO THE PERMANENT MOULD CASTING OF MAGNESIUM ALLOYS.
K. ELALEM, F. MUCCIARDI, J.E. GRUZLESKI, Mining, Metals and Materials Engineering, McGill University, Montréal, Québec, Canada, and
Z. ZHANG, InterMag Technologies, Sainte-Foy, Québec, Canada

Heat pipes have been used in industry for a number of casting applications, the most common of which is the injection moulding of polymers. In the permanent mould casting of metals, the use of heat pipes has been limited due to the higher mould temperatures and the relatively large heat fluxes. Our research has shown that the classical heat pipe which is used for low-heat flux applications such as encountered in the plastics industry cannot handle the high-heat fluxes that are inherent to the light metals industry. As a result, a novel heat pipe technology was developed that can be applied to the industrial permanent mould casting of magnesium alloys. The experimental program consisted of designing a permanent mould to produce magnesium castings with shrinkage defects. Heat pipes were then used to reduce these defects. The effects of cooling using heat pipes were evaluated. Selected results from industrial trials are also presented. The results show a promising future for heat pipe technology in cooling permanent moulds for the casting of magnesium alloys.

PAPER 29.5 — 16:10
EFFECT OF CHANGE IN SI AND CU CONTENT ON PRIMARY SILICON SIZE AND DISTRIBUTION IN HYPEREUTECTIC AL-SI ALLOYS FOR LOST FOAM CASTING PROCESS.
S. KAMBLE and C. RAVINDRAN, Department of Mechanical, Aerospace and Industrial Engineering, Ryerson University, Toronto, Ontario, Canada

Hypereutectic Al - Si alloys are known for their high wear resistance due to formation of primary silicon crystals during solidification. Previous study suggested that density, distribution and size of primary silicon crystals play a dominant role in controlling the properties and behaviour of Al - Si alloys. Experiments in lost foam casting (LFC) were conducted to calculate a direct relation between primary silicon size and fluidity for these Al-Si alloys. Silicon content was varied from 12% to 25% in order to vary the size of primary silicon crystals. Also, an attempt was made to discuss possible reasons for any change in the fluidity due to variation in primary silicon particle size. Copper content was also varied from 0% to 5% to understand effect of copper on fluidity for hypereutectic Al - Si alloys. Use of lost foam casting process has a particular significance in this research. Because of unique mould filling mechanism of LFC, it causes uniform distribution of primary silicon particles in casting. Four different section thicknesses were used for a better understanding of distribution of primary silicon crystals with change in local solidification time for each thickness. The local solidification time was related to microstructure.

PAPER 29.6 — 16:35
MULTI-SCALE MODELLING OF MICROPOROSITY FORMATION IN AL-SI-CU ALLOYS IN AUTOMOTIVE COMPONENTS.
P.D. LEE and A. CHIRAZI, Department of Materials, Imperial College London, London, United Kingdom

Microporosity forms during the solidification of Al-Si-Cu alloys due to a number of phenomena which occur over a range of temporal and spatial scales. To simulate these phenomena a multi-scale, multi-physics model is presented, combining a microscale model grain and pore formation together with a commercial macroscopic model. A combined stochastic-deterministic approach based on a cellular automata-finite difference (CAFD) method is used to solve diffusion in three phases: liquid, solid, and gas. This micromodel is coupled into a finite element method (FEM) solution of the heat transfer and fluid flow at the macroscale. The model is compared to experimental casts on both a laboratory and industrial scale.

SESSION 30: LIGHT METALS 2003 MÉTAUX LÉGERS

HOT AND COLDWORKING

Sponsor: Light Metals Section, The Metallurgical Society of CIM

Room: Port Hardie

Chairmen: T. LEWIS, Alcan International, Kingston, Ontario, Canada

PAPER 30.1 — 14:00
MODELLING OF MICROSTRUCTURE EVOLUTION OF ALUMINUM ALLOYS DURING HOT ROLLING USING AN INTERNAL STATE VARIABLE APPROACH INTEGRATED INTO AN FE MODEL.
H. AHMED, M. WELLS, D. MAIJER, Metals and Materials Engineering, The University of British Columbia, Vancouver, British Columbia, Canada, and
M. VAN DER WINDEN, Ijmuiden Technical Centre, CORUS, Ljmuiden, The Netherlands

To compete effectively in the emerging global market, manufacturers need to have a thorough understanding of their processes and the effect process parameters have on product final quality. Toward this goal, modelling microstructure using a fundamentally based physical model to predict microstructure evolution is highly desirable. In this research, an internal state variable approach based on dislocation density, sub-grain size, and misorientation between sub-grains has been integrated into an FEM simulation of a single stand hot rolling operation for aluminum alloys. This integrated model was used to predict the through thickness microstructural evolution during hot rolling for an AA5083 aluminum alloy, and the ensuing recrystallization after rolling was completed. The model predictions of recrystallization kinetics using this approach were compared with predictions made using a more empirical approach as well as detailed experimental measurements conducted using the CORUS pilot-scale rolling facility in Ljmuiden, Netherlands.

PAPER 30.2 — 14:25
ISOTHERMAL FORGING OF TI-6AL-4V ALLOY.
A. SAIGAL, Department of Mechanical Engineering, Tufts University, Medford, Massachusetts, U.S.A.

A finite element analysis-based investigation using DEFORM software was undertaken to determine the influence of forge temperature and interface friction coefficient on the deformation characteristics of isothermally forged Ti-6Al-4V alloy. Hot isothermal forging offers a number of advantages over conventional forging. For example, hot isothermal forgings can be produced too much closer finished-part dimensions, it can replace three to four steps of conventional forging, and it can be used to forge parts with higher complexity and precision with little or no residual stresses. Based on the numerical analysis, it can be concluded that isothermal forgings requires loads, which are about one-third of those required for conventional forging. In addition, there is smaller rise in workpiece temperature, the temperature distribution in the workpiece is more homogeneous as a result of lower chilling effect and improved filling of dies is observed. Finally, increasing the interface friction coefficient results in higher workpiece temperature and less homogeneous temperature distribution.

PAPER 30.3 — 14:50
THE EFFECT OF SIT PHENOMENA ON THE MICROSTRUCTURE AND MECHANICAL PROPERTIES OF SI-MN TRIP STEELS
K. GHADARGHADR JAHROMI, Dept. of Metallurgy and Material Eng., Tehran University, Tehran, Iran
A. ARAEI, Dept. of Mechanical Eng., Tehran University, Tehran, Iran
A.Z. HANZAKI, Dept of Metallurgy and Material Eng., Tehran, Iran,

Researchers have shown that the ultra fine ferrite (ferrite grains smaller than 2-3 m) can be obtained by high straining the steels at temperatures close to the Ar_3. This is attributed to the occurrence of strain induced transformation (SIT) of austenite to ferrite. In present paper, the effect of SIT phenomena on the microstructural characteristics and mechanical properties of the Si-Mn TRIP steels was studied. This was carried out applying hot compression tests at temperatures in the range of $Ar_3 \pm 15$ºC. The final mechanical properties were studied by a shear punch testing method. The results indicated that a unique microstructure with high plasticity index (i.e., UTS×T. El. more than 44000 MPa %) was obtained by 45% reduction at Ar_3-15ºC. This unique microstructure composes of ultra fine ferrite grains, small austenite particles, andbainite packets.

COFFEE BREAK — 15:15 – 15:45

PAPER 30.4 — 15:45
THE FORMATION OF SHEAR BANDS IN PLANE STRAIN COMPRESSED 7050 ALUMINUM ALLOY.
S.-C. CHANG and J.-H. FU, Department of Materials Science and Engineering, National Tsing-Hua University, Hsinchu, Taiwan

Channel die and thin sheet plane strain compression tests were used to study the formation of shear bands in 7050 aluminum alloy plate specimens. The plane strain compression test was conducted at room temperature by compression in S direction to different amount of reduction in thickness with T or L direction constrained. By assuming that the formation of shear bands was determined by the plane of maximum shear stress, the fluctuation of the true stress - true strain curves obtained in the plane strain compression tests can be predicted by the ideal £m/2£ny vs. £` curve. Most of the observed angles of shear bands of channel die specimens are between 40ø to 50ø while most angles of shear bands of thin sheet specimens are between 45ø to 57ø. This result can be explained by the shape of specimens and the characteristics of the dies.

PAPER 30.5 — 16:10
UNIAXIAL AND PLANE STRAIN COMPRESSION OF ALUMINUM ALLOYS.
A. AIROD, Metallurgy and Materials Science, Ghent University, Oost-vlanderen, Belgium,
R. COLÁS, Facultad de Ingenieria Mecanica y Electrica, Universidad Autonoma de Nuevo Leon, San Nicolás de los Garza, Mexico, and Y. HOUBAERT, Metallurgy and Materials Science, Ghent University, Oost-vlanderen, Belgium

Plane strain and axisymetric compression tests are two deformations modes that are useful to study the flow stress of a material and to define the maximum load that this material can support. Whereas the former mode is important for the simulation of flat products, the latter is necessary for the physical simulation of long products and forgings. A series of compression tests was conducted using a servo-hydraulic computer driven testing machine that can test over a wide range of constant strain rate up to 120 sec^{-1}. Testing at these high strain rates is crucial to understand the evolution of microstructure during processes such as strip rolling. The experimental data of the two compression modes for commercial-purity aluminum and 3xxx and 5xxx aluminum alloys are compared to each other for different temperatures, friction coefficients, and strain rates. Attention is given to the constitutive equations governing both deformation modes at room and at high temperatures.

SESSION 31: LIGHT METALS 2003 MÉTAUX LÉGERS

MAGNESIUM TECHNOLOGIES

Sponsor: Light Metals Section, The Metallurgical Society of CIM

Room: Beluga

Chairmen: A. FAUCHER, Norsk Hydro, and
M. PEKGULERYUZ

PAPER 31.1 — 14:00
THERMAL MODELLING OF DIRECT CHILL CAST BILLET OF AZ31 MAGNESIUM ALLOY.
H. HAO, D.M. MAIJER, M.A. WELLS, S. L. COCKCROFT, Department of Metals and Materials Engineering, The University of British Columbia, Vancouver, British Columbia, Canada, and
S.G. HIBBINS, Research and Development, Timminco Metals, Haley, Ontario, Canada

This paper outlines the development of a 2-D axisymmetric mathematical model using the commercial finite-element code, ABAQUS, to predict the evolution of temperature and stress during the direct chill (DC) casting of AZ31 magnesium billets. Model predictions of temperature and butt curl were compared to measurements made on an industrial DC casting machine at Timminco in Haley, Ontario. These measurements not only helped to fine-tune the thermal boundary conditions at various points during the DC casting operations but also provided overall validation of the mathematical model. The model has been developed as part of a strategic project aimed at improving the DC casting process for light metals through a reduction in quality related defects and increased productivity.

PAPER 31.2 — 14:30
ENVIRONMENTAL ASSESSMENT OF MAGNESIUM PRODUCTION PROCESSES: ELECTROLYTIC VERSUS PIDGEON PROCESS.
W. XIAOQIANG, L. PEIJIE and Z. DABEN, Mechanical Engineering, Tsinghua University, Beijing, China

Over the last few years, the tonnage of world primary magnesium production has grown considerably especially in China. Production was estimated at 250 000 t in 2002, where magnesium is produced almost exclusively by the Pidgeon process. In the westen world, the electrolytic process is widely used. This study is an environmental assessment comparing these two magnesium production processes involving resource and energy consumption, environmental influence, product property, and cost-efficiency. Key features of the assessment modelling and the data collection and analysis methods are included in this paper.

COFFEE BREAK — 15:00 – 15:30

PAPER 31.3 — 15:30
NOVEL EXPERIMENTS IN LFC OF MAGNESIUM ALLOYS.
L. BICHLER, Mechanical, Aerospace and Industrial Engineering, Ryerson University, Toronto, Ontario, Canada,
C. RAVI RAVINDRAN, Mechanical, Aerospace and Industrial Engineering, Centre for Near-Net-Shape Processing of Materials, Ryerson University, Toronto, Ontario, Canada, and
A. MACHIN, Aerospace and Industrial Engineering, Ryerson University, Toronto, Ontario, Canada

With a view to enhancing castability of magnesium castings via the Lost Foam Casting process, unique experiments were carried out at the Centre for Near-Net-Shape Processing of Materials, at Ryerson University. These experiments involved variations of superheat, sand temperature, foam density, and coating permeability. Suitable manipulation of the above casting parameters was seen to improve the velocity profiles of the alloys. Optical image analysis was performed and the results are discussed as well.

PAPER 31.4 — 16:00
STUDY OF PARTIALLY DEHYDRATED MAGNESIUM CHLORIDE HYDRATE DEHYDRATION IN AIR.
S. KASHANI-NEJAD, R. HARRIS and K. WING NG, Mining and Metallurgical Engineering, McGill University, Montréal, Québec, Canada

Partially dehydrated magnesium chloride hydrates are feed for many electrolytic magnesium production processes such as Dow, Magcorp, and Magnola. These materials are fed to some kind of chlorinator or electrolysis cell for increasing magnesium chloride content of electrolyte. Final dehydration of these hydrates occurs during their digestion into molten salt bath and products of this dehydration process will be directly added to the electrolyte and enter the electrolysis region with significant negative impact if the process is not carried out to minimize hydrolysis or oxygen pick-up by the electrolyte. In this study, a mixture of different typical industrial magnesium chloride hydrates has been selected, and dehydration of hydrates containing oxide species with the aid of thermal gravimetric analysis (TGA) has been studied. Selective solubility in absolute alcohol for magnesium chloride hydrates and oxides was used for separation of dehydration and hydrolysis products followed by qualitative and quantitative characterization methods to analyze products of each dehydration stage. Results of this research provide a basis for understanding dehydration of hydrates in HCl - H_2O atmosphere and industrial processes.

WEDNESDAY, AUGUST 27, 2003, A.M.

SESSION 41: LIGHT METALS 2003 MÉTAUX LÉGERS

CASTING AND SOLIDIFICATION (CONTINUED)

Sponsor: Light Metals Section, The Metallurgical Society of CIM

Room: Port McNeill

Chairmen: R. GHOMASHCHI, UQAC, Canada, and
R.I.L. GUTHRIE, McGill Metals Processing Centre, McGill University, Montréal, Québec, Canada

PAPER 41.1 — 9:00
SEED: A NEW PROCESS FOR SEMI-SOLID FORMING.
D. DOUTRE and P. WALES, Alcan International Limited, Kingston Research Centre, Kingston, Ontario, Canada

A new method for the preparation of feedstock for semi-solid forming processes is described. The process, dubbed SEED (Swirled Enthalpy Equilibration Device), consists of two steps: 1) the extraction of a controlled quantity of enthalpy from the molten metal charge in order to generate a liquid/solid slurry, and 2) draining away the excess liquid in order to form a compact, self-supporting slug which can then be handled and formed under pressure. With this approach it is unnecessary to measure the temperature of the material during processing and a wide range of alloys can be processed with ease. This paper describes the features of the process and the microstructures obtained using a variety of aluminum alloys.

PAPER 41.2 — 9:30
AN OVERVIEW OF CONTROLLED COOLING OF PERMANENT MOULDS FOR CASTING ALUMINUM ALLOYS.
C. ZHANG, F. MUCCIARDI and J.E. GRUZLESKI, Mining, Metals and Materials Engineering, McGill University, Montréal, Québec, Canada

The permanent mould casting process is a relatively popular and effective casting technology that can produce near-net-shape aluminum components with high integrity, particularly for the aerospace and the automotive industries. It is well recognized by the casting industry that it is essential to control the cooling of permanent mould castings in order to improve the quality of the castings. This paper presents an overview of the current cooling methods that are used in the production of permanent mould castings. Both their advantages and disadvantages are discussed. Moreover, in order to overcome some of the disadvantages that are inherent to the current methods, a new cooling method for permanent moulds is proposed and also discussed in this paper. This new technique is based on heat pipe technology that was developed specifically for the cooling of permanent moulds in the casting of light metals where high heat fluxes are normally encountered. Typical experimental results are also presented.

PAPER 41.3 — 10:00
STUDIES ON RHEOLOGICAL BEHAVIOUR AND PROCESSING OF $MOSI_2$ HEATING ELEMENTS.
K. JANGHORBAN, Materials Science and Engineering, Shiraz University, Shiraz, Fars, Iran

Rheology and processing of MoSi2 for injection moulding of cylindrical heating elements were studied. $MoSi_2$ has a high melting point (2020°C), relatively low density (6.22 g/cm^3), excellent oxidation and thermal shock resistance. $MoSi_2$ production through colloidal processing requires a good estimate of the critical powder volume content (CPVC). In the present research, the powder mix consisted of $MoSi_2$ and a binder composed of paraffin, bees wax, and polyethylene. Viscosity of the mix was measured by an RVT viscometer at different powder contents, and the CPVC was calculated to be ~ 60% to 65% at 130°C , and shear rates of 2.5 to 20 /s . It was concluded that CPVC depends on the speed (shear rate) and the temperature of mixing; it increased with these parameters. The inject moulded samples were sintered at 1300°C for 1.5 h, and their microstructures were observed by SEM andanalyzed by EDS.

COFFEE BREAK — 10:30 – 11:00

PROPERTIES AND APPLICATIONS OF LIGHT METALS

Chairmen: D. KSINSIK, Bécancourt Silicium, Bécancourt, Québec, and
M. SAHOO, CANMET, Ottawa, Ontario, Canada

PAPER 41.4 — 11:00

EFFECT OF DRILL WEB ON CUTTING MECHANISMS DURING HIGH-SPEED DRILLING OF LIGHT ALLOYS AND BRASS.

B. BALOUT, V. SONGMENE and J. MASOUNAVE, Department of Mechanical Engineering, École de Technologie Supérieure, Montréal, Québec, Canada

Numerous manufacturing companies are trying high-speed machining because of its positive effects on productivity and part quality. Machining knowledge on cutting practices and mechanisms at high speed is not well known. Most manufacturers rely on practices and models developed for traditional machining and fail taking full advantage of high-speed machining as some of these models do not apply. The aim of this work is to study the effects of drill web on cutting mechanisms during the drilling of light alloys and brass and developed laws governing this process. Machining trials with or without pre-drilled hole, which eliminates the effect of the drill web, are conducted on light alloys and brass and their effect of cutting forces and chip formation analyzed. This study can help optimizing the cutting conditions in order to reduce the energy required for machining, improving the part quality, and for protecting the tool thus leading to safe machining practices.

PAPER 41.5 — 11:30

FINE DUST FORMATION DURING HIGH-SPEED MACHINING OF LIGHT ALLOYS.

B. BALOUT, V. SONGMENE and J. MASOUNAVE, Department of Mechanical Engineering, École de Technologie Supérieure, Montréal, Québec, Canada

Epidemiological studies have shown that fine metallic dust produced during manufacturing represents an industrial hazard. The machining processes either low or high speed, wet or dry, and generates fine respirable dust that remains suspended in the work environment for a period longer enough to be inhaled by machine tool operators. Health problems associated with inhalation of metallic dust and aerosols range from mild respiratory illness to pneumoconiosis, asthma and several types of cancer. The aim of this work is to study fine dust generated during dry machining of light alloys in order to reduce it at the source. The reduction of machining dust will improve the health of machine tool operators and thus reduce health system costs necessary for the treatment of sickness associated with the inhalation of respirable metallic dust.

SESSION 42: LIGHT METALS 2003 MÉTAUX LÉGERS

HOT AND COLDWORKING (CONTINUED)

Sponsor: Light Metals Section, The Metallurgical Society of CIM

Room: Port Hardy

Chairmen: T. LEWIS, Alcan International, Kingston, Ontario, Canada

PAPER 42.1 — 9:00

DETERMINATION OF THE OPTIMUM FORGING CONDITIONS FOR A 7075 ALUMINUM ALLOY.

M. JAHAZI, Aerospace Manufacturing Technology Centre, National Research Council Canada, Ottawa, Ontario, Canada,
A. SAMADI and S. YUE, Department of Metals and Materials, McGill University, Montréal, Québec, Canada

The influences of heat treatment conditions on the microstructure, mechanical properties and forging behaviour of a 7075 aluminum alloy were investigated. Samples were taken from a 50 mm diameter extruded billet of the alloy. Five different cycles consisting of solution annealing, full annealing, natural aging, artificial aging, and over-aging were employed. For each heat treatment condition the mechanical properties were evaluated and the microstructure was examined in order to determine the optimum conditions for the forging of this alloy. On the basis of a proposed formability criterion, the forgeability of the alloy is predicted for each of the heat treatment conditions. The results indicated that the most appropriate samples for forging are those submitted to full and solution annealing treatments. Forging of industrial-size parts was carried out and the optimum conditions including reheating and deformation temperatures and cooling rates were determined. Finally, different heat treatments were applied on the forged parts to attain the desirable hardness and mechanical properties.

PAPER 42.2 — 9:25
THE EFFECTS OF PRE-AGING AND COLD WORK ON THE PRECIPITATION KINETICS OF AA6111 ALUMINUM AUTOMOBILE PANELS.
S. YANNACOPOULOS and G.K. QUAINOO, Mechanical Engineering, University of Saskatchewan, Saskatoon, Saskatchewan, Canada

In the automotive industry, the awareness to meet Corporate Average Fuel Efficiency (CAFE) standards has evolved the need to reduce vehicular weight in new automobile designs, with the overall goal of reducing gas emissions to the atmosphere (Kyoto Accord). One efficient method has been to use lighter materials such as aluminum in outer body panels. Heat-treatable AA6111 is one of the materials considered due to its unique combination of formability, paint bake strengthening and superior corrosion resistance characteristics. In recent times researchers have employed pre-aging condition on the 6000 series aluminum alloys and have been found to improve the mechanical properties of these alloys. For a formed and painted automobile panel however, the final mechanical properties involve a combination of strength components arising from cold work, strain aging and precipitation minus recovery.

PAPER 42.3 —9:50
AN INVESTIGATION TO HOT WORKING BEHAVIOUR OF ALTHIX (A356) AND AL (356).
A. ZAREI HANZAKI, A. HEMMATI HAZAVE and A. ARAEI, Metallurgy and Materials Engineering, Tehran University, Tehran, Iran

Al-Si alloys are extensively used in aerospace and automotive industries. In addition, the mechanical properties of these alloys are mainly dictated by the characteristics of eutectic microcomponents in the microstructure. Furthermore, many investigations have been conducted on the semi-solid macrostructures to control the matrix (Al-alpha) and eutectic phase (silicon) morphologies. As thethermomechanical treatment (TMT) is one of the most effective materials processing techniques, the objective of this research was to study the effect of TMT parameters on Si morphology in aluminum 356 alloys with two semi-solid and conventional casting macrostructures. Therefore, hot compression tests have been performed in a range of temperature (420°C to 540°C) and strain rate (0.1, 0.01, and 0.001 sec^{-1}). The results indicated that the morphology of Si phase was changed from acicular to spherical shape.

COFFEE BREAK — 10:15 – 10:40

MODIFICATION OF THE MICROSTRUCTURE

Chairman: G. DUFOUR, Alcoa, Canada, and D. GALIEN, Aluminere Alouette

PAPER 42.4 — 10:40
THE EFFECT OF METALLURGICAL VARIABLES AND POROSITY ON THE HIGH CYCLE FATIGUE BEHAVIOUR OF ALUMINIUM ALLOY A319.
L. LEE, T.C. LINDLEY, C.W. J. CHEONG, Imperial College London, London, United Kingdom,
G.R. DAVIS, J. ELLIOTT, Dental Biophysics Section, Department of Oral Growth and Development, London, United Kingdom, and M. BARTS, Queen Mary's School of Medicine and Dentistry, University of London, London, United Kingdom

The effects of microstructure and defect population on the high cycle fatigue properties of cast A319 Al-Si-Cu alloy have been investigated. Using the original unmodified base alloy for comparison, casts were made with different minor additions, namely, a strontium-modified alloy, a titanium diboride grain-refined alloy and an alloy combining Sr modification with TiB_2 grain refinement. Different solidification rates from material located at different positions in each wedge cast and the corresponding values of secondary dendrite arm spacing (SDAS) were also appraised. All specimens were subjected to a T-7 heat treatment. The individual effects on microstructure and defects of Sr modification and TiB_2 grain refinement, as well as a combination of both additions to the melt were identified. Size, shape and density of pores in the different casts were measured using both 2-dimensional metallography and 3-dimensional X-ray tomography. Tensile and S-N fatigue properties were measured for each cast condition. Fractographic examination in the scanning electron microscope revealed that fatigue cracks were initiating at pores in all casts. The aspect ratio of each crack initiating pore was measured while the pore tip radius was estimated from values of SDAS. A fracture mechanics-based model of fatigue life prediction which also includes a microstructural parameter has been developed.

PAPER 42.5 — 11:05
VARIATIONS IN MICROSTRUCTURE AND MECHANICAL PROPERTIES OF PRESSURE DIE CAST A357 ALLOY.
C.A. LOONG, C-Q. ZHENG, Industrial Materials Institute, National Research Council Canada, Boucherville, Québec, Canada,
M.T. SHEHATA, E. ESSADIQI and V. KAO, Materials Technology Laboratory, CANMET, Ottawa, Ontario, Canada

The microstructure and mechanical properties of pressure die cast components are influenced largely by the solidification and filling behaviour of the alloy in the cavity during the injection phase. It is not uncommon to find very significant variations in the microstructure and properties of a given component from one region to another. This paper examines these variations in the A357 alloy die cast at different temperatures – from a temperature near the liquidus to one a little above the eutectic temperature. Reheated commercial thixotropic feedstock material of 76 mm diameter and 152 mm long was used. Specimens from the castings produced at various temperatures were cut and evaluated. Variations in mechanical properties at difficult locations are discussed and explained in terms of variations in the microstructure and the presence of casting defects in the alloy.

PAPER 42.6 — 11:30
THE ROLE OF MANGANESE AND IRON IN POROSITY FORMATION IN ALUMINIUM-SILICON FOUNDRY ALLOYS.
C. DINNIS, Division of Materials, CRC for Cast Metals Manufacturing (CAST), The University of Queensland, Queensland, Australia,
J. TAYLOR, A. DAHLE, Division of Materials, The University of Queensland, Queensland, Australia,
D. ST. JOHN and W. SCHNEIDER, Hydro Aluminium Deutschland, Bonn, Germany

Iron is a common and deleterious impurity in Al-Si foundry alloys. Pre-eutectic beta-Al5FeSi platelets have been associated with an increase in porosity. The addition of Mn to Al-Si foundry alloys containing iron has been suggested to reduce porosity by altering the intermetallic phase to alpha-Al15(Fe,Mn)3Si_2. The addition of Mn to Al-9%Si-x%Cu-0.5%Mg-y%Fe alloys, to a Fe:Mn ratio of 2:1, reduces the amount and variability of porosity in sand-cast plates. This is largest for alloys with high iron levels (1 wt%) and no copper addition. The reduction is not as dramatic at lower iron levels (0.6%) or higher copper levels (3%).

WEDNESDAY, AUGUST 27, 2003, P.M.

SESSION 52: LIGHT METALS 2003 MÉTAUX LÉGERS

METAL MATRIX COMPOSITES

Sponsor: Light Metals Section, The Metallurgical Society of CIM

Room: Port McNeill

Chairmen: J. MASOUNAVE, École de Technologie Supérieure, Montréal, Québec, Canada, and M. BOUCHARD, UQAC, Canada

PAPER 52.1 _ 14:00
MAGNESIUM COMPOSITE MATERIALS REINFORCED Mg_2Si DISPERSOIDS VIA SOLID-STATE SYNTHESIS.
K. KONDOH, R. TUZUKI and W. DU, RCAST, The University of Tokyo, Komaba, Meguro-ku, Japan

Magnesium matrix composites have been developed via solid-state synthesis of Mg_2Si intermetallics, in employing the elemental mixture of Mg alloy and Si powder. They show high mechanical properties and good tribological resistance, compared to the conventional magnesium alloys. In particular, the composite with Mg_2Si/MgO particles, which are formed by the reaction between Mg and SiO_2, reveals a lower friction coefficient less than 0.01 under oil lubricant condisions. This is because Mg_2Si improves the wear resistance and MgO is effective on the "mild offensive effect," in contact with counter materials.

PAPER 52.2 — 14:30
AGING BEHAVIOUR OF EXTRUDED 7475 AL REINFORCED WITH AL_2O_3 PARTICULATE COMPOSITES.
A. DAOUD, Central Metallurgical Research and Development Institute, Helwan, Cairo, Egypt

7475 Al reinforced with Al_2O_3 particulates of different sizes (25 and No. 61549; mangular or 40 and No. 61549; m microsphere) and volume fractions were produced using stir casting technique. Metallographic examinations showed that the presence of the Al_2O_3 particulates in the matrix alloys refined the dendritic structures of the composites compared to the matrix alloys. SEM and energy dispersive X-ray analysis (EDXA) taken from the extracted Al_2O_3 particulate revealed that the particulate reacted with the molten 7475 Al during melting and casting to form a layer of $MgAl_2O_3$ spinel at the interface. The spinel formed at the interface led to Mg depletion in the matrix and subsequently to smaller age hardening in the composites. The reinforcement had a little effect on the aging kinetics in these composites because the hardening precipitate in 7475 Al was not nucleated on dislocation. Therefore, an increased dislocation density due to coefficient of thermal expansion mismatch between the matrix and reinforcement did not affect the aging kinetics. However, the presence of reinforcement did not alter precipitation sequence of all the investigated composites.

COFFEE BREAK — 15:00 – 15:30

PAPER 52.3 — 15:30
ROLE OF REINFORCEMENTS ON CREEP BEHAVIOUR OF AL-SIC COMPOSITES.
K. JANGHORBAN and C. ZAMANI, Materials Science and Engineering, Shiraz University, Shiraz, Fars, Iran

Effects of volume fraction and size of reinforcing SiC particles on the creep behaviour of Al-SiC composites were investigated. The PM route used for sample preparation includes: rotary wet mixing of powders, cold compaction, hot extrusion, and machining to standard dimensions. Produced samples contain 5, 10, and 15 volume % SiC, with 5 or 40 microns in size. Creep tests were performed at 573 K, 623 K, and 673 K, and stresses of 30, 35, and 40 Mpa. Results showed that the creep rate decreased with increasing volume % of SiC and with the smaller SiC particle size. Stress exponent and activation energy for creep and the threshold stress for creep were measured to determine the creep mechanism. It was concluded that diffusion in Al lattice was the rate-controlling mechanism for creep at the conditions of this work.

PAPER 52.4 — 16:00

MANUFACTURING AND PROPERTY EVALUATION OF A356/SAFFIL AND HYBRID A356/(SAFFIL+SiC_p) COMPOSITES FABRICATED VIA MELT INFILTRATION TECHNIQUE

S AMINI, S. JAVADPOUR, M.S. JAMSHIDI, Materials Science and Engineering Department, Engineering School, Shiraz University, Shiraz, Iran

The incorporation of alumina short fibers (SAFFIL) into aluminum alloys increases significantly the modulus and strangth of the alloy. Melt infilitration techniques have been emerged as an attractive fabrication route to manufacture high-volume-fraction high-performance net-shape alumina short fiber (SAFFIL) reinforced aluminum matrix composites. The production of porous SAFFIL performs and hybrid SAFFIL+SiC_p performs and the composite therefrom using squeeze casting technique have been themain steps of this research. The performs were produced by mixing SAFFIL fibers (and SiC_p) with colloidal silica binder, and different surfactants and deflocculants followed by spontaneous settlement of reinforcement(s) from the homogenous slurry, natural drying, heating and final strengthening. The effect of different process parameters on the properties of these preforms will be discussed in this paper. The influence of different superheats above the liquidus of the infiltrating A356 alloy on the infiltration profile and depth of infiltration of the A356 aluminum alloy into thepreforms and properties of the A356/SAFFIL and hybrid A356/(SAFFIL+SiC_P) composites were also determined.

PAPER 52.5 — 16:30

SQUEEZE CASTING OF ALUMINIUM ALLOYS AND MMCP.

J. MASOUNAVE, M. BORET, P. JHAGENER and M. BARTHOLE, École de Technologie Supérieure, Montréal, Québec, Canada

Squeeze casting of aluminium alloys is one of the most promising fabrication techniques for producing NNS parts. A large description of possible defects is given, and special emphasis is placed on rules for limiting the production of castings defects, mainly onMMCp.