

# Table of Contents

## Preface

## Chapter 1: Keynote Lectures

<b>Dendrite Fragmentation in Semisolid Casting: Could we Do this Better?</b>	
M.C. Flemings	3
<b>Correlation between Microstructure and Properties of Semi-Solid Products</b>	
A. Pola	12
<b>Semi-Solid Casting of Aluminium from an Industrial Point of View</b>	
J. Winklhofer	24

## Chapter 2: Materials Development and Characterization

<b>Semi-Solid Processing of Nano-SiC<sub>p</sub>/ Al-Si Composites and Mechanical Properties with Rheo-Casting</b>	
S.S. Wu, D. Yuan, Q. Chen, S.L. Lü and Z.W. Huang	33
<b>A Study of Anodising Behaviour of Al-Si Components Produced by Rheocasting</b>	
B.W. Zhu, S. Seifeddine, A.E.W. Jarfors, P. Leisner and C. Zanella	39
<b>Microstructural Evolution of SKD11 Tool Steel during Multi-Stage Thixoforming and Subsequent Heat Treatments</b>	
Y. Meng, H.M. Zhou, J.L. Gan and S. Sugiyama	45
<b>Structural Characteristics of Metal-Ceramic Interpenetrating Phase Composites Manufactured by Using Semi-Solid Forming Technology</b>	
L. Schomer and M. Liewald	51
<b>Effects of High Pressure on Fe-Rich Phases and Mechanical Properties of Al-14Si Alloys with Rheo-Squeeze Casting</b>	
C. Lin, S.S. Wu and S.L. Lü	57
<b>Wear Properties of Thixoformed Al-5.7Si-2Cu-0.3Mg Aluminium Alloy</b>	
M.A. Abdelgnei, M.Z. Omar and M.J. Ghazali	63
<b>Influence of Rare Earth Additions on the Microstructure and Mechanical Properties of Al7Si0.3Mg Alloys Processed by Semi-Solid Die Casting and Gravity Die Casting</b>	
L.F. Li, D.Q. Li, M. Luo, Y.Z. Zhang, Y.L. Kang, Q. Zhu and S.P. Midson	69
<b>Overageing Characteristics of Alloy A356 and Al-Mg-Si Casting Alloys</b>	
P. Daswa, H. Moller and G. Govender	75
<b>Variation of Properties in the Cross-Section of Semi-Solid Al-7Si-0.3Mg Castings</b>	
J. Santos, A.E.W. Jarfors and A.K. Dahle	81
<b>Microstructure and Mechanical Properties of AZ91D Alloy by Three Types of Forging Process</b>	
W.T. Tian and H. Yang	87
<b>Wear and Corrosion Behavior of Functionally Graded Semi-Solid 9Cr18Mo Steel</b>	
Y.J. Wang, R.B. Song, J. Yanagimoto and Y.P. Li	92
<b>Application of the Correlation between Hardness and Strength in Conventional Al Alloys into Semi Solid Processed Products</b>	
K. Du, W.Y. Qu, Y.H. Jing and Q. Zhu	99
<b>Comparison of Semisolid Microstructure Evolution of Wrought Nickel Based Superalloy GH4037 with Different Solid Fraction</b>	
G.F. Xiao, J.F. Jiang, Y. Wang and Y.Z. Liu	105
<b>Ti-Zr-V-Cu-Be BMGMCs Processed by Semi-Solid Processing</b>	
H.M. Guo, L.R. Bai, B. Liu and X.J. Yang	111
<b>Weldability and Joining Characteristics of AISI D2/AISI 304 Steels Using Semisolid Diffusion Joining</b>	
M.N. Abdul Razaq, M.Z. Omar, S. Al-Zubaidi, K.S. Alhawari and M.A. Abdelgnei	115

<b>Mechanical Properties of CNTS-Grafted Carbon Fiber/Magnesium Composites Prepared by Liquid-Solid Infiltration Extrusion</b>	121
J.M. Zhou, H.M. Meng, L.J. Han and L.H. Qi	
<b>Microstructure Evolution of TiB<sub>2</sub>/7075 Composites in Semi-Solid State near Liquids within Holding Time</b>	127
G.S. Gan, D.Q. Xia, X. Liu, C. Liu, H.L. Cheng, Z.Z. Ming, H.Y. Gao and B. Yang	
<b>Effect of Nano-SiC on Microstructure and Mechanical Properties of AZ91 Magnesium Alloy Processed by Thixomolding</b>	133
Ł. Rogal, B. Baran, P. Bobrowski, A. Tarasek, P. Ozga and L. Lityńska-Dobrzańska	
<b>Evolution of Microstructure and Mechanical Properties of Semi-Solid Squeeze Cast A356.2 Aluminum Alloy during Heat Treatment</b>	139
L. Cheng, H.X. Lu, Q. Zhu, X.K. Zhang, A.D. Shen and P. Yang	
<b>Microstructure of Semi-Solid Extruded Copper Alloy after Heat Treatment</b>	146
N.Y. Li, H. Xiao, C. Xiong, D.H. Lu and R.F. Zhou	
<b>Refinement of Primary Silicon Grains in Semi-Solid Al-25%Si Hypereutectic Aluminum Alloy Slurry</b>	153
W.M. Mao, P.Y. Yan and Z.K. Zheng	
<b>Characterization of Microstructure and Shrinkage Porosity of a Semi-Solid Metal Slurry in Gravity Die Casting</b>	161
S. Thanabumrungkul, W. Jumpol, R. Canyook, N. Meemongkol and J. Wannasin	

## **Chapter 3: Semi-Solid Slurry Preparation and Semi-Solid Processing Technologies**

<b>Preparation of Semi-Solid A390 Aluminum Alloy Slurry through a Serpentine Pouring Channel</b>	169
W.M. Mao, P.Y. Yan and Z.K. Zheng	
<b>SIMA Processing of Cu34wt.%Zn2wt.%Pb Brass Alloy</b>	176
H. Tavakkoli, B. NIROUMAND and A. Rezaeian	
<b>Metallurgical Structure of A356 Alloy Solidified by Mechanical Stirring</b>	183
H. Yang and W.T. Tian	
<b>Manufacture of Continuous Metal Matrix Composite Strip Reinforced by Particulate Materials from the Semisolid Processing</b>	189
A.d.P. Lima Filho, B.K.S. Ueda, T.P. de Castro and R.A.N. de Oliveira	
<b>Experimental Study on C<sub>p</sub>/Al Composite Plate with Complex Curved Surface Fabricated by Liquid-Solid Infiltration Extrusion</b>	197
L.H. Qi, L.J. Han, J.M. Zhou, H.M. Meng, X. Yu and W.J. Ma	
<b>Thixoforming of Wrought Aluminum Alloy 1973</b>	203
T.B. Ngo, A.B. Semenov and B.I. Semenov	
<b>Thixoforming of Semisolid Slurry with High Fraction Solid Fabricated by Partial Melting of Commerical Wrought Aluminum Alloys</b>	210
J.F. Jiang, Y.Z. Liu, G.F. Xiao and Y. Wang	
<b>Effects of Annular Electromagnetic Stirring Melt Treatment on Microstructure and Mechanical Properties of 7050 Rheo-Casting</b>	219
T.Y. Guan, Z.F. Zhang, M. He, Y.L. Bai and P. Wang	
<b>Influence of Pouring Temperature and Alloy Additions on the Quality of a Semisolid Material Dragged during the Continuous-Casting Strip Processing of Al-Si A413</b>	224
A. de Pádua Lima Filho, L.V.G. Ferreira, P.B. de Oliveira Neto, C.B. de Oliveira, C.H. de Oliveira Arantes, T.P. de Castro, M. Borodiak and A.L. Quadro	
<b>Microstructural Evolution of ZL104 Aluminum Alloy Semi-Solid Billet Fabricated by RAP Process</b>	234
Y.F. Wang, S.D. Zhao, C. Chen, P. Dong and P. Zhang	
<b>Damaging of Ultrasonic Horn for Semisolid Feedstock Production</b>	240
L. Montesano, A. Pola, M. Tocci, M. Gelfi and G.M. La Vecchia	
<b>Semisolid Casting of Short Freezing Range Alloys</b>	247
F. Marani and B. NIROUMAND	
<b>Semi-Solid Slurry Casting Using Gas Induced Semi-Solid Technique to Enhance the Microstructural Characteristics of Al-4.3Cu Alloy</b>	253
M. Abdi and S.G. Shabestari	

<b>Fabrication of Lotus Type Porous Ingots Using the Core-Bar Pulling Method</b>	259
T. Haga and H. Fuse	
<b>Microstructure and Properties of Semi-Solid CuSn10P1 Alloy under Different Filling Velocity by Squeeze Casting</b>	264
Y.K. Li, R.F. Zhou, L. Li, H. Xiao and Y.H. Jiang	
<b>Addition of Swarf to Produce a Semi-Solid Slurry during High Pressure Die-Casting of AS9U3 Aluminum Alloy</b>	271
H. Hadian, M. Haddad-Sabzevar and M. Mazinani	
<b>Analysis of the 355 Aluminium Alloy Microstructure for Application in Thixoforming</b>	277
L.C. de Paula, S. Tokita, K. Kadoi, H. Inoue and E.J. Zoqui	
<b>Impact of Intensification Pressure and Grain Refiner on the Hot Tearing Susceptibility of a Semi-Solid Cast Al-Zn-Mg-Cu Alloy</b>	283
H.Y. Zhao, D.Q. Li, M. Luo, S.P. Midson and Q. Zhu	
<b>Microstructural Investigation of Semisolid Aluminum A356 Alloy Prepared by the Combination of Electromagnetic Stirring and Gas Induction</b>	290
N. Nafari, F. Yekani and H. Aashuri	
<b>Effect of Particle Size and Weight Percent of SiC Particles on Microstructure and Hardness of A356-SiC Composites Produced by Semi-Solid Stir Casting</b>	296
P. Saenpong, S. Talangkun, S. Sanyajivin and P. Kaprano	
<b>Microstructural Development of Aluminum A201 Alloy Semi-Solid Processing Feedstock Produced by Different Routes</b>	302
P. Kaprano	
<b>Slurry Preparation and Hot Tearing Susceptibility of A201 Aluminum Alloy in Rheological Die Casting</b>	311
J.Z. Gao, Q. Zhu, D.Q. Li, X.G. Hu, M. Luo and Y.L. Kang	
<b>A Study on Bar Drawing Process of A356 Alloy in Semisolid State</b>	318
S. Simlandi, N. Barman and H. Chattopadhyay	
<b>Metallurgical Interface of 7075/6061 Bimetallic Composite Ingot Casted by Semi-Solid Slurry and Molten Metal Pouring</b>	326
X.P. Zheng, L. Jiang, H.B. Li, Y.Q. Tian and L.S. Chen	
<b>Development of Slurry Preparation Method by Applying Mechanical Vibration</b>	333
Y. Murakami, K. Miwa, M. Kito, T. Honda and N. Omura	
<b>Evaluation of Al-5wt%Si-5wt%Zn as Raw Material for Semisolid Forming</b>	339
C.T.W. Proni, L.C. de Paula, L. Torres and E.J. Zoqui	

## Chapter 4: Techniques of Modelling and Numerical Research

<b>Modelling and Experimental Investigations of Tooling Issues for Thixoforming of Steel</b>	347
A. Rassili	
<b>Study on Thixoforming Process of 15%SiCp/2A14 Composite for Production of Track Shoe</b>	354
H.S. Zheng, Y.L. Bai, T.Y. Guan, Z.F. Zhang and J. Xu	
<b>Modelling Semi-Solid Behaviour and Brittle Temperature Range</b>	361
K. Traidi, V. Favier, P. Lestriez, K. Debray, L. Langlois and T. Balan	
<b>Using the Phase Field Method to Investigate Microstructural Evolution of Semi-Solid 357.0 Slurries</b>	367
W.Y. Qu, D.Q. Li, Z.P. Guo, M. Luo, F. Zhang, S.P. Midson, X.G. Hu and Y.Z. Zhang	
<b>Numerical Simulation of Slurry Making Process of 7075 Aluminum Alloy under Electromagnetic Field in Rheocasting Process</b>	373
G. Li, H.X. Lu, X.G. Hu and Q. Zhu	
<b>Viscoelastic Properties of Thixotropic Semisolid Alloy Relating the Microstructure</b>	380
G. Sanjuan-Sanjuan and Á.E. Chavez-Castellanos	
<b>Rheological Investigation of Semisolid AlSi7 Alloy by Means of Oscillation Experiments</b>	385
M. Tocci, A. Pola and M. Modigell	
<b>Apparent Viscosity and Rheological Behavior of Aluminum-Alloy Slurry Containing Nano-Sized SiC Particles</b>	391
K. Lu, S.S. Wu, S.L. Lü and C. Lin	

**Effect of Primary  $\alpha$ -Al Morphology in Slurry on Segregation during 357 Semi-Solid Die Casting**

H. Zhang, D.Q. Li, W.Y. Qu, F. Zhang, M. Luo, S.P. Midson and Q. Zhu

398

## Chapter 5: Industrial Application

### Recent Advances in Commercial Application of the Rheometal Process in China and Europe

A.E. W. Jarfors, J.C. Zheng, L. Chen and J. Yang 405

### Semisolid Forging of 250 Automotive Spindles of S48C Steel

J. Lozares, G. Plata, I. Hurtado, Z. Azpilgain and I. Loizaga 411

### Recent Developments of Rheo-Diecast Components for Transportation Markets

D.Q. Li, F. Zhang, S.P. Midson, X.K. Liang and H. Yao 417

### Fabrication of Thin Heat Sinks by the Die Casting of Semisolid Al-25%Si

T. Haga, H. Fuse and M. Terao 423

### Die Design for Main Bearing Cap of Engine Block Based Semi-Solid Die Casting Process and the Comparison Analysis with Squeeze Casting Process

S. Chen, D.Q. Li, F. Zhang, M. Luo, X.K. Liang and Q. Zhu 429

### The Status of Magnesium Injection Molding in China

Y.B. Zhu and S.P. Midson 436

### Case Study: Engine Bracket Made by Rheocasting Using the SEED Process

P. Côté, B. Vlastimil and B.B. Stunová 441

### Thixoforming of Hypereutectic AlSi12Cu2NiMg Automotive Pistons

A.B. Semenov, T.B. Ngo and B.I. Semenov 446

### Industrialized Application of Rheo-HPDC Process for the Production of Large Thin-Walled Aluminum Alloy Parts

M.F. Qi, Y.L. Kang and Q.Q. Qiu 453

### Analysis of the Influence of Surface Finishing on the Performances of Dies for HPDC

F.S. Gobber, D. Ugues and M. Rosso 459

### Semi-Solid Casting of Pure Magnesium

U.A. Curle and J.D. Wilkins 464

### GISS Technology: Principle and Applications in Die Casting

J. Wannasin, M. Fuchs, J.Y. Lee, C. Lee, T.V.L. Narasimha Rao and M.C. Flemings 470

### Thixoforming of Aluminum A201- Expectations and Fulfilment

P. Kapranos 476

### Semisolid Processing of Magnesium Alloys: Progress and Limitations

F. Czerwinski 489