

# CONTENTS

|  |    |  |     |
|--|----|--|-----|
| <b>FOREWORD by the Chairman of the Conference Organising Committee</b>                       | 13 | Use of lithium carbonate in low current density aluminium pots                             | 72  |
|  |    | V BELLO and F GREGU  |     |
| <hr/>  |    |  |     |
| <b>CHAPTER 1</b><br><b>The Aluminium Industry: Overview delivered at the Plenary Session</b> |    | Oxidation of high temperature calcined anode carbon  | 78  |
|  |    | S R BRANDTZAEG, LU ZHONG SHENG and H A ØYE   |     |
| Hall, Heroult and the development of the aluminium industry                                  | 17 | Innovative treatment of aluminum anodizing wastes for recovery of aluminum                 | 83  |
| D G ALTENPOHL  |    | F M SAUNDERS   |     |
| Aluminum - 2000 and beyond   | 24 | <hr/>  |     |
| P R BRIDENBAUGH  |    | <b>CHAPTER 3</b><br><b>Treatment of the Melt</b>   |     |
| Hall-Heroult process: a century-old advanced technology                                      | 30 | Filtration of aluminium melts  | 93  |
| P BAILLOT  |    | J A EADY, D M SMITH and J F GRANDFIELD   |     |
| Introduction of aluminium radiators for automotive engine cooling                            | 33 | MINT: an in-line treatment system for removing impurities from aluminium alloy melts       | 101 |
| G WINKHAUS   |    | J E DORE and B R MILLIGAN  |     |
| Advanced aluminium alloys for structural applications  | 38 | TAC: new process for molten aluminium refining   | 111 |
| J E HAWKINS  |    | B GARIÉPY and G DUBÉ   |     |
| Technological trends of aluminum in packaging, container and automotive applications         | 45 | Grain refining of commercial aluminium alloys with titanium boron aluminium                | 117 |
| R E HANNEMAN   |    | M E J BIRCH and P FISHER   |     |
| Advanced technology aluminum materials for aerospace applications                            | 51 | Influence of microstructures of Al-Ti master alloys on their grain refining properties     | 125 |
| T R PRITCHETT  |    | D HADLET, D G MCCARTNEY and S R THISTLETHWAITE   |     |
| <hr/>  |    |  |     |
| <b>CHAPTER 2</b><br><b>Primary Technology</b>  |    | Role of borides in grain refinement of aluminium by addition of Al-Ti-B type master alloys | 133 |
| Possible uses of sensors in the aluminium industry   | 61 | H ROMBOUT  |     |
| D J FRAY   |    | Silicon metal qualities for the aluminium industry   | 139 |
| Automatic anode effect termination (Al electrolysis)   | 67 | G HALVORSEN and G SCHÜSSLER  |     |
| K A PAULSEN  |    |  |     |

CHAPTER 4  
Casting Technology

|  |   |
|--|---|
| <p><b>Pechiney hot-top casting: a simple and proven technology</b> 149<br/>G M APOSTOLOU</p> <p><b>Improved billet quality by new fully automated hot-top casting process</b> 157<br/>K BUXMANN, J-J THELER and M BOLLIGER</p> <p><b>Operation of block caster system (Alusuisse Caster II) for coiled strip production</b> 164<br/>R J DEAN</p> | <p><b>Influence of low Zr additions on thin-walled profile mechanical properties of AlCuMg2 alloy</b> 223<br/>J PRGIN</p> <p><b>Surface generation and origin of defects during extrusion of Al alloys</b> 230<br/>M P CLODE and T SHEPPARD</p> <p><b>Surface formation mechanism in direct extrusion of aluminium alloys</b> 240<br/>H VALBERG</p> <p><b>Some differences between direct and indirect extrusion of aluminium alloys</b> 252<br/>H W LONG</p> |
|--|---|

CHAPTER 5  
Deformation Processing

|  |
|--|
| <p><b>Effects of thermomechanical history on hardness of aluminum</b> 175<br/>V M SAMPLE and L A LALLI</p> <p><b>Hot working behaviour of high-strength 7012 aluminium alloy</b> 185<br/>E EVANGELISTA, E BONETTI, E DI RUSSO, P FIORINI and H J McQUEEN</p> <p><b>Formation of high angle grain boundaries and new grains during deformation of Al-5%Mg at elevated temperatures</b> 191<br/>F J HUMPHREYS and M R DRURY</p> <p><b>Deformation mechanisms in two-phase aluminium alloys deformed at elevated temperatures</b> 197<br/>P N KALU and F J HUMPHREYS</p> <p><b>Superplastic deformation characteristics of some commercial aluminium alloys</b> 204<br/>N RIDLEY and J PILLING</p> <p><b>Substructure development and properties in cold rolled Al alloy 3004</b> 211<br/>YI-LIN LIU, L DELAEY and J P BAEKELANDT</p> <p><b>Influence of heat treatment practice on extrudability and properties of AlMgSi alloy sections</b> 216<br/>J LANGERWEGER</p> |
|--|

|  |
|--|
| <p><b>Herringbone formation in sheet and foil rolling</b> 258<br/>J D DOWD</p> |
|--|

CHAPTER 6  
Texture Analysis

|   |
|---|
| <p><b>Rolling and recrystallization textures of aluminium</b> 267<br/>K LÜCKE and J HIRSCH</p> <p><b>Recrystallization and texture control during processing</b> 280<br/>E NES</p> <p><b>Investigations into the origin of cube recrystallization texture in aluminium alloys</b> 289<br/>R D DOHERTY, W G FRICKE Jr and A D ROLLETT</p> <p><b>Modulation of rolling and recrystallization textures of aluminium by variation of starting texture</b> 303<br/>J HIRSCH, W MAO and K LÜCKE</p> <p><b>Modeling mechanical properties from crystallographic texture (ODF) of aluminium alloys</b> 310<br/>W G FRICKE Jr, M A PRZYSTUPA and F BARLAT</p> <p><b>Development of subgrain morphology and texture in multi-pass rolling of aluminium</b> 317<br/>P A HOLLINSHEAD and T SHEPPARD</p> |
|---|

Anisotropy of mechanical properties of Al-Li based alloy plate 327  
S FOX, D S McDARMAID and H M FLOWER

Deformation and annealing textures produced in strip cast 3004 aluminum alloy 333  
O S ES-SAID and J G MORRIS

Texture control for continuously cast AlFeSi alloys 339  
B ANDERSSON, S E NAESS and H P FALKENSTEIN

---

CHAPTER 7  
Recrystallisation

Particle stimulated nucleation of recrystallization in Al-Mg<sub>2</sub>Si 347  
J LIU and R D DOHERTY

Hot worked and annealed microstructures in Al-Mg alloys 357  
N RAGHUNATHAN and T SHEPPARD

Metallurgy of rapid heat treatment of aluminium alloy strip by transverse flux induction heating 373  
D J WALKER, R W HILDITCH and J C BLADE

Surface analysis of aluminium foil 383  
I OLEFJORD and Å KARLSSON

---

CHAPTER 8  
Corrosion and Quench Sensitivity

Corrosion and corrosion cracking of aluminium alloys see 395  
M O SPEIDEL

Effect of quench path on properties of aluminum alloys 396  
J T STALEY

Decomposition of solid solution during quench cooling of 7075 alloy: cooling rate and C curves 408  
P ARCHAMBAULT, F MOREAUX and G BECK

Microstructural changes during retrogression and reaging in AA-7075: a TEM study 414  
F HABIBY, A UL HAQ, F H HASHMI and A Q KHAN

---

CHAPTER 9  
Aluminium-Lithium Alloys

Phase transformations in Al-Li-Cu-Mg-Zr alloys 423  
P J GREGSON and H M FLOWER

Dimensional stability during heat treatment of an Al-Li-Cu-Mg alloy 429  
O R MURPHY and J W MARTIN

Strengthening mechanisms in two Al-Li-Cu alloys 434  
J C HUANG and A J ARDELL

Temperature variation of tensile properties of an Al-Li-Cu-Mg alloy 442  
P J E BISCHLER and J W MARTIN

---

CHAPTER 10  
Properties of Aluminium Alloys

Fatigue crack propagation in Al-Li-Mg-Cu-Zr (8090) alloys 451  
S J HARRIS, B NOBLE and K DINSDALE

7075-101-T73: tough plates and forgings with improved fatigue strength for airframe applications 459  
B DUBOST, J BOUVAIST, R MACE and M O CHARUE

Fracture processes of recent 2000 and 7000 aircraft alloys under static and dynamic stresses 468  
M BURATTI, E DI RUSSO and G GIORDANO

Creep and elevated temperature strength of cold rolled AlMn1 sheet produced by strip-casting or direct chill casting 478  
H-E EKSTRÖM, A-S BOSTRÖM and R LARKER

Wear resistance of aluminium and its alloys 485  
T S EYRE and F ABDUL-MAHDI

Development of new superplastic aluminum alloy 493  
K OHORI, H WATANABE and Y TAKEUCHI

Effect of porosity on strength and ductility of gravity die cast Al-7Si-0.3Mg alloy 498  
M K SURAPPA, E BLANK and J C JAQUET

---

CHAPTER 11  
**Welding and Brazing Technology**

Fusion welding of Al-Li-Cu-(Mg)-Zr plate 507  
M H SKILLINGBERG

Plasma keyhole welding of high strength aluminium alloys 516  
J LEUPP and A MAITLAND

Development of improved aluminum vacuum brazing core alloy 521  
K D WADE and D H SCOTT

Factors influencing surface behaviour of aluminium vacuum brazing alloys 528  
B MCGURRAN, M G NICHOLAS and Å KARLSSON

Development of sagging resistant brazing sheet for fin of aluminum heat exchangers 537  
K TOHMA and Y TAKEUCHI

---

CHAPTER 12  
**Alloys for Specific Applications**

Aluminium structures in volume car production 543  
P G SHEASBY, M J WHEELER and D KEWLEY

Aluminium alloys for memory disc 550  
D CONSTANT and R EZNACK

Development of high wear resistant Al-Si alloy 557  
M SUKIMOTO, I IWAI and I MURASE

Production line for one-piece aluminium forged wheel with spinning process 565  
A ASARI, S MATSUMOTO and T DOSAI

---

CHAPTER 13  
**Formability**

Warm forming of aluminium alloy sheet 581  
T ANDREWS, W T ROBERTS,  
P M B RODRIGUES and D V WILSON

Formability testing of aluminum alloys 589  
J M STORY

Initiation and growth of sample-scale shear bands during plane strain extension of Al-Mg sheet 597  
J E BIRD, K E NEWMAN, J M CARLSON and K NARASIMHAN

Crystal-scale shear bands formed in Al-Mg alloy by transgranular coordination of coarse slip 604  
J E BIRD, K E NEWMAN and K NARASIMHAN

---

CHAPTER 14  
**Process Modelling**

Microstructure-based modeling of deformation processes 615  
O RICHMOND

Advances in hot rolling technology 619  
P J S BROOKS

Mathematical modelling of hot rolling of aluminum 628  
A J BEAUDOIN Jr and K A WOODBURY

Superplastic forming analysis using a finite element viscous flow formulation 635  
W C ZHANG, R D WOOD and O C ZIENKIEWICZ

Improvements to concentricity of extruded aluminium alloy tubes 641  
C PLUCHON

Strain analysis in deformed  
aluminium alloys 650

H A LAIRD, K R GILMOUR and D McKEAG

Thermomechanically coupled analysis of  
streamlined die extrusion including  
hardness predictions

R E SMELSER 656

Heat balance and exit temperature  
control in extrusion of  
aluminium alloys 663

R AKERET and W STREHMEL

---

CHAPTER 15  
Rapid Solidification Technology

Influence of atomizing conditions on  
structure of aluminium powders 673

A ÜNAL

Microstructure of rapidly solidified  
Al powder alloys 679

G J MARSHALL

Production and consolidation of  
ultrafine Al-alloy powder 689

R A RICKS and N J E ADKINS

Microstructural inhomogeneities in  
rapidly solidified aluminum alloy powders  
M A ZAIDI [see 697] 839

Hardening mechanism in rapidly solidified  
Al-Fe alloys and effect on  
mechanical properties 698

L ACKERMANN, S DERMARKAR and J F FAURE

An aluminium-magnesium-lithium alloy  
made by mechanical alloying 707

P J BRIDGES, J W BROOKS and P S GILMAN

Laser surface alloying and cladding of  
aluminium alloys with silicon  
A M WALKER, W M STEEN and D R F WEST 712

---

CHAPTER 16  
Composites

Local recrystallization of cold rolled  
Al alloys by high power beams:  
realization of cold rolled recrystallized  
composite sheets

J DIETZ and J MERLIN 727

Cast aluminium composites see 731  
A J CLEGG

Silicon carbide whisker reinforced  
aluminum composites: fabrication  
and properties 732

K OHORI, H WATANABE and Y TAKEUCHI

---

CHAPTER 17  
Advances in Equipment and Control:  
Melting and Casting

Application of centrifugal molten metal  
pump in producing energy efficiency,  
productivity and quality in aluminum  
melting furnaces

D V NEFF 739

Liquid aluminium remotely controlled 747  
K-O HORNUNG and O H C MESSNER

Recovery of aluminium process scrap by  
coreless induction melting  
L SMITH 753

Electromagnetic pumps in foundry and  
for use in the metal industry 763  
A W JONES

CerHx ceramic heat exchangers: five  
years of energy conservation in the  
aluminum industry 771  
R M WOODWARD

Rebuilding of open well furnace for  
improved energy efficiency  
(Al casthouse) 780  
T JOHNSEN

---

CHAPTER 18  
**Advances in Equipment and Control:  
Deformation Processing**

|  |     |
|--|-----|
| Role of modern salt baths in processing<br>of aluminium and its alloys                           | 789 |
| B BECKETT  |     |
| Direct conversion from molten aluminium<br>to extruded profile by Conform                        | 794 |
| B MADDOCK  |     |
| Conform/Conklad by Babcock   | 802 |
| R D PARKINSON  |     |
| Development of tool materials for<br>the extrusion industry                                      | 813 |
| K HABERFELLNER, A SCHINDLER and G FERSTL   |     |
| TFX induction annealing of aluminium<br>strip: experience in Japan with<br>first production line | 818 |
| R C J IRESON   |     |
| A new generation of foil rolling mills   |     |
| A E BARTEN   | 826 |
| Future developments in profile<br>thickness gauging of aluminium<br>hot-rolled strip             | 830 |
| D R ALLEN, P M REYNOLDS and<br>K R WHITTINGTON   |     |

---

**APPENDIX**

|  |     |
|--|-----|
| Microstructural inhomogeneities in<br>rapidly solidified aluminum<br>alloy powders |     |
| M A ZAIDI  | 839 |

---

|                         |     |
|-------------------------|-----|
| <b>INDEX OF AUTHORS</b> | 847 |
|-------------------------|-----|