

# Table of Contents

## Preface

|                                                                                                                                                                                              |     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>Multiscale Science: Materials in the 21<sup>st</sup> Century</b><br>J.A. Krumhansl                                                                                                        | 1   |
| <b>The Industrial Applications of Shape Memory Alloys in North America</b><br>L.M. Schetky                                                                                                   | 9   |
| <b>Applications of Shape Memory Alloys in Japan</b><br>M. Asai and Y. Suzuki                                                                                                                 | 17  |
| <b>Study of Ti-Ni-Nb Shape Memory Alloys with a Wide Hysteresis</b><br>L.C. Zhao                                                                                                             | 23  |
| <b>Development of a Shape Memory Alloy Damper for Intelligent Bridge Systems</b><br>Y. Adachi, S. Unjoh and M. Kondoh                                                                        | 31  |
| <b>Development of Anti-Loosening Nuts Using Shape Memory Alloys</b><br>X.R. Zhang, J.X. Nie and G. Hou                                                                                       | 35  |
| <b>Design of a New High Pressure Apparatus Using Shape Memory Alloy</b><br>G. Oomi, S. Aduma, I. Kosaka, T. Kagayama and M. Nishida                                                          | 39  |
| <b>SMA - Present State and Perspective for New Applications</b><br>B. Bundara, M. Tokuda and M. Ye                                                                                           | 43  |
| <b>Vertical Seismic Prospecting System Using Super Elastic Alloy</b><br>T. Inaba, N. Horiba, K. Yamauchi, A. Hirata and K. Kaneko                                                            | 47  |
| <b>Directly Acting Pipeline SM Devices for Nuclear Power Plants</b><br>R.R. Ionaitis                                                                                                         | 51  |
| <b>Medical Application of NiTi Shape Memory Alloy in China</b><br>Y. Chu, K.R. Dai, M. Zhu and X.J. Mi                                                                                       | 55  |
| <b>Medical Uses of Nitinol</b><br>A.R. Pelton, D. Stöckel and T.W. Duerig                                                                                                                    | 63  |
| <b>Orthodontic Applications of a Superelastic Shape-Memory Alloy Model</b><br>R.W. Glendenning, J.A.A. Hood and R.L. Enlow                                                                   | 71  |
| <b>Physical Characterisation of Endodontic Instruments in NiTi Alloy</b><br>L. Torrisi and G. Di Marco                                                                                       | 75  |
| <b>Mechanical Compatibility Characterization of Shape Memory Mesh Stents</b><br>X.J. Mi, M. Zhu, J.F. Guo, Y.M. Kou, F.H. Wang and G. Yuan                                                   | 79  |
| <b>Smart Materials Based on Shape Memory Alloys: Examples from Europe</b><br>R. Gotthardt, P. Scherrer and R. Stalmans                                                                       | 83  |
| <b>Researches of Smart Materials in Japan</b><br>Y. Furuya and J. Tani                                                                                                                       | 91  |
| <b>Intelligent Bearing System for Passing through Critical Speed of Aeroengine Rotor by Changing Stiffness Using SMA Wires</b><br>J.X. Nie and X.J. Yan                                      | 99  |
| <b>Crystallography and Boundary Structure of Twins in Ti-Ni and Ti-Pd Martensites</b><br>M. Nishida and S. Ii                                                                                | 103 |
| <b>Effect of Pre-Deformation on Hysteresis in TiNiFe Shape Memory Alloys</b><br>C.B. Jiang and H.B. Xu                                                                                       | 111 |
| <b>Hydrostatic Pressure Dependence of Transformation Temperatures of Ti-Ni-Cu Alloys</b><br>T. Fukuda, T. Kakeshita, N. Tamura, T. Saburi and S. Endo                                        | 115 |
| <b>Pseudo-Elasticity and Shape Memory Effect on the TiNiCoV Alloy</b><br>S.E. Hsu, M.T. Yeh, I.C. Hsu, S.K. Chang, Y.C. Dai and J.Y. Wang                                                    | 119 |
| <b>Fatigue Crack Growth Properties and Scanning Electron Microscopy of Fatigue Fracture Surface of a Ti-Ni-Co Shape Memory Alloy</b><br>Y. Kishi, Z. Yajima, K. Shimizu and K. Morii         | 123 |
| <b>The Interface of Sputter-Deposited TiNi Thin Film on (100) Si Wafer</b><br>S.K. Wu, J.Y. Wang, I.J. Wu and H.C. Lin                                                                       | 127 |
| <b>Amorphous-Crystalline Microstructures of Heat-Treated, Melt-Spun Ti<sub>50</sub>Ni<sub>25</sub>Cu<sub>25</sub> Ribbons</b><br>P. Schlossmacher, H. Rösner, A.V. Shelyakov and A.M. Glezer | 131 |

|                                                                                                                                                                                               |     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>The Electrical Resistance of Ni<sub>50</sub>Ti<sub>30</sub>Hf<sub>20</sub> and Ni<sub>50</sub>Ti<sub>40.5</sub>Hf<sub>9.5</sub> Melt-Spun Ribbons during Current-Driven Thermal Cycles</b> |     |
| G. Airoidi, S. Piredda, M. Pozzi and A.V. Shelyakov                                                                                                                                           | 135 |
| <b>Defect Modelling of Martensitic Transformations in NiTi</b>                                                                                                                                |     |
| R.C. Pond and T. Nixon                                                                                                                                                                        | 139 |
| <b>The Pseudoelasticity of a Ni<sub>45</sub>Ti<sub>50</sub>Cu<sub>5</sub> Alloy</b>                                                                                                           |     |
| T. Ranucci, S. Besseghini and G. Airoidi                                                                                                                                                      | 143 |
| <b>Effect of Alloying Elements Zr, Cr, V on Corrosion Behavior of Ti-Ni-Nb Shape Memory Alloy</b>                                                                                             |     |
| Z.Z. Dong, D. Jia, Z. Tang, W.X. Liu and D.G. Wang                                                                                                                                            | 147 |
| <b>Fatigue Properties of TiNi Shape Memory Alloy</b>                                                                                                                                          |     |
| H. Tobushi, T. Hashimoto, Y. Shimeno and K. Takata                                                                                                                                            | 151 |
| <b>Constitutional Phases and Transformation Characteristics of Ni<sub>41</sub>Ti<sub>39</sub>Ta<sub>20</sub> Alloy</b>                                                                        |     |
| K.H. Wu, J.L. Ma and Z. Pu                                                                                                                                                                    | 155 |
| <b>HREM Studies on the Microstructure of Severely Cold-Rolled TiNi Alloy after Reverse Martensitic Transformation</b>                                                                         |     |
| Y.F. Zheng, L.C. Zhao and H.Q. Ye                                                                                                                                                             | 159 |
| <b>Relation between {20-1} Twinning of B19' Martensitic and {114} Twinning of B2 Parent Phases in Ti-Ni Shape Memory Alloy</b>                                                                |     |
| Y. Maruhashi, A. Ozaygen and M. Nishida                                                                                                                                                       | 163 |
| <b>Effect of Thermal Cycling and Aging on Microstructure in Near-Equiatomic Ti-Pd Alloys</b>                                                                                                  |     |
| S. Ii, N. Matsuzaki, Y. Morizono and M. Nishida                                                                                                                                               | 167 |
| <b>New Precipitate Phase in Pd and Ni Rich Ti-Pd-Ni Shape Memory Alloys</b>                                                                                                                   |     |
| Y. Shirakawa, Y. Morizono and M. Nishida                                                                                                                                                      | 171 |
| <b>Effect of Ti Content on Nanometric Substructure and Shape Memory Property in Sputter-Deposited Ti-Rich Ti-Ni Thin Films</b>                                                                |     |
| T. Matsunaga, S. Kajiwar, K. Ogawa, T. Kikuchi and S. Miyazaki                                                                                                                                | 175 |
| <b>Microstructure and Transformation Behavior of Ni<sub>50</sub>Ti<sub>50-x</sub>Ta<sub>x</sub> Alloys</b>                                                                                    |     |
| J.L. Ma, K.H. Wu and Z. Pu                                                                                                                                                                    | 179 |
| <b>Creep Behavior of NiTi Shape Memory Alloys and the Effect of Pre-Creep on the Martensitic Phase Transformation</b>                                                                         |     |
| G.F. Eggeler, K. Neuking, A. Dlouhý and E. Kobus                                                                                                                                              | 183 |
| <b>Study into the Influence of the Shape Setting Rate on Memory Effect Manifestation in Titanium Nickelide</b>                                                                                |     |
| N.N. Popov, N.D. Sevryugina, I.V. Sevryugin and N.V. Derkach                                                                                                                                  | 187 |
| <b>Reversibility in Martensitic Transformation and Shape Memory in High Mn Ferrous Alloys</b>                                                                                                 |     |
| Y. Tomota and T. Maki                                                                                                                                                                         | 191 |
| <b>Fe-Mn-Si Based Shape Memory Alloys</b>                                                                                                                                                     |     |
| T.Y. Hsu                                                                                                                                                                                      | 199 |
| <b>Martensitic Transformation in Thin Foils of an Fe-Ni-Co-Ti Shape Memory Alloy</b>                                                                                                          |     |
| S. Morito, T. Moritani, T. Furuhashi and T. Maki                                                                                                                                              | 207 |
| <b>Mechanism of Improvement of Shape Memory Effect by Training in Fe-Mn-Si-Based Alloys</b>                                                                                                   |     |
| S. Kajiwar and K. Ogawa                                                                                                                                                                       | 211 |
| <b>Continuous AFM Observation of Martensitic Transformation and Its Reversion in Training Cycles of Fe-Mn-Si Based Shape Memory Alloys</b>                                                    |     |
| D.Z. Liu, T. Kikuchi, S. Kajiwar and N. Shinya                                                                                                                                                | 215 |
| <b>Prediction of Martensitic Transformation Start Temperature M<sub>s</sub> in Fe-Mn-Si Shape Memory Alloys</b>                                                                               |     |
| X.S. Jin and T.Y. Hsu                                                                                                                                                                         | 219 |
| <b>Strengthening of Fe-Mn-Si Based Shape Memory Alloys by Grain Size Refinement</b>                                                                                                           |     |
| A. Sato, T. Masuya, M. Morishita, S. Kumai and A. Inoue                                                                                                                                       | 223 |
| <b>Shape Memory Effect of Fe-17%Mn-X Alloys</b>                                                                                                                                               |     |
| S.H. Lee, H.J. Kim, J.H. Jun, S.H. Baik and C.S. Choi                                                                                                                                         | 227 |
| <b>Influence of SME and Microstructure in FeMnSiCrNi SMA for Strengthening of Austenite Matrix</b>                                                                                            |     |
| N. Gu, C.X. Lin, X.Y. Song, H. Peng, F. Yin and Q.S. Liu                                                                                                                                      | 231 |
| <b>An ODF Analysis of Annealing Texture and Its Effect on SME in an Fe-Mn-Si-Cr Alloy Wire</b>                                                                                                |     |
| B. Jiang, X. Qi, Y. Ren and C.M. Wang                                                                                                                                                         | 235 |

|                                                                                                                                                                                                                                                                       |     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>Shape Memory Behavior of an Fe-Mn-Si SMA Spring</b><br>J. Tang                                                                                                                                                                                                     | 239 |
| <b>Characteristics of Fe-28Mn-6Si-5Cr Shape Memory Alloy Produced by Centrifugal Casting</b><br>H. Otsuka, T. Maruyama and H. Kubo                                                                                                                                    | 243 |
| <b>The Welding Characteristics of Fe-Based Shape Memory Alloys</b><br>H.C. Lin, K.M. Lin, Y.C. Chuang, T.S. Chou and F.H. Chen                                                                                                                                        | 247 |
| <b>Effect of Pre-Deformation Temperature on Reverse Transformation Characteristic in Fe-Mn-Si Based Alloys</b><br>D.G. Wang, X. Xing, J.M. Chen, Z.Z. Dong and W.X. Liu                                                                                               | 251 |
| <b>Atomic Force Microscopy Study of Stacking Modes of Martensitic Transformation in Fe-Mn-Si Based Shape Memory Alloys</b><br>D.Z. Liu, T. Kikuchi, S. Kajiwara and N. Shinya                                                                                         | 255 |
| <b>Effects of High Magnetic Field on Martensitic Transformation Behavior and Structure in Fe-Based Alloys</b><br>H. Ohtsuka, G. Ghosh and H. Wada                                                                                                                     | 259 |
| <b>Influence of Ausforming on Substructures and Shape Memory Behavior in Fe-28Mn-6Si-5Cr Alloy</b><br>D.G. Wang, W. Ji, M. Han, D. Jia and W.X. Liu                                                                                                                   | 263 |
| <b>Grain Size Effect on the Microstructure of Deformed Fe-Mn-Si Based Shape Memory Alloys</b><br>T. Masuya, N. Yoneyama, S. Kumai and A. Sato                                                                                                                         | 267 |
| <b>High Temperature Shape Memory Effect in Some Alloys and Compounds</b><br>Y.N. Koval                                                                                                                                                                                | 271 |
| <b>Thermal Cyclic Characteristics under Load in a <math>\text{Ti}_{50.6}\text{Pd}_{30}\text{Ni}_{19.4}</math> Alloy</b><br>W. Cai, S. Tanaka and K. Otsuka                                                                                                            | 279 |
| <b>Recrystallization of <math>\text{Ti}_{51}\text{Ni}_{13}\text{Pd}_{36}</math> High Temperature Shape Memory Alloys</b><br>S.K. Gong, S. Hu and H.B. Xu                                                                                                              | 283 |
| <b>Influence of Substitution of V for Ti on Martensitic Transformation of TiPd Alloy</b><br>K. Enami, K. Morota, M. Hisa and K. Inoue                                                                                                                                 | 287 |
| <b>High-Temperature Cu-Al-Nb Shape Memory Alloys</b><br>H. Morawiec, J. Lel'tko, Y. Koval and V. Kolomytsev                                                                                                                                                           | 291 |
| <b>Fabrication, Microstructure and Stress Effects in Sputtered TiNi Thin Films</b><br>D.S. Grummon                                                                                                                                                                    | 295 |
| <b>Structure of Sputter-Deposited Ti-Rich Ti-Ni Alloy Films</b><br>Y. Kawamura, A. Gyobu, T. Saburi and M. Asai                                                                                                                                                       | 303 |
| <b>The Ti-Ni-Me and Cu-Al-Me Melt-Spun Shape Memory Ribbons: Relation between the Microstructure and Functional Properties</b><br>V. Kolomytsev, A. Pasko, R. Portier, P. Ochinnikov, A. Seereneels, W. Van Moorleghe, E. Cesari, C. Seguí and J. Van Humbeeck        | 307 |
| <b>Microstructure and Functional Properties of the TiNi- and CuAl-Based SMA Thin Films and Coats Produced by PVD Technique</b><br>V. Kolomytsev, R.Y. Musienko, V. Nevdacha, V. Panarin, A. Pasko, R. Portier, P. Ochinnikov, E. Cesari, C. Seguí and J. Van Humbeeck | 311 |
| <b>Interfacial Structure and the Shape Memory Effect</b><br>D.P. Dunne                                                                                                                                                                                                | 315 |
| <b>Transformation Thermomechanics of SMAs</b><br>K. Tanaka                                                                                                                                                                                                            | 323 |
| <b>Shape Memory Alloys as Damping Materials</b><br>J. Van Humbeeck and Y. Liu                                                                                                                                                                                         | 331 |
| <b>The Hysteresis Expansion and the Relaxation of Elastic Energy in Thermoelastic Martensitic Transformations</b><br>X.Q. Zhao                                                                                                                                        | 339 |
| <b>Thermomechanical Constitutive Modeling of Polyurethane-Series Shape Memory Polymer</b><br>H. Tobushi, N. Ito, K. Takata and S. Hayashi                                                                                                                             | 343 |
| <b>The Phase Field Model and Computer Simulation of Martensitic Transformation under Applied Stresses</b><br>A. Artemev and A.G. Khachaturyan                                                                                                                         | 347 |
| <b>Bending of Beams in Superelasticity Domain</b><br>F. Kosel and B. Bundara                                                                                                                                                                                          | 351 |

|                                                                                                                                                                                          |     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>Study on Indirect Method for Determination of Compression Characteristics of SMA</b><br>B. Bundara, M. Tokuda and M. Ye                                                               | 355 |
| <b>On Formal Structure of Constitutive Equations for Materials Exhibiting Shape Memory Effects</b><br>I. Dobovšek                                                                        | 359 |
| <b>Change in Young's Modulus Associated with Martensitic Transformation in Shape Memory Alloys</b><br>K.I. Sugimoto and M. Nakaniwa                                                      | 363 |
| <b>Landau Theory of the Displacive Phase Transformations in Gold-Cadmium and Titanium-Nickel Alloys</b><br>G.R. Barsch                                                                   | 367 |
| <b>Asymmetric Behavior of Elastic Scattering Appearing Prior to the Transformation in Au-47.5at%Cd</b><br>T. Ohba, K. Sato and K. Otsuka                                                 | 377 |
| <b>Evolution of Lattice Vibration through Vortex into Change of Crystal Structure: A Path in the Martensitic Transformation</b><br>T. Suzuki, M. Shimono and S. Takeno                   | 381 |
| <b>Defect-Induced Microstructure and Shape Memory in a Continuum Model</b><br>A. Saxena, T. Lookman, S.R. Shenoy and A.R. Bishop                                                         | 385 |
| <b>Intrinsic Hysteresis of Superelastic Deformation</b><br>A.L. Roytburd                                                                                                                 | 389 |
| <b>The Effect of Specimen Size on the B2B19 Martensitic Transformation under Quasi-Static Condition in 49.5Ti-40Ni-10Cu-0.5Al(at%) Alloy</b><br>S. Onai and H. Sakamoto                  | 393 |
| <b>A Study of Martensitic Transformation in Au-51.5at%Cd Alloy</b><br>M. Inami, T. Ishii, X.B. Ren and K. Otsuka                                                                         | 397 |
| <b>Bainitic Transformation of Au-47.5at%Cd Alloy</b><br>K. Ogawa, S. Yamada, X.B. Ren, T. Ishii, K. Otsuka and T. Ohba                                                                   | 401 |
| <b>Observation on Plastic Accommodation of Shape Strain in Martensitic Transformation in Fe-Ni-C Shape Memory Alloys</b><br>D.Z. Liu, N. Bergeon, T. Kikuchi, S. Kajiwarra and N. Shinya | 405 |
| <b>Facets of Nanometer-Sized Fe-Ni Alloy Particles and Their Change upon the Martensitic Transformation</b><br>K. Asaka, Y. Hirotsu and T. Tadaki                                        | 409 |
| <b>Origin of the Annihilation Effect of Martensite Aging</b><br>X.B. Ren and K. Otsuka                                                                                                   | 413 |
| <b>Surface Morphological Study of the Transformation Strain of Martensites and Bainites in Copper Alloys</b><br>K. Marukawa, I. Kumagai and K. Takezawa                                  | 417 |
| <b>Pretransitional Effects in Martensitic Transformations</b><br>A. Planes and L. Mañosa                                                                                                 | 421 |
| <b>Why Does the Martensitic Transformation Temperature Strongly Depend on Composition?</b><br>X.B. Ren and K. Otsuka                                                                     | 429 |
| <b>Heterophase Fluctuation of <math>\omega</math>-Phase Nucleation</b><br>H. Kubo                                                                                                        | 433 |
| <b>Pre-Martensitic Phenomenon in NiTi Studied by Positron Lifetime Spectroscopy</b><br>H. Araki, N. Matake, P. Chalermkarnnon and Y. Shirai                                              | 437 |
| <b>Observations on Diffuse Scattering in a Ti<sub>50</sub>Ni<sub>48</sub>Fe<sub>2</sub> Alloy by Energy-Filtering TEM</b><br>Y. Murakami, D. Shindo and K. Otsuka                        | 441 |
| <b>Precursors of Thermoelastic Fcc-Fct Martensite Transformation of Fe<sub>3</sub>Pt Alloys</b><br>R. Oshima, S. Muto and M. Takahashi                                                   | 445 |
| <b>Lattice Instability for <math>\frac{1}{2}(110)[110]</math> Wave in Shape Memory Alloys</b><br>Y. Nakata                                                                               | 449 |
| <b>The Two Way Shape Memory Effect: Influence of Stabilization in Single and Polycrystals of Cu-Based Alloys</b><br>E. Cingolani, P.A. Larochette and M. Ahlers                          | 453 |
| <b>Stress and Aging Effects on the Transformation Characteristics in Au-Cd Alloys</b><br>T.R. Finlayson, G.L. Kelly, T. Ersez and T.F. Smith                                             | 457 |

|                                                                                                                     |     |
|---------------------------------------------------------------------------------------------------------------------|-----|
| <b>Monte Carlo Study of Atomic Ordering in Relation to the Rubber Effect and the Stabilization of Martensites</b>   |     |
| K. Marukawa, S. Moteki and K. Tsuchiya                                                                              | 461 |
| <b>Effect of Aging on the Martensitic Transformation Temperature in Ag-Zn-Al Alloys</b>                             |     |
| K. Takezawa, H. Hoshi and K. Marukawa                                                                               | 465 |
| <b>Aging Response of Shape Memory Behavior in <math>\gamma</math>-MnCu Alloys</b>                                   |     |
| K. Tsuchiya, O. Kawabata, M. Umemoto, H. Sato and K. Marukawa                                                       | 469 |
| <b>Effect of Co Addition on the Ordering and Martensitic Transformations in Cu-Al-Mn Shape Memory Alloys</b>        |     |
| Y. Sutou, R. Kainuma and K. Ishida                                                                                  | 473 |
| <b>Superplastic Deformation and Shape Memory Effects of Cu-Zn-Sn Alloys</b>                                         |     |
| H. Honda, R. Matubara, N. Ashie, K. Nakamura and S. Miura                                                           | 477 |
| <b>Acoustic Emission at the Premartensitic and Martensitic Transitions of Ni<sub>2</sub>MnGa Shape Memory Alloy</b> |     |
| L. Mañosa, L. Carrillo, E. Vives, E. Obradó, A. González-Comas and A. Planes                                        | 481 |
| <b>Martensitic Transformations in Ni-Mn-Ga System Affected by External Fields</b>                                   |     |
| V.A. Chernenko, O. Babii, V.A. L'vov and P.G. McCormick                                                             | 485 |
| <b>Properties of Ni<sub>2</sub>MnGa Shape Memory Alloy Prepared by Spark Plasma Sintering</b>                       |     |
| Z. Wang, M. Matsumoto, S.T. Pantelides, K. Oikawa, J. Qiu, T. Takagi and J. Tani                                    | 489 |
| <b>Premartensitic States in the Ferromagnetic Ni-Mn-Ga Alloys</b>                                                   |     |
| V.V. Kokorin                                                                                                        | 493 |
| <b>NiAl Shape Memory Alloy by Powder Metallurgy Method</b>                                                          |     |
| C.H. Man and C.Y. Chung                                                                                             | 497 |