

# Contents

## Volume I

### Plenary Papers

|                                                                                            |    |
|--------------------------------------------------------------------------------------------|----|
| Titanium Developments in the UK.....                                                       | 1  |
| <i>M. Ward-Close</i>                                                                       |    |
| Development of Titanium Processing Technologies in the USA.....                            | 9  |
| <i>K.-O. Yu, M.A. Imam</i>                                                                 |    |
| Current Status of Titanium Production, Research and Applications in CIS .....              | 17 |
| <i>O.M. Ivasishin, A.V. Aleksandrov</i>                                                    |    |
| Recent Titanium Research and Development in Germany .....                                  | 25 |
| <i>D. Helm, O. Roder</i>                                                                   |    |
| Challenges for the Development of Titanium in France and in the European Industry .....    | 33 |
| <i>P.-F. Louvigné</i>                                                                      |    |
| Review of Titanium Industry in China .....                                                 | 41 |
| <i>L. Zhou</i>                                                                             |    |
| Recent Developments in the Research, Production and Application of Titanium in Japan ..... | 49 |
| <i>T. Kaya</i>                                                                             |    |

### Extractive Metallurgy

#### Keynote Paper

|                                                                                                                              |     |
|------------------------------------------------------------------------------------------------------------------------------|-----|
| Application of the FFC Cambridge Process for the Production of Titanium Alloys .....                                         | 59  |
| <i>R. Dashwood, M. Jackson, K. Dring, K. Rao, R. Bhagat, D. Inman</i>                                                        |     |
| Study on the Effect of Mechanical Activation on the Kinetics of Hydrochloric Acid Leaching of Ilmenite .....                 | 67  |
| <i>M.H. Paydar, J. Bahrani, M.H. Shariat</i>                                                                                 |     |
| Chlorination of Titanium Oxycarbide Produced by Carbothermal Reduction of Rutile .....                                       | 71  |
| <i>A. Adipuri, G. Zhang, O. Ostrovski</i>                                                                                    |     |
| Synthesis of Titanium Oxycarbide by Carbothermal Reduction of Titania in Different Gas Atmospheres .....                     | 75  |
| <i>M.A.R. Dewan, G. Zhang, O. Ostrovski</i>                                                                                  |     |
| Synthesis of Titanium Oxycarbonitride by Carbothermal Reduction of Titania in Nitrogen Containing Gas Mixtures.....          | 79  |
| <i>S.A. Rezan, G. Zhang, O. Ostrovski</i>                                                                                    |     |
| Operation of Electrolysis Cells for the Direct Production of Titanium from Solid Oxide Precursors .....                      | 83  |
| <i>K. F.Dring, O.-A. Lorentsen, E. Hagen, C. Rosenkilde</i>                                                                  |     |
| Cathodic Behaviour of $\text{TiO}_2$ in Molten $\text{CaCl}_2$ -based Electrolytes .....                                     | 87  |
| <i>K. Dring, K. Rao, R. Dashwood, D. Inman</i>                                                                               |     |
| Investigation of the Reduction Electrochemistry of Titanium Oxides in Molten Calcium Chloride using a Cavity Electrode ..... | 91  |
| <i>K. Rao, K. Dring, D. Brett, D. Inman, R. Dashwood</i>                                                                     |     |
| Direct Electrochemical Production of Ti-10V-2Fe-3Al from Mixed Oxide Precursors.....                                         | 95  |
| <i>K. Dring, R. Bhagat, M. Jackson, R. Dashwood, D. Inman</i>                                                                |     |
| Calciothermic Reduction of $\text{TiO}_2$ with $\text{ZrO}_2$ Anode in Molten $\text{CaCl}_2$ .....                          | 99  |
| <i>R.O. Suzuki</i>                                                                                                           |     |
| Reduction of $\text{TiCl}_4$ Gas by Ca Dissolved in Molten Calcium Chloride .....                                            | 103 |
| <i>T. Naito, R. O. Suzuki, Y. Tomii</i>                                                                                      |     |
| Preparation of Hydrogen Storage Ti-V-Cr Alloy from the Oxide Mixture in $\text{CaCl}_2$ .....                                | 107 |
| <i>Y. Kano, R.O. Suzuki</i>                                                                                                  |     |

|                                                                                                                     |     |
|---------------------------------------------------------------------------------------------------------------------|-----|
| Fundamental Study on Titanium Production Process by the Disproportionation Reactions of Titanium Subchlorides ..... | 111 |
| <i>T. Oi, T.H. Okabe</i>                                                                                            |     |
| Titanium Production Process by Utilizing Titanium Subchlorides.....                                                 | 115 |
| <i>O. Takeda, T.H. Okabe</i>                                                                                        |     |
| Production of Titanium Powder Directly from Titanium Ore .....                                                      | 119 |
| <i>H. Zheng, T.H. Okabe</i>                                                                                         |     |
| A Thermodynamic Study on the Deoxidation of Titanium by Calcium Halide Flux .....                                   | 123 |
| <i>S. M. Han, G.S.Choi, D.J. Min</i>                                                                                |     |
| Application of a ‘See-through’ Electrolytic Cell for Titanium Electrowinning .....                                  | 127 |
| <i>K. McGregor, A.J. Urban, E.J. Frazer</i>                                                                         |     |
| DCW Synthetic Rutile - A Feed Stock for Titanium Sponge.....                                                        | 131 |
| <i>B. Yadav</i>                                                                                                     |     |
| Stepped-up Production Capacity of Titanium Sponge .....                                                             | 135 |
| <i>J. Nanjyo, N. Mochizuki, T. Hyodo</i>                                                                            |     |
| History of Improving TOHO TITANIUM Sponge Quality .....                                                             | 139 |
| <i>N. Nakahara, S. Kosemura, A. Karato, E. Fukasawa</i>                                                             |     |
| Development of New Titanium Production Process .....                                                                | 143 |
| <i>M. Yamaguchi, Y. Ono, S. Kosemura, W. Kagohashi, T. Takenaka</i>                                                 |     |
| New Smelting Method Development (Ca Cleaner Technology) .....                                                       | 147 |
| <i>M. Yamaguchi, T. Ogasawara, H. Ichihashi</i>                                                                     |     |
| Titanium Alloy Melt Process Quality Improvements .....                                                              | 151 |
| <i>A.P. Woodfield, C.E. Shamblen</i>                                                                                |     |
| Titanium Ingot Production at Toho Titanium Co., Ltd.....                                                            | 155 |
| <i>H. Okano, Y. Hatta, O. Tada, H. Tanaka</i>                                                                       |     |
| Optimization of VAR Process by Applying Computational Simulation.....                                               | 159 |
| <i>K. Suzuki, N. Fukada, O. Kanou</i>                                                                               |     |
| Simulation of Macroscopic Segregation in Titanium Alloy VAR Ingots .....                                            | 163 |
| <i>H. Yokoyama, N. Mitsui, H. Ishida, K. Nakayama, T. Kusamichi</i>                                                 |     |
| Experience in Using Scull Arc Remelt for Production of Multi-Component Titanium Alloys.....                         | 167 |
| <i>V.V. Tetyukhin, I.V. Levin, M.I. Musatov, I.U. Puzakov, S.M. Chechulin, N.U. Tarenkova</i>                       |     |
| Segregation and Solidification in Titanium Alloy .....                                                              | 173 |
| <i>A. Mitchell, A. Kawakami</i>                                                                                     |     |
| Extraction of Titanium in a Liquid State from Molten Slag with a DC-ESR Unit .....                                  | 177 |
| <i>A. Matsuyama, T. Kawabata, M. Sugawara, T. Takenaka, M. Kawakami</i>                                             |     |
| Ingots Crystallization in Titanium Sponge Cakes Electron Beam Direct Melting .....                                  | 181 |
| <i>B.E. Paton, H.V. Zhuk, M.P. Trygub</i>                                                                           |     |
| The Electron Beam Cold Hearth Melting Technology .....                                                              | 185 |
| <i>X. Wang, Z. Chen, F. Chen, W.Zoi, J. Jiang, Q. Gao</i>                                                           |     |
| The Preparation of Homogeneous Ingot of Ti35 Alloy .....                                                            | 189 |
| <i>J. Wu, Y. Yang, Q. Lin, H. Zhao, B. Zhao, X.Mao, Y. Zhao</i>                                                     |     |

## Properties

### Keynote Paper

|                                                                                                                                      |     |
|--------------------------------------------------------------------------------------------------------------------------------------|-----|
| Microstructure Formation in Titanium Alloys by Solid/Solid Phase Transformation: Towards Prediction of Morphology Distributions..... | 195 |
| <i>E. Aeby-Gautier, B. Appolaire, J. Da Costa Teixeira, F. Bruneseaux, S. Denis</i>                                                  |     |

|                                                                                                                                                      |     |
|------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Ultrafine-grained CP-Ti Fabricated by Severe Plastic Deformation and Annealing .....                                                                 | 203 |
| <i>D. Terada, M. Inoue, H. Kitahara, N. Tsuji</i>                                                                                                    |     |
| Influence of Heat Generation during HPT-straining on Strengthening and Grain Refinement in Commercial Purity Ti .....                                | 207 |
| <i>Y. Todaka, M. Umemoto, A. Yamazaki, J. Sasaki, K. Tsuchiya</i>                                                                                    |     |
| Anisotropic Behavior of Pure-titanium Sheet under Biaxial Tension .....                                                                              | 211 |
| <i>M. Ishiki, T. Kuwabara, M. Yamaguchi, Y. Maeda, Y. Hayashida</i>                                                                                  |     |
| Influence of Grain Size and Strain Rate on the Constitutive Response and Texture Evolution in High-purity Titanium .....                             | 215 |
| <i>G.T. "Rusty" Gray III, E.K. Cerreta, S.R. Chen</i>                                                                                                |     |
| Deep Drawing of Pure Titanium and Pure Aluminum Using Plastic Die for Prevention of Seizure .....                                                    | 219 |
| <i>Y. Harada, K. Fukaura</i>                                                                                                                         |     |
| Forming of Long Titanium Alloy Cups by Multistage Deep Drawing .....                                                                                 | 223 |
| <i>Y. Harada, K. Fukaura, T. Murao</i>                                                                                                               |     |
| Micro-indentation of Commercially Pure Titanium .....                                                                                                | 227 |
| <i>R. Chen, F. Yang, M. A. Imam</i>                                                                                                                  |     |
| Direct Observation of Solidification and Morphological Development in Pure Titanium .....                                                            | 231 |
| <i>Y. Komizo, H. Terasaki, M. Ikeda, F. Nishino</i>                                                                                                  |     |
| Influence of Solid Solution Hydrogen on Grain Growth in Commercially Pure Titanium .....                                                             | 235 |
| <i>H. Fujii, H. Otsuka, H. Araki, Y. Shirai</i>                                                                                                      |     |
| In situ 3-D Imaging of Combined Microstructure and Crack Propagation in Ti Alloys using Phase Sensitive Synchrotron Microtomography .....            | 239 |
| <i>M. Karadge, L. Babout, F. Garcia-Pastor, W. Ludwig, P. J. Withers, J-Y. Buffière, and M. Preuss</i>                                               |     |
| The Reason to Produce Noises in Ultrasonic Detection of Titanium Alloys .....                                                                        | 243 |
| <i>X. Ma, Y. Zhang, J. Liu</i>                                                                                                                       |     |
| X-ray Stress Measurement of Titanium Casting Materials .....                                                                                         | 247 |
| <i>A. Shiro, M. Nishida, T. Jing</i>                                                                                                                 |     |
| Formability of Newly Developed High-performance Titanium Alloys for Automotive Exhaust Systems .....                                                 | 251 |
| <i>H. Otsuka, K. Takahashi, Y. Itami, H. Fujii, K. Tokuno</i>                                                                                        |     |
| Creep Properties of Near Alpha Titanium Alloys at Elevated Temperatures Higher than 600° C .....                                                     | 255 |
| <i>Y. Kosaka, S.P. Fox</i>                                                                                                                           |     |
| Description and Characterisation of Texture Heterogeneities in Titanium Alloy TIMETAL 834 with a Bimodal Microstructure .....                        | 259 |
| <i>E. Uta, M. Humbert, N. Gey, A. Hazotte, P. Bocher, M. Jahazi</i>                                                                                  |     |
| Recrystallization during Alpha + Beta Processing of IMI834 .....                                                                                     | 263 |
| <i>P. Vo, M. Jahazi, S. Yue</i>                                                                                                                      |     |
| Microstructural Modeling of Cold Creep/Fatigue in Near Alpha Titanium Alloys Using Cellular Automata Method .....                                    | 267 |
| <i>N. Boutana, P. Bocher, M. Jahazi, D. Piot, F. Montheillet</i>                                                                                     |     |
| Inhomogeneous Strain Accumulation in a Model Near $\alpha$ Titanium Alloy .....                                                                      | 271 |
| <i>L. Germain, E.E. Sckett, M. Bache</i>                                                                                                             |     |
| Comparison of Isothermal and Thermomechanical Fatigue Behaviour of a High-temperature Titanium Alloy and a Third Generation TiAl Intermetallic ..... | 275 |
| <i>T. K. Heckel, A. Guerrero-Tovar, H.-J. Christ, F. Appel</i>                                                                                       |     |
| Effect of Oxygen on Stress-Corrosion Cracking and Fatigue Crack Growth of Ti-6211 .....                                                              | 279 |
| <i>P. Pao, M. A. Imam, H. Jones, R. Bayles, J. Feng</i>                                                                                              |     |
| The Effect of Precipitates on Mechanical Properties of Ti-6Al-4V Alloy .....                                                                         | 283 |
| <i>D.-G. Lee, S. Lee, Y.T.Lee, J.T. Yeon, J.H. Kim, N.K. Park</i>                                                                                    |     |

|                                                                                                                                                                   |     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Modeling Formation of $\alpha$ Sideplates in Alpha/Beta Ti-alloys - Effect of Interfacial Energy Anisotropy and Coherency Elastic Strain Energy .....             | 287 |
| <i>N. Ma, F. Yang, C. Shen, G. Wang, G..B. Viswanathan, P. C.Collins, D. Xu, R. Yang, H.L. Fraser, Y. Wang</i>                                                    |     |
| Prediction of Precipitate Morphology by the FEM Analysis Based on the 3D-NCS Model in BCC/HCP System .....                                                        | 291 |
| <i>N. Miyano, J. Miyazaki, K. Ameyama</i>                                                                                                                         |     |
| The Effect of Primary and Secondary Alpha Morphology on the Cold Creep Response of $\beta$ -Processed Ti-6-2-4-2 .....                                            | 295 |
| <i>M.C. Brandes, M.J. Mills, J.C. Williams</i>                                                                                                                    |     |
| Effect of Severe Deformation on the Indentation of Titanium .....                                                                                                 | 299 |
| <i>R. Chen, F. Yang, K. Okazaki, M. A. Imam, J. Feng, P. Pao</i>                                                                                                  |     |
| The Response of Ti-6Al-4V to One-dimensional Shock Loading: Variations of Shear Strength with Stress Amplitude and Orientation .....                              | 303 |
| <i>J.C.F. Millett, G. Whiteman, P. Taylor, G.T. Gray III, N.K. Bourne</i>                                                                                         |     |
| Deformation Characteristics of Individual Alpha and Beta Phase Compositions in Timetal 6-4 .....                                                                  | 307 |
| <i>A.F. Wilson, P.S. Garratt, M. Rushton, V.Venkatesh, S.P. Fox</i>                                                                                               |     |
| Dislocation Density Based Constitutive Model for Ti-6Al-4V at Low Strain Rates .....                                                                              | 311 |
| <i>B. Babu</i>                                                                                                                                                    |     |
| A Hot Deformation Model for Two-phase Titanium Alloys Based on an Internal State-variable Approach .....                                                          | 315 |
| <i>M. Mulyadi, M.A. Rist, L.Edwards, J.W. Brooks, A.F.Wilson</i>                                                                                                  |     |
| Modelling of Hot Deformation Behavior of Equiaxed Ti-6Al-4V ELI, in Two Phase ( $\alpha + \beta$ ) Region, Using Neural Networks .....                            | 319 |
| <i>A. A. Ziaei Moayyed, V. Fallah, A. R. Fotovati</i>                                                                                                             |     |
| Modeling of the Effect of a Plastic Deformation in the $\beta$ Phase Field on the Further Precipitation of $\alpha$ Phase on Cooling .....                        | 323 |
| <i>J.Da Costa Teixeira, B. Appolaire, E. Aeby-Gautier, S. Denis, M. Mineur</i>                                                                                    |     |
| Microstrucutural and Mechanical Evaluation under Elevated Temperature Condition of Ti-64 Linear Friction Joints .....                                             | 327 |
| <i>N. Oiwa, S. Nishikiori</i>                                                                                                                                     |     |
| Influence of Post Weld Heat Treatment on Mechanical Properties of 5V Alloy.....                                                                                   | 331 |
| <i>I.V .Gorynin, A.S. Kudryavtsev, S.S. Ushkov</i>                                                                                                                |     |
| The Role of Twinning on the Room Temperature Creep Behavior of Titanium Alloys.....                                                                               | 335 |
| <i>S. Ankem, P. G. Oberson</i>                                                                                                                                    |     |
| Straightly-aligned Dislocation Arrays in h.c.p. Metals after Ambient Temperature Creep .....                                                                      | 339 |
| <i>T. Matsunaga, E. Sato</i>                                                                                                                                      |     |
| Fatigue Crack Initiation Behavior at Cryogenic Temperatures in Ti-5%Al-2.5%Sn ELI Alloy .....                                                                     | 343 |
| <i>Y. Ono, M. Demura, T. Yuri, T. Ogata, S. Matsuoka</i>                                                                                                          |     |
| Superplasticity in Ti-3Al-5V Alloy .....                                                                                                                          | 347 |
| <i>T. Maeda, Y. Maehara</i>                                                                                                                                       |     |
| Superplastic Behavior of Ti-6Al-4V Alloy after Dynamic Globularization .....                                                                                      | 351 |
| <i>C.H. Park, Y.G. Ko, K.-T. Park, D.H. Shin, C.S. Lee</i>                                                                                                        |     |
| Study on Microstructures and Superplastic Properties of a Submicrocrystalline Structure Titanium Alloy .....                                                      | 355 |
| <i>L. Zeng, G. Yang, Y. Zhao, Q. Li, X. Mao, Q. Hong</i>                                                                                                          |     |
| Analysis of Slip and Crack Initiation Processes Activated by Fatigue in a $\alpha/\beta$ Titanium Alloy in Relation with Local Crystallographic Orientation. .... | 359 |
| <i>F. Bridier, P. Villechaise, J. Mendez, M. Mineur</i>                                                                                                           |     |

|                                                                                                                                |     |
|--------------------------------------------------------------------------------------------------------------------------------|-----|
| Evolution of Lattice Strain in Ti-6Al-4V During Tensile Loading at Room Temperature .....                                      | 363 |
| <i>A.M. Stapleton, I. Bantounas, S.L. Raghunathan, T.C. Lindley, D.Dye</i>                                                     |     |
| Residual Stress-induced Subsurface Fatigue Crack Nucleation in Titanium Alloys.....                                            | 367 |
| <i>M. Kocan, H. Rack, L. Wagner,</i>                                                                                           |     |
| Influence of Microstructure on Periodic Overload Effects in Ti-6Al-4V .....                                                    | 371 |
| <i>J. Heideman, O.M. Ferri, E. Notkina, J. Albrecht, G. Luetjering</i>                                                         |     |
| Microstructural and Mean Stress Effects in Fatigue Performance of Shot Peened Ti-6Al-4V .....                                  | 375 |
| <i>J. Mueller, T. Ludian, H.J. Rack, L. Wagner,</i>                                                                            |     |
| Statistical Evaluation of the Fatigue Life of Fine-grained Ti6242.....                                                         | 379 |
| <i>S. Gebhard, P. W.M. Peters, H. Voggenreiter</i>                                                                             |     |
| Effects of Supra- and Subtransus Heat Treatments on Fatigue Performance of Ti-6Al-4V .....                                     | 383 |
| <i>J. Muller, H.J. Rack, L. Wagner</i>                                                                                         |     |
| Crack Growth, Microstructure and Texture in Ti-6Al-4V.....                                                                     | 387 |
| <i>I. Bantounas, D. Dye, T.C. Lindley,</i>                                                                                     |     |
| Microstructures and Mechanical Properties of Extruded and Cast Ti-6Al-4V .....                                                 | 391 |
| <i>M.N. Gungor, K.R. Reasbeck, I. Ucok, L.S. Kramer, H. Dong</i>                                                               |     |
| Study on Microstructure Refinement for Ti-6Al-4V Alloy Bar by Huge-deformation and Three-dimensional Compression Rolling ..... | 395 |
| <i>D. Li, Y. Zhao, W. Zeng, P. Zhang</i>                                                                                       |     |
| Heat Treatment Behavior of Ti-Cr Binary System Alloys.....                                                                     | 399 |
| <i>S. Doi, M. Ikeda, M. Ogawa</i>                                                                                              |     |
| Studies and Researches Concerning the Structure and Properties of Some Titanium-Aluminium-Molibden Alloys .....                | 403 |
| <i>I. Butnariu, I. Butnariu, N. Constantin</i>                                                                                 |     |
| Influence of Lanthanum Addition on the $\alpha$ - $\beta$ Transformation Kinetics in the Ti6Al4V Alloy .....                   | 407 |
| <i>P. Jencus, C. Siemers, M. Kopsidis, J. Rösler</i>                                                                           |     |
| Characteristic of Microstructure and Properties of Cold Deformed and Annealed Titanium Alloy of Ti-6Al-2Zr-2V-1.5Mo .....      | 411 |
| <i>S. Wei, Z. Guo, Q. Hu, S. Wang</i>                                                                                          |     |
| Investigation on the Anisotropy and the Hardening Behaviour of a Titanium Alloy .....                                          | 415 |
| <i>B. Rossi, T. Lelotte, A.-M. Habraken</i>                                                                                    |     |
| Microstructure and Mechanical Property of HRS Processed Pure Titanium and Ti-6Al-4V Alloy Powder Compacts .....                | 419 |
| <i>H. Fujiwara, K. Ono, A. Noro, K. Ameyama</i>                                                                                |     |
| Texture Characteristics of Pack Ply-rolling Ti-6Al-4V Alloy Sheets and Its Mechanical Properties .....                         | 423 |
| <i>Q. Hong, G. Yang, Y. Zhao, Y. Qi</i>                                                                                        |     |
| Titanium Alloys Design on Machinability and Forgeability .....                                                                 | 427 |
| <i>S. Murakami, K. Ozaki, K. Ono, Y. Isumi</i>                                                                                 |     |
| Study on Fatigue Crack Growth Behavior of TC4-DT Alloy of Damage Tolerance .....                                               | 431 |
| <i>H. Li, Y. Zhao, W. Zeng, X. Mao</i>                                                                                         |     |
| The Mechanical Properties of TC21 Alloy Developed by Different Thermal Mechanical Processing .....                             | 435 |
| <i>L. Feng, H. Qu, Y. Zhao, H. Li, J. Chen</i>                                                                                 |     |
| Transformation in Two-phase Titanium Alloy at Shock Loading .....                                                              | 439 |
| <i>N. Krylov, M. Skotnikova, M. Martynov, G. Motovilina, A. Lanina</i>                                                         |     |
| Element Partitioning Behavior in Commercial $\beta$ Titanium Alloys .....                                                      | 443 |
| <i>T. Maeda, H.M. Flower</i>                                                                                                   |     |
| Precipitation of Fine Beta-phase in High Nitrogen Titanium Alloy .....                                                         | 447 |
| <i>T. Ando, K. Nakashima, T. Tsuchiyama, S. Takaki</i>                                                                         |     |

|                                                                                                                                             |     |
|---------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Characterization of the Nanophase Precipitations from Beta Metastable Titanium Based Alloys .....                                           | 451 |
| <i>T. Gloriant, G. Texier, F. Prima, F. Sun, I. Thibon, D. Ansel</i>                                                                        |     |
| Alpha-phase Structure Observed in a Needle Shape Omega-phase Precipitate Formed by a Two-step Aging Method in a Beta-Type Ti-Mo Alloy ..... | 455 |
| <i>E. Sakedai</i>                                                                                                                           |     |
| Effect of Microstructural Evolutions on Hardness in a Metastable $\beta$ Ti Alloy .....                                                     | 459 |
| <i>T. Sakamoto, M. Maeda, K. Nakai, S. Kobayashi</i>                                                                                        |     |
| Experimental Evidence for the Displacive Growth of Bainitic $\alpha$ Plates in $\beta$ Ti Alloys .....                                      | 463 |
| <i>S.M.C. van Bohemen, J. Sietsma</i>                                                                                                       |     |
| Study of Microstructure Evolution of Grain Boundary $\alpha$ Phase during $\beta$ to $\alpha$ Transformation in Timetal 21S Alloy .....     | 467 |
| <i>S.R. Dey, E.M. Lauridsen, W. Ludwig, D.J. Rowenhorst, R.W. Fonda</i>                                                                     |     |
| Phase Transformations in Ti-5Al-5Mo-5V-3Cr-0.5Fe .....                                                                                      | 471 |
| <i>J.D. Cotton, R.R. Boyer, R.D. Briggs, R.G. Baggerly, C.A. Meyer, M.D. Carter, W. Wood, G. Tewksbury, V. Li, X. Yao</i>                   |     |
| Three-dimensional Characterization and Mesoscale Mechanical Modeling of a Beta Titanium Alloy ....                                          | 475 |
| <i>A.B. Geltmacher, A.C. Lewis, D.J. Rowenhorst, M.S. Qidwai, G. Spanos</i>                                                                 |     |
| Phase Kinetics Modelling of Titanium Alloys Undergoing Plasticity Induced Transformation .....                                              | 479 |
| <i>P.E J.Rivera-Díaz-de -Castillo, P. Di Napoli, S. Neelakantan, S. van der Zwaag</i>                                                       |     |
| Properties of Amorphous/Nanocrystalline TiNi Shape Memory Alloys Produced by Plastic Deformation .....                                      | 483 |
| <i>K. Tsuchiya, M. Katahira, A. Hosokawa, Y. Todaka, M. Umemoto</i>                                                                         |     |
| Ballistic Evaluation of Titanium Alloys against Handgun Ammunition.....                                                                     | 487 |
| <i>J. Fanning</i>                                                                                                                           |     |
| Study of Transformations and Microstructural Modifications in Ti-LCB and Ti-555 Alloys Using Differential Scanning Calorimetry .....        | 491 |
| <i>M. Carton, P. Jacques, N. Clément, J. Lecomte-Beckers</i>                                                                                |     |
| Comparison of the Microstructure and Mechanical Properties of the Metastable Beta Titanium Alloys Ti-LCB and Ti-555.....                    | 495 |
| <i>N. Clément, A. Lenain, P.J. Jacques</i>                                                                                                  |     |
| Heat Treatment, Microstructure, and Properties of TIMETAL 555 .....                                                                         | 499 |
| <i>J.C. Fanning, S.L. Nyakana, K.M. Patterson, R.C. McDaniel</i>                                                                            |     |
| Thermomechanical Processing of TIMETAL 555 .....                                                                                            | 503 |
| <i>V. Venkatesh, M Kamal, J. Fanning</i>                                                                                                    |     |
| Inverse Modeling of Nanoindentation Tests to Identify Ti-555 Behavior .....                                                                 | 507 |
| <i>A. Gerday, N. Clement, P. Jacques, T. Pardoën, A. Habraken</i>                                                                           |     |
| Flow Behaviour and Microstructure during Hot Deformation of Ti-5Al-5Mo-5V-3Cr-1Zr .....                                                     | 511 |
| <i>F. Warchomicka, M. Stockinger, H.P. Degischer</i>                                                                                        |     |
| Low-Cycle Fatigue Behaviour of Metastable $\beta$ -Titanium Alloy TIMETALR® LCB: Mechanical and Microstructural Aspects.....                | 515 |
| <i>B. Koch, B. Skrotzki, O. Schauerte</i>                                                                                                   |     |
| The Effect of Yield Stress Level on the Mechanical Properties of Ti-6246 .....                                                              | 519 |
| <i>T. Krull, J. Albrecht, G.. Luetjering</i>                                                                                                |     |
| Mechanical and Texture Evaluations of Ti 6246 as a Dwell Fatigue Tolerant Alloy .....                                                       | 523 |
| <i>M.R. Bache, L. Germain, T. Jackson, A.R.M. Walker,</i>                                                                                   |     |
| Variant Selection and Texture Studies in Ti-6246 .....                                                                                      | 527 |
| <i>M. Preuss, L. Pocock, P. Bate</i>                                                                                                        |     |
| Damping Behavior of Quenched Ti-6Al-2Sn-4Zr-6Mo Alloy during Phase Transformation.....                                                      | 531 |
| <i>Y. Mantani, M. Tajima</i>                                                                                                                |     |

|                                                                                                                                              |     |
|----------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Effect of Alloying Elements on Hot Deformation of Duplex Titanium Alloys.....                                                                | 535 |
| <i>B. Poorganji, T. Murakami, T. Narushima, C. Ouchi, T. Furuhashi</i>                                                                       |     |
| Anelastic Behavior of Ti-8mass%Mo Alloy by Pre-deformation.....                                                                              | 539 |
| <i>Y. Takemoto, A. Sakakibara, T. Senuma</i>                                                                                                 |     |
| The Effects of Deformation Mechanism on Plastic Behavior of $\beta$ -type Ti-Mo Alloys .....                                                 | 543 |
| <i>I. Shimizu, Y. Takemoto</i>                                                                                                               |     |
| Mechanical Properties and Microstructure of Ti-20V-4Al-1Sn Produced by $\alpha + \beta$ Processing .....                                     | 547 |
| <i>S. Matsumoto, T. Maeda, N. Ariyasu, K. Nagashima</i>                                                                                      |     |
| Effect of Cold Working and Annealing on the Mechanical and Physical Properties of Ti-20V-4Al-1Sn .....                                       | 551 |
| <i>S. Matsumoto, T. Maeda</i>                                                                                                                |     |
| Influence of Hot-rolling and Aging on Mechanical Properties and Fatigue Strength of Ti-20V-4Al-1Sn Alloy .....                               | 555 |
| <i>T. Morita, T. Yoshimoto, T. Maeda, S. Matsumoto</i>                                                                                       |     |
| Work Hardening of Ti-20V-4Al-1Sn .....                                                                                                       | 559 |
| <i>S. Komatsu, M. Ikeda, T. Sugimoto, T. Nishitani, K. Imaizumi</i>                                                                          |     |
| In Situ Characterization of the Transformation Sequences of Ti17 Alloy by High Energy X-ray Diffraction: Influence of the Thermal Path ..... | 563 |
| <i>F. Bruneseaux, G. Geandier, E. Gautier, B. Appolaire, M. Dehmas, P. Boulet</i>                                                            |     |
| High Temperature Deformation of SP-700 .....                                                                                                 | 567 |
| <i>M. Tang</i>                                                                                                                               |     |
| Effect of Cooling Rate on Superelasticity of Ti-10V-2Fe-3Al Alloys .....                                                                     | 571 |
| <i>Y. Tomio, T. Furuhashi, T. Maki</i>                                                                                                       |     |
| Ductility Optimization through Plasticity Induced Martensitic Transformation in Ti-10V-2Fe-3Al and Ti-5Al-2Sn-4Zr-4Mo-2Cr-1Fe Alloys .....   | 575 |
| <i>S. Neelakantan, M. Rijs, P.E.J. Rivera-Díaz-del-Castillo, D. M. San Martin, S. van der Zwaag</i>                                          |     |
| Investigation of Adiabatic Shear Bands of Ti-B19 Titanium Alloy.....                                                                         | 579 |
| <i>J. Chen, Y. Zhao, H. Yang, H. Li, Q. Hong</i>                                                                                             |     |
| Aging Response of a New Metastable Beta Titanium Alloy .....                                                                                 | 583 |
| <i>P. Ge, Y. Zhao, L. Zhou, H. Li</i>                                                                                                        |     |
| Fabrication of Fine-grained $\beta$ -Type Titanium Alloy through Mechanical Alloying Treatment .....                                         | 587 |
| <i>T. Tsuchiyama, S. Hamamoto, K. Nakashima, S. Takaki</i>                                                                                   |     |
| Mechanical Properties of Ti-13mass%Cr-1mass%Fe-3mass%Al Alloy as Vanadium and Molybdenum Free Beta Titanium Alloys .....                     | 591 |
| <i>M. Ogawa, T. Shimizu, T. Noda, M. Ikeda</i>                                                                                               |     |
| Local Deformation of Ti Alloys and Ti Matrix Composites .....                                                                                | 595 |
| <i>C. Poletti, F. Warchomicka, S. Kremmer, M. Stockinger, H.P. Degischer</i>                                                                 |     |
| The Potential for Achieving Enhanced Mechanical Performance in TiC Particulate Reinforced Ti-6Al-6V-2Sn Powder Metallurgy Composites.....    | 599 |
| <i>S. Chandrasekaran, B. Yazgan-Kokuoz, J. Hudson, H.J. Rack</i>                                                                             |     |
| Fabrication of Ti <sub>2</sub> AlC/TiAl Composites by MA and SPS .....                                                                       | 603 |
| <i>Y. Chen, F. Yang, F. Kong, Z. Liu</i>                                                                                                     |     |
| Study on Microstructure and Mechanics Properties of TiAl/TC-4 Composite Sheet .....                                                          | 607 |
| <i>F. Kong, F. Yang, Y. Chen, Z. Liu</i>                                                                                                     |     |
| Mechanical Properties of (TiB + TiC) Hybrid Titanium Matrix Composites .....                                                                 | 611 |
| <i>B.-J. Choi, S.-Y. Sung, Y.-J. Kim</i>                                                                                                     |     |
| The Relationship of TiCp/Titanium Based Composites Creep Mechanism and Microstructure.....                                                   | 615 |
| <i>P. Zhang, Y. Zhao, X. Mao, W. Zeng, L. Yu</i>                                                                                             |     |

|                                                                                                                                                                |     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Ideal Deformation in Gum Metal .....                                                                                                                           | 619 |
| <i>T. Li, E. Withey, J.W. Morris, Jr., N. Nagasako, S. Kuramoto, D.C. Chrzan,</i>                                                                              |     |
| Mechanical Properties and Phase Stability Dependence of Ti-Nb-Ta-Zr-O Alloys .....                                                                             | 623 |
| <i>T. Furuta, S. Kuramoto, J. Hwang, K. Nishino, T. Saito</i>                                                                                                  |     |
| Elastic Deformation Behavior of Single-crystal Gum Metal .....                                                                                                 | 627 |
| <i>M. Hara, S. Kuramoto, N. Takesue</i>                                                                                                                        |     |
| Deformation of Ti-36Nb-2Ta-3Zr-0.3O (Gum Metal).....                                                                                                           | 631 |
| <i>R. Talling, M. Jackson, R. Dashwood, D. Dye</i>                                                                                                             |     |
| Special Deformation Mechanisms in Gum Metal.....                                                                                                               | 635 |
| <i>M. Y. Gutkin, T. Ishizaki, S. Kuramoto, I.A. Ovid'ko, N.V. Skiba</i>                                                                                        |     |
| The Deformation of Gum Metal in Nanoindentation .....                                                                                                          | 639 |
| <i>E.A. Withey, M. Jin, A.M. Minor, S. Kuramoto, D.C. Chrzan, J.W. Morris, Jr.</i>                                                                             |     |
| Formation of Gamma-massive Microstructure in a TiAl-based Alloy .....                                                                                          | 643 |
| <i>A. Sankaran, M. Humbert, E. Bouzy, A. Hazotte</i>                                                                                                           |     |
| Severe Plastic Deformation Applied to a Model Lamellar Ti <sub>52</sub> Al <sub>48</sub> Alloy .....                                                           | 647 |
| <i>W. Lefebvre, R. Valiev</i>                                                                                                                                  |     |
| Deformation Studies of ( $\alpha_2 + \gamma$ ) TiAl Alloy Using In-situ High Energy X-ray Diffraction .....                                                    | 651 |
| <i>F.A. Garcia-Pastor, D. Hu, H. Jiang, M. Karadge, X. Wu, M.H. Loretto, P.J. Withers, M. Preuss</i>                                                           |     |
| Control of Misfit Dislocations on Gamma/Alpha <sub>2</sub> Boundaries by Alloy Addition to Lamellar TiAl Alloy .....                                           | 655 |
| <i>Y. Toriyama, H. Zhu, K. Yoshimi, K. Maruyama</i>                                                                                                            |     |
| A Novel in-situ Composite Structure in TiAl Alloys .....                                                                                                       | 659 |
| <i>F. Appel, M. Oehring, J.D.H. Paul</i>                                                                                                                       |     |
| Processing of TiAl Alloys by Spark Plasma Sintering .....                                                                                                      | 663 |
| <i>A. Couret, G. Molénat, J. Galy, M. Thomas</i>                                                                                                               |     |
| Mechanical Properties and Formability of Ultrafine Grained $\gamma$ -TiAl Based Ti-47Al and Ti-45Al-2Cr-2Nb-1B-0.5Ta (at%) Alloys Produced by a PM Route ..... | 667 |
| <i>H. Yu, D. Zhang, Y. Chen, P. Cao, B. Gabbitas, V.Nadakuduru</i>                                                                                             |     |
| Thermophysical Properties of Titanium Aluminides .....                                                                                                         | 671 |
| <i>I. Egry, R. Brooks, D. Holland-Moritz, R. Novakovic, T. Matsushita, E. Ricci, S. Seetharaman, R. Wunderlich</i>                                             |     |
| Effects of Strain Rate on Tensile Properties of Cr Doped Gamma TiAl .....                                                                                      | 675 |
| <i>K. Hashimoto, K. Yasui, T. Kumagai</i>                                                                                                                      |     |
| Axial-torsional Thermo-mechanical Fatigue of Ti-45Al-5Nb-0.2B-0.2C .....                                                                                       | 679 |
| <i>S.P. Brooks, H.J. Kühn, B. Skrotzki, H. Klingelhöffer, R. Sievert, J. Pfetzinger, G. Eggeler</i>                                                            |     |
| Micromechanical Modeling of Near-gamma Titanium Aluminides .....                                                                                               | 683 |
| <i>C. Zambaldi, F. Roters, T.R. Bieler, D. Raabe</i>                                                                                                           |     |
| Influence of C and Nb Concentrations on the High Temperature Deformation Behaviour of Nb-rich Gamma-TiAl Alloys .....                                          | 685 |
| <i>A. Stark, A. Bartels, F.-P. Schimansky, R. Gerling, H. Clemens</i>                                                                                          |     |
| Performance of Ti(Al,O)-Al <sub>2</sub> O <sub>3</sub> Composite Coatings in Molten Aluminium.....                                                             | 689 |
| <i>B. Gabbitas, A. Salman, P. Cao, D. Zhang, S. Raynova,</i>                                                                                                   |     |
| Processing Microstructure and Property of an Orthorhombic Ti-22Al-25Nb Alloy .....                                                                             | 693 |
| <i>S. Li, Y. Cheng, X. Liang, J. Zhang</i>                                                                                                                     |     |
| The Effect of Boron on the Elevated-temperature Creep Behavior of Cast Ti-6Al-4V(wt.%) .....                                                                   | 697 |
| <i>C.J. Boehlert, S. Tamirisakandala, D.B. Miracle</i>                                                                                                         |     |
| B2 Grain Refinement of W-modified Ti <sub>2</sub> AlNb Base Alloy.....                                                                                         | 701 |
| <i>S. Emura, M. Hagiwara</i>                                                                                                                                   |     |



|                                                                                                                                     |     |
|-------------------------------------------------------------------------------------------------------------------------------------|-----|
| Compositional Modification and Property Evaluation of Orthorhombic Ti <sub>2</sub> AlNb-based Alloys.....                           | 705 |
| <i>M. Hagiwara, Y. Mao, S. Emura</i>                                                                                                |     |
| A New Free Machining Titanium Alloy Containing Lanthanum.....                                                                       | 709 |
| <i>C. Siemers, P. Jencus, M. Bäker, J. Rösler, F. Feyerabend</i>                                                                    |     |
| Processing and Properties of Timetal 54M.....                                                                                       | 713 |
| <i>V. Venkatesh, Y. Kosaka, J. Fanning, S. Nyakana</i>                                                                              |     |
| Processing and Characterization of Rapidly Quenched Ti-Based Amorphous/Nanoquasicrystalline Composites .....                        | 717 |
| <i>H. Lefaix, P. Vermaut, R. Portier, T. Gloriant, D. Janickovic, P. Svec, F. Prima</i>                                             |     |
| Change of Mechanical Properties with $\beta$ -phase Stability in High Zr-containing Ti-based Alloys.....                            | 721 |
| <i>M. Abdel-Hady, K. Hinoshita, H. Fuwa, M. Morinaga</i>                                                                            |     |
| Formation of Ti <sub>2</sub> FeSn Compound and Phase Equilibria at the Ti-Fe Side of Ti-Fe-Sn Ternary System. ....                  | 725 |
| <i>T. Kozakai, T. Moritani, M. Doi</i>                                                                                              |     |
| Effect of Mo Addition on FeTi Formation in Ti-Al-Fe Based Titanium Alloys .....                                                     | 729 |
| <i>K. Mori, H. Fujii</i>                                                                                                            |     |
| Structure and Deformation Behavior of High Strength Hypereutectic Ti-Based Alloys.....                                              | 733 |
| <i>D.V. Louzguine-Luzgin, L.V. Louzguina-Luzgina, H. Kato, A. Inoue</i>                                                             |     |
| An Overview of Titanium Alloys Modified with Boron .....                                                                            | 737 |
| <i>S. Tamirisa, D. Miracle</i>                                                                                                      |     |
| Fine-grained Titanium by Inclusion-assisted Microstructure Control .....                                                            | 741 |
| <i>Y. Komizo, H. Terasaki, M. Ikeda, F. Nishino, K. Toudai</i>                                                                      |     |
| Mechanical Behavior of B Modified Ti-6Al-4V Alloys .....                                                                            | 745 |
| <i>I. Sen, U. Ramamurty</i>                                                                                                         |     |
| Chemical Homogeneity, Structure, and Properties of Titanium Alloys Produced by Electron-Beam Single-Melting (EBSM).....             | 749 |
| <i>S. Nyakana, J. Fanning, D. Tripp</i>                                                                                             |     |
| Microstructure Property Comparison of Beta Titanium Alloys Produced by the Single Melt and Direct Rolling Process.....              | 753 |
| <i>J.G. Ferrero, J.R. McGibbney, K.O. Yu</i>                                                                                        |     |
| Production of Titanium Components from Hydrogenated Titanium Powder: Optimization of Parameters .....                               | 757 |
| <i>O.M. Ivasishin, D.G. Savvakina, V.S. Moxson, V.A. Duz, C. Lavender</i>                                                           |     |
| The Equal Channel Angular Processing of Two Ti-10wt%Mg Powder Feedstocks .....                                                      | 761 |
| <i>C.J. Bettles, C. Piquard, B. C. Muddle</i>                                                                                       |     |
| Effect of $\beta$ -Stability on Diffusion of Hydrogen in $\beta$ -Titanium Alloys.....                                              | 765 |
| <i>H.-J. Christ, P. Schmidt</i>                                                                                                     |     |
| Improvement of the Fatigue Properties of Metastable $\beta$ -Titanium Alloys by Using Hydrogen as a Temporary Alloying Element..... | 769 |
| <i>P. Schmidt, G. Lohse, H.-J. Christ</i>                                                                                           |     |
| Hydrogen Absorption Behaviors of Titanium in High Pressure Gaseous Hydrogen .....                                                   | 773 |
| <i>H. Fujii, S. Ohmiya</i>                                                                                                          |     |
| Metallographic Structures and Hydrogenation Properties of Ti <sub>4</sub> Ni <sub>2</sub> Ox Hydrogen Storage Materials .....       | 777 |
| <i>H.T. Takeshita, N. Kuriyama, T. Sakai</i>                                                                                        |     |
| Development and Application of Microstructure and Mechanical Property Models for Titanium Alloys .....                              | 781 |
| <i>D. Furrer, A. Chatterjee, G. Shen, A. Woodfield, S.L. Semiatin, J. Miller, M. Glavicic, R. Goetz, D. Barker</i>                  |     |
| Titanium Metallography Using Heat Tinting.....                                                                                      | 785 |
| <i>M.L. Harper, Y. Kosaka, S.P. Fox</i>                                                                                             |     |

|                                                                                                                                                     |     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Study on Interface Reaction and Phase Composition of Titanium Aluminum Alloys Investment Casting .....                                              | 789 |
| <i>J. Tian, S. Xiao, L. Xu, H. Xie, Y. Chen</i>                                                                                                     |     |
| Residual Stress Measurement of Titanium Casting Alloy by Neutron Diffraction.....                                                                   | 793 |
| <i>M. Nishida, T. Jing, M.R. Muslih, T. Hanabusa</i>                                                                                                |     |
| Structural-Phase Transformation in Metal of Steam Turbine Blade of Titanium Alloy after Impact by Steam Particles.....                              | 797 |
| <i>M. Skotnikova, Y. Zubarev, T. Chizhik, N. Krylov, A. Lanina</i>                                                                                  |     |
| High Temperature Shape Memory Behavior in Ti-Ta Alloys .....                                                                                        | 801 |
| <i>P.J.S. Buenconsejo, H.Y. Kim, T. Koyano, H. Hosoda, S. Miyazaki</i>                                                                              |     |
| Annealing Effect on Martensitic Transformations of Severely Cold-rolled Ti <sub>50</sub> Ni <sub>40</sub> Cu <sub>10</sub> Shape Memory Alloy ..... | 805 |
| <i>K.-N. Lin, S.-K. Wu</i>                                                                                                                          |     |
| New Titanium Alloys Designed and Developed by NIN.....                                                                                              | 809 |
| <i>Y. Zhao, G. Yang, L. Zhou</i>                                                                                                                    |     |
| Effects of Alloying Elements on Ti-V-Cr Burn-resistant Titanium Alloy's Mechanical Properties .....                                                 | 813 |
| <i>S. Xin, Y. Zhao, W. Zeng, H. Wu, X. Mao</i>                                                                                                      |     |
| Research on Microstructure and Properties of Ti-26 Titanium Alloy after Large Deformation.....                                                      | 817 |
| <i>Y. Luo, Y. Zhao, Z. Xi, Y. Qin, P. Zhang, X. Mao</i>                                                                                             |     |
| Hot Deformation Behavior and Constitutive Equation of Titanium Alloy Ti600.....                                                                     | 821 |
| <i>Y. Qi, Y. Zhao, W. Zeng, Z. Xi, Q. Hong, P. Guo, X. Liu, R. Wang, Y. Luo, Y. Du</i>                                                              |     |
| Research on Creep Property at the Elevated Temperature of Ti-600 Alloy .....                                                                        | 825 |
| <i>P. Guo, Q. Hong, Y. Qi, X. Liu, Y. Zhao</i>                                                                                                      |     |
| Author Index .....                                                                                                                                  | 829 |
| Subject Index .....                                                                                                                                 | 839 |

## **Volume II**

### **Wrought Processing**

#### **Keynote Paper**

|                                                                                                                       |     |
|-----------------------------------------------------------------------------------------------------------------------|-----|
| Progress in Wrought Processing of Titanium .....                                                                      | 855 |
| <i>V.V. Tetyukhin, I.V. Levin, A.S. Shibanov</i>                                                                      |     |
| FEM Simulation of Microstructure Evolution during Hot Forging Process of a Small-scale Titanium Alloy Wing-panel..... | 861 |
| <i>J. T. Yeom, C.S. Lee, J.H. Kim, D.-G. Lee, N.K. Park</i>                                                           |     |
| Application of Microstructure and Damage Models in the Primary Conversion of Ti-6-4 .....                             | 865 |
| <i>V. Venkatesh, A.F. Wilson</i>                                                                                      |     |
| A Numerical Study of the Influence of Stirring Parameters on Titanium Ingot Quality Using SOLAR V4.2. ....            | 869 |
| <i>A.F. Wilson, A. Jardy, S.P. Fox</i>                                                                                |     |
| An Analysis of Microstructure in TIMETALR® 6-2-4-6 Billet Taking Process History into Account ....                    | 873 |
| <i>N. Nasser, B.P. Wynne, W. M. Rainforth, A.F. Wilson</i>                                                            |     |
| Semisolid Forging of Titanium Alloy Making Use of Rapid Resistance Heating .....                                      | 877 |
| <i>S. Maki, K. Mori</i>                                                                                               |     |
| Manufacturing Technologies for Ti-6246 Alloy Aero Engine Disc Forgings .....                                          | 881 |
| <i>Y. Momota, A. Shigeomi, S. Ishigai, S. Murakami, Y. Maeda, T. Choda</i>                                            |     |
| Forgings from Ti-5Al-5V-5Mo-3Cr with Optimized Fracture Toughness .....                                               | 885 |
| <i>M. Büscher, G. Terlinde, G. Wegmann, C. Thoben, Y. Millet, G. Lütjering, J. Albrecht</i>                           |     |

|                                                                                                                                                                                                    |     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Integrated Computer-aided Design and Engineering during Manufacture of Ti Alloy Die Forging .....                                                                                                  | 889 |
| <i>V.V. Tetyukhin, A.S. Shibano, V.B. Timokhov, V.A. Kropotov, A.N. Troshin</i>                                                                                                                    |     |
| Impact of Die Shape, Arrangement and Conditions of Drawing and Upsetting on Non-uniformity of Temperature Distribution and Accumulated Deformation in Titanium Alloys Semi-finished Products ..... | 893 |
| <i>A. Shibano, A. Bogatov, V. Kropotov, A. Troshin</i>                                                                                                                                             |     |
| State-of-the-art Processes of Titanium Tube and Hollow Die-forging Manufacture by Russian and CIS Companies.....                                                                                   | 897 |
| <i>V.V. Tetyukhin, V.G. Smirnov, D.A. Krashennnikov</i>                                                                                                                                            |     |
| Grain Growth Behavior of Commercially Pure Titanium .....                                                                                                                                          | 901 |
| <i>K. Matsumoto, Y. Sugizaki</i>                                                                                                                                                                   |     |
| Characteristic Features of Hot Deformation of Two-phase Titanium Alloys .....                                                                                                                      | 905 |
| <i>K. Kubiak, J. Sieniawski, M. Motyka</i>                                                                                                                                                         |     |
| Hot Working of Ti-6Al-4V (ELI) with Lamellar Starting Microstructure: Processing Map and Microstructural Mechanisms.....                                                                           | 909 |
| <i>S.J. Safavi, A.A. Z. Moayyed, V. Fallah</i>                                                                                                                                                     |     |
| Dynamic Recrystallization in Titanium Alloys during Hot Deformation.....                                                                                                                           | 913 |
| <i>T. Furuhashi, H. Abe, B. Poorganji, T. Maki</i>                                                                                                                                                 |     |
| The Profile of Microstructure and Properties of the Different Deformation for VT22 Alloy .....                                                                                                     | 921 |
| <i>X. Mao, P. Zhang, L. Yu, Y. Zhao</i>                                                                                                                                                            |     |
| Development of Sharp Local $\alpha$ Microtextures during $\alpha/\beta$ Thermo-mechanical Processing of TIMETAL 834 .....                                                                          | 925 |
| <i>L. Germain, P. Vo, N. Gey, M. Jahazi, M. Humbert, P. Bocher</i>                                                                                                                                 |     |
| The Evolution of Lattice Strain in Ti-10V-2Fe-3Al during Tensile Loading at Room Temperature .....                                                                                                 | 929 |
| <i>S. Raghunathan, A. Stapleton, R. Dashwood, M. Jackson, D. Dye</i>                                                                                                                               |     |
| Comparative Study of Different Low-Cost Beta Titanium Alloys Highly Strengthened Using Cold Deformation and Rapid Recrystallization Approach .....                                                 | 933 |
| <i>P.E. Markovsky, M. Ikeda, M. Ogawa</i>                                                                                                                                                          |     |
| Grain Refinement by Means of Rapid Heating in Ti-2.5Cu and TIMETAL LCB.....                                                                                                                        | 937 |
| <i>A. Frischkorn, J. Atoura, I. Konkova-Loemker, L. Wagner</i>                                                                                                                                     |     |
| Discussion on the Texture Voids in Wrought Material of Deformed Titanium Alloy Ti-5Al-2.5Sn .....                                                                                                  | 941 |
| <i>Y. Zhang, L. He, X. Luo, Q. Guo</i>                                                                                                                                                             |     |
| Characterisation of Texture and Microtexture Heterogeneities in a Timetal®834 Billet .....                                                                                                         | 945 |
| <i>P. Davies, B. Wynne, W.M. Rainforth, W. Kockelmann, R. Eccleston</i>                                                                                                                            |     |
| Investigating Microstructural Evolution in the Near Alpha Titanium Alloy Timetal® 834 using Electron Back Scatter Diffraction (EBSD) .....                                                         | 949 |
| <i>P. Davis, B. Wynne, W.M. Rainforth</i>                                                                                                                                                          |     |
| Crystallographic Texture and the Definition of Effective Structural Unit Size in Titanium Products .....                                                                                           | 953 |
| <i>L. Germain, M.R. Bache</i>                                                                                                                                                                      |     |
| Processing and Properties of Uniform Fine Grain Ti 6-4 Billet .....                                                                                                                                | 957 |
| <i>V. Venkatesh, C. McDaniel, M. Harper, Y. Kosaka, S. Fox</i>                                                                                                                                     |     |
| Phase Field Modeling of the Growth and Dissolution of the $\alpha$ Phase in Near- $\beta$ Titanium Alloys .....                                                                                    | 961 |
| <i>B. Appolaire, J. Da Costa Teixeira, E. Aeby-Gautier, F. Bruneseaux</i>                                                                                                                          |     |
| Stability of Ti-5Al-5Mo-2Cr-1Ni (Corona-X) .....                                                                                                                                                   | 965 |
| <i>B. Yazgan-Kokuoz, J. Braswell, P. Martin, J. Hudson, H.J. Rack</i>                                                                                                                              |     |
| Anisothermal Alpha Phase Precipitation in Ti-3Al-8V-6Cr-4Zr-4Mo (Ti-38644).....                                                                                                                    | 969 |
| <i>B. Yazgan-Kokuoz, J. Hudson, H.J. Rack</i>                                                                                                                                                      |     |
| The Influence of Heating Rate on Phase Transformation Kinetics and Microstructures Evolutions at Aging in Metastable Beta Titanium Alloy--Ti-B19 .....                                             | 973 |
| <i>H. Chang, E. Aeby-Gautier, F. Bruneseaux, L. Zhou</i>                                                                                                                                           |     |

|                                                                                                                               |      |
|-------------------------------------------------------------------------------------------------------------------------------|------|
| Production of Plates and Sheets from As-Cast Ti-6Al-4V via Boron Modification .....                                           | 977  |
| <i>R. Srinivasan, S. Tamirisakandala, D. Miracle, K.-O. Yu, V. Sinha, F. Sun, M. Bennett, J.M. Scott</i>                      |      |
| Development of a New $\alpha + \beta$ Type Titanium Alloy for Cold Strip .....                                                | 981  |
| <i>S. Matsumoto, T. Maeda, T. Takechi, N. Ariyasu, A. Kuroda</i>                                                              |      |
| Cold Formability and Rolling Ability of New Alpha + Beta Titanium Alloy for Cold Strip .....                                  | 985  |
| <i>T. Takechi, T. Maeda, N. Ariyasu, S. Matsumoto, A. Kuroda, S. Honda</i>                                                    |      |
| Near Conventional Forging of Titanium Aluminides.....                                                                         | 989  |
| <i>S. Kremmer, H.F. Chladil, H. Clemens, A. Otto, V. Güther,</i>                                                              |      |
| Microstructure Homogeneity of Wrought TiAl.....                                                                               | 993  |
| <i>X. Chang, J. Zhang, K. Xia</i>                                                                                             |      |
| Production of Gas Atomized Ti Alloy Powder by Levitation Melting Furnace with Electro Magnetic Nozzle .....                   | 997  |
| <i>T. Okumura, T. Shibata, N. Okochi</i>                                                                                      |      |
| Microstructures and Mechanical Properties of Gum Metal Sheets Correlated with Cold Rolling Reduction.....                     | 1001 |
| <i>R. Aoto, G. Itoh, T. Suzuki, Y. Motohashi</i>                                                                              |      |
| Comparing the Hot Working Behaviour of High Strength Beta Alloys Ti-5Al-5Mo-5V-3Cr with That of Ti-10V-2Fe-3Al.....           | 1005 |
| <i>N. Jones, M. Jackson, D. Dye, R. Dashwood</i>                                                                              |      |
| Microstructural Transformation of $\beta$ -solution Treated and Forged Ti-6Al-4V Alloy during Super-plastic Deformation ..... | 1009 |
| <i>M. Motyka, K. Kubiak, J. Sieniawski</i>                                                                                    |      |
| Comparative Study of Forming Ti-TWBs under Single and Multi-stage Forming Process at Elevated Temperatures .....              | 1013 |
| <i>C. Lai, L. Chan</i>                                                                                                        |      |
| Optimization of Hot Workability and Control of Microstructure During Hot Deformation of Ti53311S Alloys.....                  | 1017 |
| <i>R. Wang, Z. Xi, Y. Zhao, Y. Qi, Y. Du, X. Mao</i>                                                                          |      |
| Sheet Rolling and Performance Evaluation of Beta Gamma ( $\beta$ - $\gamma$ ) Alloys .....                                    | 1021 |
| <i>D.S. Shih, Y.-W. Kim</i>                                                                                                   |      |
| Recycling Technology of Titanium Scrap by ESR Process.....                                                                    | 1025 |
| <i>Y.-D. Seo, J.-S. Park, D.-J. Lee, H.-S. Lee, H.-S. Sohn</i>                                                                |      |
| The 40 Years of Baoji Titanium .....                                                                                          | 1029 |
| <i>H. Wang</i>                                                                                                                |      |
| Recrystallization Kinetics of Ti-Ta Alloy .....                                                                               | 1033 |
| <i>W. Zhou, J. Chen, Y. Zhao, Q. Hong, H. Qu, L. Feng, D. Guo, H. Li</i>                                                      |      |
| The Distribution Character of Ta Element in Ti-Ta Alloy Ingot.....                                                            | 1037 |
| <i>Q. Lin, Y. Yang, J. Wu, B. Zhao, H. Zhao, J. Yin, H. Su, D. Guo, X. Mao</i>                                                |      |
| Numerical Simulation of Hot Push-expanding Forming on High Strength Titanium Alloy Ring Pipe..                                | 1041 |
| <i>H. Zhao, Y. Yang, B. Zhao, J. Wu, D. Guo, Q. Hong</i>                                                                      |      |
| Study of Large Area, Thick Ti/Steel Plate Explosion Cladding Technology .....                                                 | 1045 |
| <i>R. Liu, J. Fan, S. Guen, L. Ren</i>                                                                                        |      |

## Component Manufacturing

### Keynote Paper

|                                                                                                        |      |
|--------------------------------------------------------------------------------------------------------|------|
| Recent Development in Component Manufacturing Technology of Titanium and Titanium Alloy in Japan ..... | 1051 |
| <i>H. Kamiya, A. Suzuki</i>                                                                            |      |

|                                                                                                                                                     |      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------|------|
| Casting and Properties of Al-rich Ti-Al Alloys .....                                                                                                | 1059 |
| <i>M. Paninski, A. Drevermann, G.J. Schmitz, M. Palm, F. Stein, M. Heil-Maier, N. Engberding, H. Saage, D. Sturm</i>                                |      |
| Influence of the Reinforcement Particles on the Cutting Behaviour of Titanium MMC .....                                                             | 1063 |
| <i>E. Uhlmann, M. Roeder, S. Herter</i>                                                                                                             |      |
| Recent Developments in Titanium Powder Metallurgy .....                                                                                             | 1067 |
| <i>V.A. Duz, V.S. Moxson, O.M. Ivasishin</i>                                                                                                        |      |
| Development of Porous Materials Made from High-quality Spherical Titanium Powder .....                                                              | 1071 |
| <i>T. Onishi, K. Azuma, T. Ogasawara</i>                                                                                                            |      |
| Fabrication of Ti Coatings by an Improved Atmospheric Spray Process .....                                                                           | 1075 |
| <i>J. Kawakita, H. Katanoda, M. Watanabe, K. Yokoyama, T. Wu, S. Kuroda</i>                                                                         |      |
| Development of High Lubricity Titanium Sheet with Excellent Press Formability .....                                                                 | 1079 |
| <i>K. Takahashi, T. Hayashi, I. Takayama, J. Tamenari, K. Tokuno</i>                                                                                |      |
| Application and First Results of a Titanium-based System Consisting of an Alloy and a Surface Layer for High Temperatures e.g. Exhaust Systems..... | 1083 |
| <i>H. Sibum, J. Kiese, G. Mueller</i>                                                                                                               |      |
| Ultrasonic Testing of Titanium Welded Tubing .....                                                                                                  | 1087 |
| <i>H. Richaud-Minier, P. Gerard</i>                                                                                                                 |      |
| Modelling and Experimental Calibration of Electron Beam Welded Ti-6Al-4V .....                                                                      | 1091 |
| <i>R. Pederson, D. Berglund, F. Skystedt, R. Warren</i>                                                                                             |      |
| Stationary Shoulder Friction Stir Welding of Ti-6Al-4V: Process and Evaluation .....                                                                | 1095 |
| <i>M.J. Russell, P.L. Threadgill, M.J. Thomas, B.P. Wynne</i>                                                                                       |      |
| Micro-incremental Forming of Ti Foils by Indentation Method.....                                                                                    | 1099 |
| <i>M. Otsu, H. Taniguchi, K. Takashima</i>                                                                                                          |      |
| High Temperature Forming of Ti-6Al-4V Alloy Considering Microstructure Evolution .....                                                              | 1103 |
| <i>Y.H. Lee, C.S. Lee</i>                                                                                                                           |      |
| Ridging Phenomenon during Cold Rolling in Ti-15V-3Cr-3Sn-3Al Sheet.....                                                                             | 1107 |
| <i>K. Takahashi, M. Masaki</i>                                                                                                                      |      |
| Development of High Strength MWCNT Reinforced Titanium Alloy Matrix Composites .....                                                                | 1111 |
| <i>S. Anzawa, H. Takizawa, T. Tanimoto, A. Ogawa</i>                                                                                                |      |
| Infrared Brazing Ti-6Al-4V and 17-4PH Stainless Steel with Barrier Layers.....                                                                      | 1115 |
| <i>S. Wu, C. Wu, R. Shiue</i>                                                                                                                       |      |
| Infrared Brazing High Strength Titanium Alloys Using the Ti-20Zr-20Cu-20Ni Foil .....                                                               | 1119 |
| <i>C. Chang, R. Shiue, C. Chang</i>                                                                                                                 |      |
| Electroplating on Titanium .....                                                                                                                    | 1123 |
| <i>K. Schmut, B. Gollas, J. Besenhard, G. Nauer, H. Kronberger, G. Fafilek, J. Etzkorn, R. Herber</i>                                               |      |

## **Near Net Shape Production**

### **Keynote Paper**

|                                                                                                       |      |
|-------------------------------------------------------------------------------------------------------|------|
| Net Shape Hot Isostatic Pressing and Metal Injection Moulding of Ti Powders .....                     | 1127 |
| <i>X. Wu, M. Ward-Close, R. Singh, J. Mei, W. Voice, M. Bache</i>                                     |      |
| Effect of Oxygen on Mechanical Properties of Metal Injection Molded Titanium and Titanium Alloy ..... | 1135 |
| <i>K. Doi, T. Sugimoto, K. Hanami, H. Tanaka, T. Teraoka</i>                                          |      |
| New Production Method by Gas-atomization Process of Titanium Alloy Powder .....                       | 1137 |
| <i>A. Arimoto, M. Fujita, K. Nishioka, H. Miura</i>                                                   |      |
| Economical Sintering of Titanium Powder .....                                                         | 1141 |
| <i>I.M Robertson, R.J. Low, G.B. Schaffer</i>                                                         |      |

|                                                                                                               |      |
|---------------------------------------------------------------------------------------------------------------|------|
| Development of Ultra-fine Microstructure by Rapid Hot-compaction of Armstrong-process Titanium Powder .....   | 1145 |
| <i>D. Eylon, W.A. Ernst, D.P. Kramer, L.E. Jacobsen</i>                                                       |      |
| Processing of Titanium Powder Made by the Armstrong Process .....                                             | 1149 |
| <i>F.R. Dax, T. Lyssenko, S. Luckowski, K.-O. Yu</i>                                                          |      |
| Effect of Nb on Pore Structure and Permeability of Ti-48Al Cellular Alloy .....                               | 1153 |
| <i>Y. Wang, J. Lin, Y. He, G. Sun, Y. Wang, G. Chen</i>                                                       |      |
| The Effect of Some Process Variables on Defects in Titanium Aluminide Castings .....                          | 1157 |
| <i>R.A. Harding, M. Wickins</i>                                                                               |      |
| Alpha-case Controlled Titanium Alloys Casting .....                                                           | 1161 |
| <i>S.-Y. Sung, B.-J. Choi, Y.-J. Kim</i>                                                                      |      |
| Near Net Shape of Porous Titanium Scaffolds Using 3D Fiber Deposition .....                                   | 1165 |
| <i>J. Li, J. de Wijn, C. Wison, C.A. van Blitterswijk, K. de Groot</i>                                        |      |
| Superplastic Behavior of In Situ Synthesized (TiB + TiC)/Ti Matrix Composite .....                            | 1169 |
| <i>W. Lu, M. Wang, J. Qin, D. Zhang</i>                                                                       |      |
| The Action of Isothermal Processing Routes on Relieving Distortion of TC11 Titanium Alloy Blade Airfoil ..... | 1173 |
| <i>Z. Yao, H. Zhang, Z. Tan, J. Geng, H. Guo, Y. Liu</i>                                                      |      |
| Three Dimensional FE Simulation of Ring Rolling Process for Jet Engine Fan Case .....                         | 1177 |
| <i>T. Sato, S. Takashina, S. Kojima, T. Tanaka</i>                                                            |      |
| Research on Powder Metallurgy of Titanium Alloy .....                                                         | 1181 |
| <i>Z. Chen, H. Zhou</i>                                                                                       |      |
| Effect of Mixed Powders on the Properties of Ti-6Al-7Nb Alloy by Metal Injection Molding .....                | 1185 |
| <i>Y. Itoh, H. Miura, T. Uematsu, K. Sato, M. Niinomi, T. Ozawa</i>                                           |      |
| Economic Net-shape Forming of Ti and Ti Alloy Biomaterial by Investment Casting .....                         | 1189 |
| <i>B.-J. Choi, S.-Y. Sung, M.-G. Kim, Y.-J. Kim</i>                                                           |      |
| Progress of Near Net-shape Techniques for Titanium Alloy .....                                                | 1193 |
| <i>Y. Yang, H. Zhao, Y. Zhao, J. Yin, D. Guo, P. Zhang</i>                                                    |      |
| Advances in Thin-walled Welded Tube Manufacture from Titanium Alloys .....                                    | 1197 |
| <i>A.M. Dmitrenko, Y.A. Myagkov</i>                                                                           |      |
| Development of a Microstructure Model for Metal Deposition of Titanium Alloy Ti-6Al-4V .....                  | 1201 |
| <i>C. Charles, N. Järvstråt</i>                                                                               |      |

## Environment Behavior

### Keynote Paper

|                                                                                                                      |      |
|----------------------------------------------------------------------------------------------------------------------|------|
| Current Research Situation of Corrosion, Oxidation and Surface Modification of Titanium Alloys ...                   | 1207 |
| <i>Z.X. Li, Y.Q. Zhao, L. Zhou, J.H. Du, G.R. Gao, S.P. Wang</i>                                                     |      |
| Development of a New Corrosion Resistant Titanium Alloy for the Chemical Process Industry ....                       | 1213 |
| <i>J. Grauman, S. Fox</i>                                                                                            |      |
| Stress Corrosion Resistance of Grade 23 and 29 Titanium Riser Pipe in Aqueous Glycol Drill Fluids...                 | 1217 |
| <i>R.W. Scutz</i>                                                                                                    |      |
| Effects of Mechanical Stress on Corrosion Resistance of Metallic Biomaterials .....                                  | 1221 |
| <i>N. Hisamori, K. Komotori, A. Nakajima</i>                                                                         |      |
| A Mechanism of Interior-originating Fatigue of Ti-6Al-4V Based on Crack Growth Behavior in a High Vacuum .....       | 1225 |
| <i>T. Nakamura, H. Oguma, R. Yamashita</i>                                                                           |      |
| Detection of Hydrogen Evolution during Tensile Deformation of a Ti-Ni alloy Affected by Hydrogen Embrittlement ..... | 1229 |
| <i>K. Horikawa, Y. Kawabata, H. Kobayashi</i>                                                                        |      |

|                                                                                                                                 |      |
|---------------------------------------------------------------------------------------------------------------------------------|------|
| Improvement of the High Temperature Oxidation Resistance of $\gamma$ -TiAl by means of Si-based Coatings .....                  | 1233 |
| <i>M. Fröhlich, A. Ebach, R. Braun, C. Leyens</i>                                                                               |      |
| Effect of Molybdenum on the Crevice Corrosion for Titanium Alloys .....                                                         | 1237 |
| <i>T. Nishimura</i>                                                                                                             |      |
| Considering Environmental and Mean Stress Effects in Understanding the Fatigue Performance of Shot Peened Titanium Alloys ..... | 1241 |
| <i>M. Kocan, H. Rack, L. Wagner</i>                                                                                             |      |
| Effect of Isothermal Aging after Beta Quenching on the General Corrosion Properties in Ni/Fe Added Titanium Alloys .....        | 1245 |
| <i>K. Takahashi, T. Hayashi, M. Kohda, M. Masaki, M. Ishii, M. Kaneko</i>                                                       |      |
| Anodic Polarization Behavior of Titanium and Titanium-nickel Electrode in Ionic Liquid.....                                     | 1249 |
| <i>H. Nakagawa, K. Tsuchimoto, T. Uda, K. Murase, Y. Awakura</i>                                                                |      |

## Aero-Vehicle Applications

### Keynote Paper

|                                                                                                                                            |      |
|--------------------------------------------------------------------------------------------------------------------------------------------|------|
| Recent Titanium Developments and Applications in the Aerospace Industry .....                                                              | 1255 |
| <i>R.R. Boyer, K.T. Slattery, D.J. Chellman, H. R. Phelps</i>                                                                              |      |
| Properties and Microstructures of Ti-555 (Ti-5Al-5Mo-5V-3Cr-0.6Fe) for Fasteners .....                                                     | 1263 |
| <i>J. Fanning, L. Zeng, S. Nyakana, L. Haylock</i>                                                                                         |      |
| Skull Melting, an Alternative Melting Process for the Production of Ti 6Al-4V Aerospace Plates ...                                         | 1267 |
| <i>D. Fischer, F. Guglielmi</i>                                                                                                            |      |
| A Three-dimensional Steady State Thermal Fluid Model of the Ingot Casting Process Associated with Electron Beam Melting of Ti-6Al-4V ..... | 1271 |
| <i>X. Zhao, D.M. Maijer, S.L. Cockcroft, D.W. Tripp, S. Fox, J. Zhu</i>                                                                    |      |
| Hot Stretch Forming of Titanium 6Al-4V Alloy Extrusions.....                                                                               | 1275 |
| <i>A. Keskar, K. Minakawa</i>                                                                                                              |      |
| Computational Modeling of the Vacuum Arc Remelting (VAR) Process Used for the Production of Ingots of Titanium Alloys .....                | 1279 |
| <i>K.M. Kelkar, S.V. Patankar, A. Mitchell, O. Kanou, N. Fukada, K. Suzuki</i>                                                             |      |
| Friction Welding of Near Net Shape Preforms in Ti-6Al-4V .....                                                                             | 1283 |
| <i>P.L. Threadgill, M.J. Russell</i>                                                                                                       |      |
| Superplastic Sheet Forming Aircraft Parts from Ti-alloys .....                                                                             | 1287 |
| <i>B. Gershon, I. Eldror</i>                                                                                                               |      |
| Machinability of Near Beta Titanium Alloys Employed in Aeronautics.....                                                                    | 1291 |
| <i>P.-J. Arrazola, L.-M. Iriarte, A. Garay, S. Marya, J. Vigneau, F. Le Maître</i>                                                         |      |
| $\alpha$ to $\beta$ Transformations in the Ti-10V-2Fe-3Al Alloy. Characterization and Mechanical and Microstructural Characteristics.....  | 1295 |
| <i>P. Tarín, J.M. Abellán, A.G. Simón, J.M. Badía, N.M. Piris</i>                                                                          |      |

## Aero-Propulsion Applications

### Keynote Paper

|                                                                            |      |
|----------------------------------------------------------------------------|------|
| Issues and Progress in Manufacturing of Turbo-engines Titanium Parts ..... | 1301 |
| <i>J.-M. de Monicault, J.-Y. Guédou, P. Belaygue, V. André</i>             |      |
| Close Die Forging of Ti 6246 Engine Disks.....                             | 1309 |
| <i>J-F. Uginet, V. Albert</i>                                              |      |
| Titanium for High Strength Aerospace Forgings .....                        | 1313 |
| <i>P. Héritier</i>                                                         |      |

|                                                                                                                              |      |
|------------------------------------------------------------------------------------------------------------------------------|------|
| Designing TiAl Alloys to Transform Massively during Slow Cooling.....                                                        | 1317 |
| <i>D. Hu, A. Huang, M.H. Loretto, X. Wu</i>                                                                                  |      |
| Effect of Carbon on Phase Equilibria between $\alpha$ and $\gamma$ Phases in Ti-Al-Nb System.....                            | 1321 |
| <i>M. Kurashige, T. Matsuo, M. Takeyama</i>                                                                                  |      |
| Influence of Processing on Matrix Microstructure and Properties of Titanium Matrix Composites.....                           | 1325 |
| <i>L. Chernova, J. Hausmann</i>                                                                                              |      |
| Compression Strength of Titanium Matrix Composites Depending on Fibre Volume Content, Fibre Orientation and Temperature..... | 1329 |
| <i>J. Hausmann, J. Schröder</i>                                                                                              |      |
| Torsion Fatigue in Near Alpha and Alpha-beta Titanium Alloys .....                                                           | 1333 |
| <i>W.J. Evans, M.T. Whittaker, J.P. Jones</i>                                                                                |      |
| Designing for Variability in Fatigue Performance.....                                                                        | 1337 |
| <i>W.J. Evans, M. McElhone, D. Rugg</i>                                                                                      |      |
| The Use of Modeling and Experiment to Understand “Dwell Fatigue” in Ti Alloys.....                                           | 1341 |
| <i>D. Norfleet, J. Williams, S. Ghosh, M. Mills, S. Rokhlin</i>                                                              |      |
| Effect of Prestrain on Ambient and High Temperature Creep in Ti834 .....                                                     | 1345 |
| <i>M., Whittaker, J. Evans, P. Jones, D. Rugg, T. Jackson</i>                                                                |      |
| Titanium Alloys for High Temperature Applications .....                                                                      | 1349 |
| <i>Z. Hervier, P. Belaygue, J. Alexis, J.-A. Petit, J.-F. Uginet</i>                                                         |      |
| Improvement of Fretting-Wear Behaviour of Titanium Alloy by Surface Toughening Treatments .....                              | 1353 |
| <i>G.R. Yantio Njankeu, J. Denape, J.-Y. Paris, L. Pichon, J.-P. Riviere</i>                                                 |      |
| Creep-fatigue Interaction Mechanisms in a Near-alpha Titanium Alloy at Room Temperature.....                                 | 1357 |
| <i>P. Lefranc, V. Doquet, C. Sarrazin-Baudoux, M. Gerland</i>                                                                |      |
| Characterization of Refractory Titanium Alloys Welded by TIG and Laser Processes.....                                        | 1361 |
| <i>C. Ferdinand, J. Alexis, T. Masri, J.-A. Petit, J.-C. Ganza</i>                                                           |      |
| Microstructural Evolution of TC11 Titanium Alloy during Thermomechanical Processing.....                                     | 1365 |
| <i>A.B. Li, L. Shi, L.J. Huang, L. Geng, Z.F. Yang, Q.Y. Meng</i>                                                            |      |

## Automobile Applications

### Keynote Paper

|                                                                                                                               |      |
|-------------------------------------------------------------------------------------------------------------------------------|------|
| Status on Titanium and Titanium Alloys in Automotive Applications .....                                                       | 1371 |
| <i>L. Wagner, O. Schauerte</i>                                                                                                |      |
| Recent Titanium Applications for Motorcycles .....                                                                            | 1379 |
| <i>E. Sato, K. Takahashi</i>                                                                                                  |      |
| Recent Development of Titanium and Its Alloys in Automotive and Motorcycle Applications .....                                 | 1383 |
| <i>Y. Kosaka, S.P. Fox, K. Faller</i>                                                                                         |      |
| Development of a High Temperature Oxidation-resistant Titanium Alloy for Exhaust Systems of Motorcycles and Automobiles ..... | 1387 |
| <i>T. Yashiki</i>                                                                                                             |      |
| Development of High-formability Titanium Alloys for Automotive Exhaust Systems .....                                          | 1391 |
| <i>H. Otsuka, H. Fujii, K. Takahashi, M. Ishii</i>                                                                            |      |
| Development of Cold Forging Technology for Beta-titanium.....                                                                 | 1395 |
| <i>N. Matsukura</i>                                                                                                           |      |
| Casting and Modeling of Titanium Aluminides for Automotive .....                                                              | 1399 |
| <i>S.-Y. Sung, B.-J. Choi, Y.-J. Kim</i>                                                                                      |      |
| Properties of TIMETAL Exhaust XT Developed for Automotive/ Motorcycle Exhaust Applications.....                               | 1403 |
| <i>Y. Kosaka, S.P. Fox, K. Faller</i>                                                                                         |      |



|                                                              |      |
|--------------------------------------------------------------|------|
| Improvement of Mechanical Properties in Ti-64 Castings ..... | 1407 |
| <i>N. Yunoki, S. Nishikiori</i>                              |      |
| Progress on Titanium Spring .....                            | 1411 |
| <i>B. Bai, J. Yang, Q. Hong</i>                              |      |

## Biomedical and Healthcare Applications

### Keynote Paper

|                                                                                                                                                        |      |
|--------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| Titanium Alloys for Biomedical, Dental and Healthcare Applications .....                                                                               | 1417 |
| <i>M. Niinomi</i>                                                                                                                                      |      |
| Investigation on Process, Microstructure and Mechanical Properties of the Newly Developed Near $\beta$ Type Biomedical Titanium Alloy TLM.....         | 1425 |
| <i>Z. Yu, L. Zhou, J. Niu, L. Luo, S. Yuan, F. Huang, Y. Zhang</i>                                                                                     |      |
| Development of Ti-Mg Alloys Resistant to an Aqueous Fluoride Solution.....                                                                             | 1429 |
| <i>T. Haruna, D. Motoya, Y. Nakagawa, N. Yamashita, T. Oishi</i>                                                                                       |      |
| The Effect of Tin Addition on the Phase Constitution and Heat Treatment Behavior in Ti-7mass%Cr Alloy for Biomedical and Healthcare Applications ..... | 1433 |
| <i>M. Ikeda, S. Masuda, M. Ogawa</i>                                                                                                                   |      |
| Crystal Growth and Plastic Deformation Behavior of Ti-29Nb-13Ta-4.6Zr Bcc-based Single Crystal ..                                                      | 1437 |
| <i>T. Nakano, K. Hagihara, H. Maki, Y. Umakoshi, M. Niinomi</i>                                                                                        |      |
| Evaluation of Ti-29Nb-13Ta-4.6Zr as New Spinal Implants.....                                                                                           | 1441 |
| <i>T. Tamura, S. Kozuka, K. Oribe, M. Nakai, M. Niinomi</i>                                                                                            |      |
| Effect of Bcc-phase Stability on Cyclic Deformation Behavior in Beta-type Ti-Nb-Ta-Zr Alloys Single Crystals with Different Nb Content.....            | 1445 |
| <i>K. Hagihara, T. Nakano, A. Sonoura, K. Watanabe, Y. Umakoshi, M. Niinomi</i>                                                                        |      |
| Texture and Elastic Anisotropy of Ti-Nb-Zr-Ta-O Gum Metal .....                                                                                        | 1449 |
| <i>Y. Nii, H.Y. Kim, H. Hosoda, S. Miyazaki</i>                                                                                                        |      |
| Deformation and Recrystallization Textures of Ti-18Zr-15Nb Alloy .....                                                                                 | 1451 |
| <i>H. Tobe, H.Y. Kim, T. Inamura, H. Hosoda, S. Miyazaki</i>                                                                                           |      |
| Effect of N Addition on Mechanical Properties of Ti-20Nb-4Zr-2Ta (at%) Biomedical Superelastic Alloy .....                                             | 1453 |
| <i>M. Tahara, H.Y. Kim, T. Inamura, H. Hosoda, S. Miyazaki</i>                                                                                         |      |
| Effect of Nb and O Contents on the Mechanical Properties of Ti-Nb-O Alloys .....                                                                       | 1455 |
| <i>M. Yamamoto, H. Y. Kim, H. Hosoda, S. Miyazaki</i>                                                                                                  |      |
| Interfacial Defects at $\beta/\alpha'$ Interface in Ti-Nb Shape Memory Alloys.....                                                                     | 1457 |
| <i>Y.-W. Chai, H.Y. Kim, H. Hosoda, S. Miyazaki</i>                                                                                                    |      |
| Wear Resistance and Mechanical Properties of Biomedical $\beta$ -type Ti-Nb-Ta-Zr System Alloy Subjected to Gas Nitriding Process .....                | 1461 |
| <i>T. Akahori, M. Niinomi, M. Nakai, H. Nishimura, H. Fukui, M. Ogawa</i>                                                                              |      |
| Friction Wear Patterns of Dental Restorative $\beta$ -type Titanium Alloy.....                                                                         | 1465 |
| <i>H. Fukui, S. Tsuruta, M. Toyama, M. Niinomi, T. Akahori</i>                                                                                         |      |
| Plastic Deformation of Titanium for Implantation of Hydroxyapatite Granules .....                                                                      | 1469 |
| <i>A. Watazu, Y. Li, S. Tsutsumi, K. Matsumura, N. Saito</i>                                                                                           |      |
| Apatite Formation on Ti-29Nb-13Ta-4.6Zr Alloy Coated with a Calcium Phosphate Glass-ceramic ...                                                        | 1473 |
| <i>T. Kasuga, M. Niinomi</i>                                                                                                                           |      |
| In Vivo and in Vitro Evaluations of Calcium Phosphate Films Coated on Titanium by RF Magnetron Sputtering .....                                        | 1477 |
| <i>K. Ueda, T. Narushima, T. Goto, H. Nakagawa, H. Kawamura, T. Katsube</i>                                                                            |      |
| Immobilization of Poly (Ethylen Glycol) to Titanium Surface .....                                                                                      | 1481 |
| <i>T. Hanawa, Y. Tanaka, H. Doi, E. Kobayashi, T. Yoneyama</i>                                                                                         |      |

|                                                                                                                                      |      |
|--------------------------------------------------------------------------------------------------------------------------------------|------|
| Mechanical Properties of Porous $\beta$ -Ti Alloy Compacts for Biomedical Applications .....                                         | 1485 |
| <i>N. Nomura, H. Matsumoto, A. Chiba, N. Masahashi, S. Hanada</i>                                                                    |      |
| Mechanical Properties of Ti-Cr System Alloys Prepared by Powder Metallurgy .....                                                     | 1489 |
| <i>Y. Murayama, A. Okubo, H. Kimura</i>                                                                                              |      |
| Mechanical Properties of Porous Titanium Alloy Fabricated by Powder Sintering for Medical Use ....                                   | 1493 |
| <i>K. Doi, T. Matsushita, T. Kokubo, A. Yoshida, M. Takemoto, T. Nakamura, H. Kitagaki</i>                                           |      |
| Development of Fabrication Process of Porous Titanium and Polymethylmethacrylate (PMMA)<br>Composite Biomaterial .....               | 1497 |
| <i>M. Nakai, M. Niinomi, T. Akahori, Y. Shinozaki, H. Toda, S. Itsuno, N. Haraguchi, Y. Itoh, T. Ogasawara, T. Onishi</i>            |      |
| Developments of Dental Precision Casting Technology for Biomedical $\beta$ -type Ti-29Nb-13Ta-4.6Zr<br>Alloy .....                   | 1501 |
| <i>T. Takeuchi, M. Niinomi, S. Katsura, T. Akahori, H. Fukui</i>                                                                     |      |
| Fatigue Properties of Titanium Wires for Medical Applications .....                                                                  | 1505 |
| <i>T. Narushima, K. Ueda, T. Kinami, H. Kimura, C. Ouchi, Y. Iguchi</i>                                                              |      |
| Microstructural Evolution of $\beta$ -TiNb(Sn) Orthopaedic Alloys during High Energy Mechanical Mill-<br>ing and Consolidation ..... | 1509 |
| <i>P. Cao, D. Zhang, B. Gabbitas, K.-D. Woo</i>                                                                                      |      |
| Superelasticity in Ti-Nb Base Alloys.....                                                                                            | 1513 |
| <i>H.-Y. Kim, T. Inamura, H. Hosoda, S. Miyazaki</i>                                                                                 |      |
| Mechanical Properties of Ti-Nb Shape Memory Alloys Containing 3d Transition Metal Elements<br>(V, Cr, Mn, Fe, Co, Ni and Cu) .....   | 1517 |
| <i>H. Hosoda, Y. Horiuchi, K. Nakayama, T. Inamura, K. Wakashima, S. Miyazaki</i>                                                    |      |
| Internal Twin and Defect of $\alpha'$ -Martensite in Ti-Nb-Al Shape Memory Alloy .....                                               | 1521 |
| <i>T. Inamura, J.-I. Kim, H.-Y. Kim, K. Wakashima, S. Miyazaki, H. Hosoda</i>                                                        |      |
| Effect of In Addition on Shape Memory Characteristics of Ti-Nb Alloys.....                                                           | 1525 |
| <i>Y. Fukui, O. Katsuda, T. Inamura, H. Hosoda, K. Wakashima, S. Miyazaki</i>                                                        |      |
| Microstructure of Ti-24Nb-3Al Melt-spun Ribbon.....                                                                                  | 1529 |
| <i>Y. Yamamoto, T. Inamura, H. Hosoda, K. Wakashima, S. Miyazaki, S. Tsurekawa, T. Nakano, Y. Umakoshi</i>                           |      |
| Synthesis, Microstructure and Cytocompatibility of New Beta Titanium Alloys for Biomedical Ap-<br>plications.....                    | 1533 |
| <i>E. Delvat, D.-M Gordin, T. Gloriant, R. Chelariu, J.-L. Duval, M.-D. Nagel</i>                                                    |      |
| Animal Experiments on Bone Tissue Reaction to a Low Rigidity Titanium Alloy of Ti-29Nb-13Ta-<br>4.6Zr .....                          | 1537 |
| <i>T. Hattori, K. Morikawa, K. Sato, M. Niinomi</i>                                                                                  |      |
| Phase Transformation Behavior of Ni-rich and Reclaimed NiTi Shape Memory Alloy Prepared by<br>Vacuum Arc Remelting .....             | 1541 |
| <i>Y. Motemani, M. Nili-Ahmadabadi, M. Bornapour, S. Raygan, S. Ahmadi, T. Shahoseini</i>                                            |      |
| Preparation and Characterization of TiNi Shape Memory Alloy Foams by Powder Metallurgy.....                                          | 1545 |
| <i>J. Xiong, Y. Li, P. Hodgson, C. Wen</i>                                                                                           |      |
| Surface Modification of Medical Ni-Ti Alloys through Forming TiO <sub>2</sub> Thin Film .....                                        | 1549 |
| <i>H. Uchiyama, Y. Kimura</i>                                                                                                        |      |
| Corrosion Resistance and Biocompatibility of Ti-Ni Alloy Modified by Isothermal Oxidation .....                                      | 1553 |
| <i>Y. Matsumura, H. Sugawara, J. Komotori, N. Hisamori</i>                                                                           |      |
| Corrosion Behavior of Laser-fabricated Hydroxyapatite Coating on Titanium Alloy for Biomedical<br>Applications.....                  | 1557 |
| <i>C.T. Kwok, P.K. Wong</i>                                                                                                          |      |
| Electrolytic Treatment to Form Nickel-free Surface Oxide Layer on Super-elastic Ti-Ni Alloy .....                                    | 1561 |
| <i>T. Yoneyama, O. Fukushima, T. Komiya, Y. Tanaka, H. Doi, T. Hanawa</i>                                                            |      |

|                                                                                                           |      |
|-----------------------------------------------------------------------------------------------------------|------|
| A Novel Fabrication Technique for Titanium Dental Implant and its Evaluation .....                        | 1563 |
| <i>K. Okazaki</i>                                                                                         |      |
| Evaluation of Cast Ti-Al-Fe Alloys for Dental Prostheses.....                                             | 1567 |
| <i>M. Koike, H. Fujii, Q. Guo, M. Brezner, T. Okabe</i>                                                   |      |
| Development of Titanium Alloy for Mouthpiece of Brass Instrument and Its Precision Casting Process .....  | 1571 |
| <i>M. Niinomi, T. Akahori, T. Nozaki, M. Nakai, S. Horihata, T. Suzuki, K. Wakanabe, K. Sone, H. Toda</i> |      |
| Photocatalyst Development at Sumitomo Titanium .....                                                      | 1575 |
| <i>S. Shimosaki, H. Kanno, K. Azuma, T. Ogasawara, K. Nishihara, Y. Masaki</i>                            |      |

## **Sport, Leisure and Civil Applications**

### **Keynote Paper**

|                                                                                                                                                                   |      |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| Recent Civil Applications and Supporting Technologies .....                                                                                                       | 1581 |
| <i>T. Oda</i>                                                                                                                                                     |      |
| Three Case Studies for the Architectural and Structural Use of Titanium: Abu Dhabi Airport, Tian-jin Titanium Towers, Titanium Gridshells .....                   | 1589 |
| <i>S. Salat</i>                                                                                                                                                   |      |
| The Anti-corrosive Reinforcement Method for Heavy Duty Coatings by Titanium Foils .....                                                                           | 1595 |
| <i>K. Sakamoto, S. Moriya, Y. Ogura</i>                                                                                                                           |      |
| Titanium Covering Method for Corrosion Protection of Concrete Structures in Sewerage Facilities ...                                                               | 1599 |
| <i>T. Tomiyama, T. Yamamoto, H. Osawa, H. Ito, I. Nishizaki</i>                                                                                                   |      |
| Titanium Alloy for Golf Club Head.....                                                                                                                            | 1603 |
| <i>N. Ariyasu, S. Matsumoto, K. Nagashima</i>                                                                                                                     |      |
| Ti-Nb-Sn and Ti-V-Sn Alloys with Low Young's Modulus and High Strength .....                                                                                      | 1607 |
| <i>H. Matsumoto, N. Nomura, A. Chiba, N. Masahashi, S. Hanada</i>                                                                                                 |      |
| The Art of Refraction and Reflection-A History of the Early Evolution of the Use of Titanium in Jewellery Dedicated to the Memory of Professor Harvey Flower..... | 1611 |
| <i>L. Bartlett</i>                                                                                                                                                |      |

## **Marine and Offshore Applications**

### **Keynote Paper**

|                                                                                                                                            |      |
|--------------------------------------------------------------------------------------------------------------------------------------------|------|
| Titanium - Key to Ocean Depth .....                                                                                                        | 1617 |
| <i>I.V. Gorynin, S.S. Ushkov, V.I. Mikhaylov</i>                                                                                           |      |
| Update and Trends in Titanium Alloy Riser Applications and Technology .....                                                                | 1625 |
| <i>C.F. Baxter, R.W. Schutz</i>                                                                                                            |      |
| Processing and Properties of Heavy Section Ti 6-4 ELI Billet .....                                                                         | 1629 |
| <i>C. McDaniel, C. Bresson, M. Kamal, V. Venkatesh, S.P. Fox</i>                                                                           |      |
| The Development of Hollow Forged Ti 6-4 ELI Rounds .....                                                                                   | 1633 |
| <i>C. McDaniel, C. Bresson, M. Kamal, S.P. Fox, A. McNally</i>                                                                             |      |
| Misalignment Effect on Fatigue Strength of CP Titanium Butt-welded Joints .....                                                            | 1637 |
| <i>T. Iwata, K. Matsuoka</i>                                                                                                               |      |
| Microstructures and Mechanical Properties of Ultrafine Grained Ti-47Al-2Cr (at%) Alloy Produced by Hot Isostatic Pressing of Powders ..... | 1641 |
| <i>V. N Nadakuduru, P. Cao, D. Zhang, B. Gabbitas</i>                                                                                      |      |
| Cost Competitive Welding of Titanium for Sea Water Piping for Navy Vassels.....                                                            | 1645 |
| <i>S. Marya, P. Hoyt</i>                                                                                                                   |      |

## Surface Modification

|                                                                                                                                                  |      |
|--------------------------------------------------------------------------------------------------------------------------------------------------|------|
| Nitride Strengthened Titanium via Deposition Processing .....                                                                                    | 1651 |
| <i>C.A. Brice</i>                                                                                                                                |      |
| Stress Gradient at the $\alpha_s/\beta$ Interface in a Ti-6Al-4V Alloy .....                                                                     | 1655 |
| <i>P. Castany, F. Pettinari-Sturm, J. Douin, A. Coujou</i>                                                                                       |      |
| Effect of Hybrid Surface Modification Composed with Plasma Carburizing and FPB Treatment on Fatigue Strength of Ti-6Al-4V Alloy .....            | 1659 |
| <i>T. Morita, T. Ohtomo, C. Kagaya, N. Tsuji, S. Tanaka, T. Miyasaka</i>                                                                         |      |
| Characterization of Surface Modified Ti6Al4V Alloy by Combination of Plasma-carburizing and Cold-rolling .....                                   | 1663 |
| <i>N. Tsuji, S. Tanaka, T. Takasugi</i>                                                                                                          |      |
| Near-surface Characteristics and Fatigue Behavior of Laser Shock Peened Titanium Alloy Timetal LCB.....                                          | 1667 |
| <i>M.A. Cherif, H. Knobbe, I. Altenberger, U. Krupp</i>                                                                                          |      |
| Effect of Attachment of Silica Nanoparticles on Coordination of Titanium Surface Species of Titania .....                                        | 1671 |
| <i>H. Nur</i>                                                                                                                                    |      |
| Fabrication of Titanium by High Performance Nano Adhesive for Aerospace Applications .....                                                       | 1675 |
| <i>S. Bhowmik, R. Benedictus, H. Poulis, H.W. Bonin, V.T. Bui</i>                                                                                |      |
| Development of Titanium Alloy Separator for Polymer Electrolyte Fuel Cell.....                                                                   | 1679 |
| <i>T. Sato, J. Suzuki, T. Yashiki, M. Fukuda</i>                                                                                                 |      |
| Titanium Coating on Iron and Steels by Disproportionation Reaction in Molten Salt .....                                                          | 1683 |
| <i>T. Takenaka, M. Muro, M. Kawakami</i>                                                                                                         |      |
| Development of Colored Titanium Sheets with Highly Resistant to Discoloration in Atmospheric Environments .....                                  | 1687 |
| <i>M. Kaneko, K. Tokumo</i>                                                                                                                      |      |
| Effect of Carbon Content on Interface Separation Phenomenon in Ti-Al/Fe-C Joints.....                                                            | 1691 |
| <i>Y. Morizono, Y. Kodama, M. Nishida, T. Yamamuro</i>                                                                                           |      |
| Formation of a Protective Alumina Layer by Fluorine Doping of Titanium Aluminide Surfaces ....                                                   | 1695 |
| <i>H.-E. Zschau, M. Schutze</i>                                                                                                                  |      |
| Comparative Fluorine Surface Treatments for TiAl Oxidation Protection .....                                                                      | 1699 |
| <i>P. Masset, H.-E. Zschau, S. Neve, M. Schutze</i>                                                                                              |      |
| Influence of Mechanical Surface Treatments on the High Cycle Fatigue Performance of Gamma Titanium Aluminides .....                              | 1703 |
| <i>J. Lindemann, M. Glavatskikh, C. Leyens, M. Oehring, F. Appel</i>                                                                             |      |
| Tensile Deformation Behaviour of the Titanium Alloy with Hard Elastic Coating .....                                                              | 1707 |
| <i>W. Ziaja, J. Sieniawski, R. Filip</i>                                                                                                         |      |
| Fatigue Behavior and Residual Stress Relaxation of Laser-shock Peened and Deep Rolled Ti-6Al-4V .....                                            | 1711 |
| <i>M.A. Cherif, Y. Sano, C. Ruppel, M. Esmailian, I. Altenberger</i>                                                                             |      |
| Effect of Laser Carbonizing on Microstructure and Wear Properties of Ti-6Al-4V Titanium Alloy ....                                               | 1715 |
| <i>R. Filip, J. Sieniawski, W. Ziaja</i>                                                                                                         |      |
| Material Transfer and Diffusion in Peening Process on Ti-6Al-4V Alloy .....                                                                      | 1719 |
| <i>Y. Kameyama, A. Sasago, J. Komotori</i>                                                                                                       |      |
| The Effect of Friction Stir Processing on the Microstructure and Properties of Investment Cast Ti-6Al-4V.....                                    | 1723 |
| <i>A.L. Pilchak, M.C. Juhas, J.C. Williams</i>                                                                                                   |      |
| Surface Modification Technology of Titanium, 'Fresh Green' Durability and Photocatalytic Activity of Carbon-doped Titanium Dioxide Surface ..... | 1727 |
| <i>M. Furuya, M. Tokiwai, N. Tanaka, M. Horie</i>                                                                                                |      |

|                                                                                             |      |
|---------------------------------------------------------------------------------------------|------|
| Gas Nitriding of Biocompatible Beta Titanium Alloys.....                                    | 1731 |
| <i>D.-M. Gordin, I. Thibon, A. Guillou, D. Ansel, T. Gloriant</i>                           |      |
| Influence of Laser Treatment on Microstructure of Surface Layer of the Ti-6Al-4V Alloy..... | 1735 |
| <i>W. Serbinski, A. Zienlinski, A. Dziadon, M. Jazdzewska</i>                               |      |
| Assessment of Bioactivity of Zirconium and Titanium-zirconium Alloy .....                   | 1739 |
| <i>X. Chen, Y Li, J. Lin, P.D. Hodgson, B. Usher, C. Wen</i>                                |      |
| Author Index .....                                                                          | 1743 |
| Subject Index .....                                                                         | 1753 |