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Memory Alloy Hybrid Composites Ni-free Ti-based Shape Memory Alloys Advances in Shape Memory Materials Shape-Memory Polymers Shape Memory Materials and Its Applications Pseudoelasticity of Shape Memory Alloys Shape Memory Alloys Thin Film Shape Memory Alloys Shape Memory Implants Modeling and Testing of Shape Memory Alloys Theoretical and Numerical Modeling of Shape Memory Alloys

Pseudoelasticity of Shape Memory Alloys: Theory and Experimental Studies is devoted to the phenomenon of pseudoelasticity (superelasticity) exhibited by shape memory alloy materials. It provides extensive introductory content on the state-of-the-art in the field, including SMA materials development, definition of shape memory effects, and discussions on where shape memory behavior is found in various engineering application areas. The book features a survey of modeling approaches targeted at reliable prediction of SMA materials' behavior on different scales of observation, including atomistic, microscopic, mezoscopic, and macroscopic. Researchers and graduate students will find detailed information on the modern methodologies used in the process of building constitutive models of advanced materials exhibiting complex behavior. Introduces the phenomenon of pseudoelasticity exhibited by shape memory alloy

materials Features a survey of modeling approaches targeted at reliable prediction of SMN materials' behavior on different scales of observation Provides extensive coverage of the state-of-the-art in the field Ideal reference for researchers and graduate students interested in the modern methodologies used in the process of building constitutive models of advanced materials Overview of recent achievements, describing the microactuator development of microvalves and liner actuators comprehensively from concept through prototype. Further key aspects included are three-dimensional models for handling complex SMA actuator geometries and coupled simulation routines that take multifunctional properties into account. Mechanical and thermal optimization criteria are introduced for actuator design, allowing an optimum use of the shape memory effect. It is shown that some of the prototypes presented, e.g. SMA microgrippers, already outperform conventional components. A shape memory alloy (SMA, also known as a smart metal, memory alloy, or muscle wire) is an alloy that "remembers" its shape, and can be returned to that shape after being deformed, by applying heat to the alloy. When the shape memory effect is correctly harnessed, this material becomes a lightweight, solid-state alternative to conventional actuators such as hydraulic, pneumatic, and motor-based systems. Shape memory alloys have numerous

applications in the medical and aerospace industries. This book presents the latest research in the field from around the globe. This book is devoted to the development of the shape memory materials and their applications. It covers many aspects of smart materials. It also describes the method on how we can obtain not only large recovery strains but also high recovery stress, energy storage and energy dissipation in applications. This volume treats the mechanical properties of shape memory alloys, shape memory polymers and the constitutive equations of the materials which are necessary to design the shape memory elements in applications. It also deals with the fatigue properties of materials, the method to design the shape memory elements, and the shape memory composites. The authors are international experts on shape memory alloys and shape memory polymers in the metallurgical, chemical, mechanical and engineering fields. The book will be of interest to graduate students, engineers, scientists and designers who are working in the field of electric and mechanical engineering, industries, medical engineering, aerospace engineering, robots, automatic machines, clothes and recycling for research, design and manufacturing. Shape memory alloys are suitable for a wide range of biomedical applications, such as dentistry, bone repair and cardiovascular stents. Shape

memory alloys for biomedical applications provides a comprehensive review of the use of shape memory alloys in these and other areas of medicine. Part one discusses fundamental issues with chapters on such topics as mechanical properties, fabrication of materials, the shape memory effect, superelasticity, surface modification and biocompatibility. Part two covers applications of shape memory alloys in areas such as stents and orthodontic devices as well as other applications in the medical and dental fields. With its distinguished editors and international team of contributors, Shape memory alloys for biomedical applications is an essential reference for materials scientists and engineers working in the medical devices industry and in academia. A comprehensive review of shape memory metals and devices for medical applications Discusses materials, mechanical properties, surface modification and biocompatibility Chapters review medical and dental devices using shape memory metals, including stents and orthodontic devices This book systematically describes the fundamentals of Magnetic shape memory alloys (MSMAs), with an emphasis on low-dimensional structures such as foams, microwires and micro-particles. The respective chapters address basic concepts and theories, the fabrication of various architectures, microstructure tailoring, property

optimization and cutting-edge applications. Taken together, they provide a clear understanding of the correlation between processing and the microstructural properties of MSMAs, which are illustrated in over two hundred figures and schematics. Given its scope and format, the book offers a valuable resource for a broad readership in various fields of materials science and engineering, especially for researchers, students and engineers. Shape memory polymer chemistry and design for active materials and morphing structuresCovers shape memory in polymers, alloys and composites, including models and testing Essential equations for analysis of the structure, behavior and properties of SMPsMany graphs and figures in full color A technical analysis of shape-memory polymers (SMPs) and their composites, particularly in adaptive materials, this volume introduces designs linking SMPs to metals, elastomers, foams, nanoparticles and other materials, as well as the engineering of SMPs directly into parts and active (morphing) components. Attention is given to controlled structures activated by light, heat, electricity and other energy sources, as well as the connection of SMPs with actuators. Part one discusses the activation and analysis of the shape memory response, including shape recovery. Subsequent chapters offer modeling and other tools for investigating the SMP response, including shape

recovery. Part three combines the response with micro- and macro-scale reinforcing phases for producing SMP composites, and the following section discusses synthetic and nanostructured customization of the shape memory polymer response. The final section focuses on specific SMP concepts in aircraft, including morphing skins, wings, unimorph composite actuators for deployment, and variable stiffness elements. Table of Contents -Shape-Memory Polymers and Shape-Changing Polymers By M. Behl, J. Zotzmann, and A. Lendlein -Shape-Memory Polymer Composites By Samy A. Madbouly and Andreas Lendlein -Characterization Methods for Shape-Memory Polymers By W. Wagermaier, K. Kratz, M. Heuchel, and A. Lendlein -Shape-Memory Polymers for Biomedical Applications By Christopher M. Yakacki and Ken Gall -Controlled Drug Release from Biodegradable Shape-Memory Polymers By ChristianWischke, Axel T. Neffe, and Andreas Lendlein This study examines the use of embedded shape memory alloy (SMA) actuators for adaptive control of the thermomechanical response of composite structures. A nonlinear thermomechanical model is presented for analyzing shape memory alloy hybrid composite (SMAHC) structures exposed to steady-state thermal and dynamic mechanical loads. Also presented are (1) fabrication procedures for SMAHC specimens, (2) characterization of constituent

materials for model quantification, (3) development of the test apparatus for conducting static and dynamic experiments on specimens with and without SMA, (4) discussion of the experimental results, and (5) validation of the analytical and numerical tools developed in the study. Excellent agreement is achieved between the predicted and measured SAMHC responses including thermal buckling, thermal post-buckling and dynamic response due to inertial loading. Alloys, which when deformed can return to their original shape once heated are called shape memory alloys (SMA). The field of shape memory alloys over the past few years has evolved as a significant topic of study. The complexity of relationship between properties and structure has always interested researchers and is mostly associated with the fact that strong multidimensional interactions occur in these alloys. This is reflected by initial researches on thermal and mechanical induced phase transformations and also latest developments emphasizing on magnetically induced structural changes. Applications of shape memory alloys offer innovative aspects which have drawn significant industrial interest attributing to its singular behavioral characteristics. These have led to the subject of shape memory alloys acquiring a position of great interest for undergoing research and studies in various fields varying from crystallography

and thermodynamics to mechanical evaluation of electrical and chemical properties. The book includes recent researches and studies in this field. It encompasses various aspects of shape memory alloys like processing, novel applications and relationship between structure and properties. This volume contains the proceedings of the International Conference on Shape Memory and Superelastic Technologies and Shape Memory Materials (SMST-SMM 2001) which was held in Kunming, China, on the 2-6 September, 2001. This built on the SMST and SMM international conference series; thus making the present conference more international, and fostering a lively cross-fertilization which could only promote developments in both materials themselves and in their applications. The proceedings comprise 131 papers which cover all aspects of shape memory materials (SMM), and the application of shape memory and superelastic technologies (SMST). The main topics covered are: Shape memory alloy implants or "smart biomaterial" have already been used in humans for 20 years in selected countries. Restrictions in the use of biomaterials in living organisms being reduced throughout the world now the use of SMA implants continue to expand in the fields of vascular and orthopaedic surgery, minimally invasive surgery and drug delivery systems. This book is to provide a state

of the art of SMA implants and devices. For the first time long-term clinical experiences and techniques of SMA biocompatibility are presented. Alloy Materials and Their Allied Applications provides an in-depth overview of alloy materials and applications. The 11 chapters focus on the fabrication methods and design of corrosion-resistant, magnetic, biodegradable, and shape memory alloys. The industrial applications in the allied areas, such as biomedical, dental implants, abrasive finishing, surface treatments, photocatalysis, water treatment, and batteries, are discussed in detail. This book will help readers solve fundamental and applied problems faced in the field of allied alloys applications. This book explores the recent advances in the field of shape memory polymers, whose ease of manufacturing and wide range of potential applications have spurred interest in the field. The book presents details about the synthesis, processing, characterization, and applications of shape memory polymers, their blends and composites. It provides a correlation of physical properties of shape memory polymers with macro, micro and nano structures. The contents of this book will be of interest to researchers across academia and industry. This book introduces readers to the fundamental properties and practical applications of shape memory alloys (SMAs) from the perspective of seismic engineering. It objectively

discusses the superiority of this novel class of materials, which could potentially overcome the limitations of conventional seismic control technologies. The results, vividly presented in the form of tables and figures, are demonstrated with rigorous experimental verifications, supplemented by comprehensive numerical and analytical investigations. The book allows readers to gain an in-depth understanding of the working mechanisms of various SMA-based structural devices and members, including beam-to-column connections, dampers, and braces, while also providing them with a broader vision of next-generation, performance-based seismic design for novel adaptive structural systems. Helping to bridge the gap between material science and structural engineering, it also sheds light on the potential of commercializing SMA products in the construction industry. The cutting-edge research highlighted here provides technical incentives for design professionals, contractors, and building officials to use high-performance and smart materials in structural design, helping them stay at the forefront of construction technology. Abstract: Two experimental set ups were explored during uniaxial tensile testing of nickel-titanium wires , which exhibit super elastic and shape memory behaviors respectively. Soft wires were heated in a makeshift spool and successively cooled in order

to shape set the wires and also explore the various deformation regions described by martensite phase theory for heat-cool cycled shape memory wires. Both super elastic and heat-treated shape memory specimens were cut between approximately 2-4 inches in length. The results of this investigation and the experiments performed are congruent with composition and temperature dependent phase behavior of nickel-titanium. The tests have been used in the construction of a finite element structural wire feature that can be used to model super-elastic wires, as well as the elastic-plastic behavior of soft shape memory wires. The experimental results show the start of the one-way shape memory effect upon reheating of the soft wires. Strain recovery of ~1% is observed after cyclic heating in some specimens. The cycle temperature is approximated as 72 0C for all specimens. The super elastic transformation strain has been approximated as ~6% . The initial experimental set up which used c-clamps to secure the specimens resulted in premature failure of the super elastic wires and also produced lower experimental estimates of the modulus of elasticity for the soft wires. Excessive bending and twisting of specimen ends, as well as the alignment of specimens in the load direction were addressed through the use of material grips and loading hooks. This secondary set up produced closer

results to both empirical and vendor specified values for elastic modulus, yield strength, and tensile strength. Through the use of the second set up loading and unloading tensile tests were performed in order to explore the shape memory effect and super elastic transformation stresses. A lack of strain recovery in some of the specimens points to a shift in the start of hysteresis during the heating cycle as a result of additional prestress in the wires. This work addresses the basic principles, synthesis / fabrication and applications of smart materials, specifically shape memory materials Based on origin, the mechanisms of transformations vary in different shape memory materials and are discussed in different chapters under titles of shape memory alloys, ceramics, gels and polymers Complete coverage of composite formation with polymer matrix and reinforcement filler conductive materials with examples In order to contribute to solving the problems of resources and the energy and environment of the earth, the development of high performance materials is required. The development of intelligent or smart materials and their systems is vital since they have various functions, such as sensing, working, and crack-healing by themselves, etc. In intelligent materials, the development of shape memory alloy (SMA) has attracted high attention because of the unique properties that shape memory

effect (SME) and superelasticity (SE) possess. If we use the SME and SE in practical applications, not only large recovery strain but also high recovery stress, energy storage and energy dissipation can be obtained. This book describes the mechanical and fatigue properties of SMA, and will be of interest to graduate students, engineers, scientists and designers who are working in the area of electric and mechanical engineering, medical engineering, aerospace engineering, robots, automatic machines, clothes and recycling for the job of research, design, manufacturing and fabrication. Shape-memory polymers (SMP) are a unique branch of the smart materials family which are capable of changing shape on-demand upon exposure to external stimulus. The discovery of SMP made a significant breakthrough in the developments of novel smart materials for a variety of engineering applications, superseded the traditional materials, and also influenced the current methods of product designing. This book provides the latest advanced information of on-going research domains of SMP. This will certainly enlighten the reader to the achievements and tremendous potentials of SMP. The basic fundamentals of SMP, including shape-memory mechanisms and mechanics are described. This will aid reader to become more familiar with SMP and the basic concepts, thus guiding them in undergoing

independent research in the SMP field. The book also provides the reader with associated challenges and existing application problems of SMP. This could assist the reader to focus more on these issues and further exploit their knowledge to look for innovative solutions. Future outlooks of SMP research are discussed as well. This book should prove to be extremely useful for academics, R&D managers, researcher scientists, engineers, and all others related to the SMP research. Engineering Aspects of Shape Memory Alloys provides an understanding of shape memory by defining terms, properties, and applications. It includes tutorials, overviews, and specific design examples—all written with the intention of minimizing the science and maximizing the engineering aspects. Although the individual chapters have been written by many different authors, each one of the best in their fields, the overall tone and intent of the book is not that of a proceedings, but that of a textbook. The book consists of five parts. Part I deals with the mechanism of shape memory and the alloys that exhibit the effect. It also defines many essential terms that will be used in later parts. Part II deals primarily with constrained recovery, but to some extent with free recovery. There is an introductory paper which defines terms and principles, then several specific examples of products based on constrained recovery. Both Parts III and IV deal with

actuators. Part III introduces engineering principles while Part IV presents several of the specific examples. Finally, Part V deals with superelasticity, with an introductory paper and then several specific examples of product engineering. The aim of this book is to understand and describe themartensitic phase transformation and the process of martensiteplatelet reorientation. These two key elements enable the author tointroduce the main features associated with the behavior ofshape-memory alloys (SMAs), i.e. the one-way shape-memory effect,pseudo-elasticity, training and recovery. Attention is paid in particular to the thermodynamical frame forsolid materials modeling at the macroscopic scale and itsapplications, as well as to the particular use of such alloys– the simplified calculations for the bending of bars andtheir torsion. Other chapters are devoted to key topics such as theuse of the "crystallographical theory of martensite"for SMA modeling, phenomenological and statistical investigationsof SMAs, magneto-thermo-mechanical behavior of magnetic SMAs andthe fracture mechanics of SMAs. Case studies are provided on thedimensioning of SMA elements offering the reader an additionaluseful framework on the subject. Contents 1. Some General Points about SMAs. 2. The World of Shape-memory Alloys. 3. Martensitic Transformation. 4. Thermodynamic Framework for the Modeling of

SolidMaterials. 5. Use of the “CTM” to Model SMAs. 6. Phenomenological and Statistical Approaches for SMAs. 7. Macroscopic Models with Internal Variables. 8. Design of SMA Elements: Case Studies. 9. Behavior of Magnetic SMAs. 10. Fracture Mechanics of SMAs. 11. General Conclusion. Appendix 1. Intrinsic Properties of Rotation Matrices. Appendix 2. “Twinning Equation” Demonstration. Appendix 3. Calculation of the Parameters a, n and Q from the“Twinning” Equation. Appendix 4. “Twinned” Austenite/MartensiteEquation. About the Authors Christian Lexcellent is Emeritus Professor at the ÉcoleNational Supérieure de Mécanique et des Microtechniquesde Besançon and a researcher in the Department of AppliedMechanics at FEMTO-ST in France. He is a specialist in themechanics of materials and phase transition and has taught in thesubjects of mechanics of continuum media and shape memory alloys.He is also a member of the International Committee of ESOMAT. The International Symposium on Shape Memory Effects and Appli cations was held at the University of Toronto on May 19-20, 1975, in four sessions over two days, as part of the regular 1975 Spring Meeting of The Metallurgical Society of AlME, sponsored by the Physical Metallurgy Committee of The Metallurgical Society. This was the first symposium on the subject, the only previous meeting at all related being the 1968 NOL Symposium

on TiNi and Associated Compounds. One of the major intentions of this Symposium was to provide a forum for cross-communication between workers in the diverse metallurgical areas pertinent to shape memory effects, areas such as martensitic transformation, crystallography and thermodynamics, mechanical behavior, stress-induced transformation, lattice sta bility, and alloy development. Authors were encouraged to place an emphasis on delineation of general controlling factors and mech anisms, and on comparison of shape memory effect alloy systems with systems not exhibiting SME. This book consists of two chapters. The first chapter deals with the thermomechanical macroscopic theory describing the transformation and deformation behavior of shape memory alloys. The second chapter deals with the extensive and fundamental review of the experimental works which include crystallography, transformations and mechanical characteristics in Ti-Ni, Cu-base and ferrous shape memory alloys. The book presents selected, peer reviewed papers from the 3rd International Conference on “Shape Memory Alloys” (SMA 2018). Covered are: Physical, mechanical and functional properties of shape memory alloys. Structure and martensitic phase transformations. Theory and mathematical modelling. Materials design and calculations of functional properties. Design,

synthesis and functional properties of novel materials. Manufacturing technology and applications of shape memory alloys. This book provides a systematic approach to realizing NiTi shape memory alloy actuation, and is aimed at science and engineering students who would like to develop a better understanding of the behaviors of SMAs, and learn to design, simulate, control, and fabricate these actuators in a systematic approach. Several innovative biomedical applications of SMAs are discussed. These include orthopedic, rehabilitation, assistive, cardiovascular, and surgery devices and tools. To this end unique actuation mechanisms are discussed. These include antagonistic bi-stable shape memory-superelastic actuation, shape memory spring actuation, and multi axial tension-torsion actuation. These actuation mechanisms open new possibilities for creating adaptive structures and biomedical devices by using SMAs. This short monograph presents an analysis and design methodology for shape memory alloy (SMA) components such as wires, beams, and springs for different applications. The solid-solid, diffusionless phase transformations in thermally responsive SMA allows them to demonstrate unique characteristics like superelasticity and shape memory effects. The combined sensing and actuating capabilities of such materials allows them to provide a system level

response by combining multiple functions in a single material system. In SMA, the combined mechanical and thermal loading effects influence the functionality of such materials. The aim of this book is to make the analysis of these materials accessible to designers by developing a "strength of materials" approach to the analysis and design of such SMA components inspired from their various applications with a review of various factors influencing the design process for such materials. This book, the first dedicated to this exciting and rapidly growing field, enables readers to understand and prepare high-quality, high-performance TiNi shape memory alloys (SMAs). It covers the properties, preparation and characterization of TiNi SMAs, with particular focus on the latest technologies and applications in MEMS and biological devices. Basic techniques and theory are covered to introduce new-comers to the subject, whilst various sub-topics, such as film deposition, characterization, post treatment, and applying thin films to practical situations, appeal to more informed readers. Each chapter is written by expert authors, providing an overview of each topic and summarizing all the latest developments, making this an ideal reference for practitioners and researchers alike. This book provides a working knowledge of the modeling and engineering applications of shape memory alloys (SMAs), beginning

with a rigorous introduction to continuum mechanics and continuum thermodynamics as they relate to the development of SMA modeling.Modern SMAs can recover from large amounts of bending and deformation, and millions of repetitions within recoverable ranges. SMAs are used in the medical industry to create stents, in the dental industry to create dental and orthodontic archwires, and in the aerospace industry to create fluid fittings. The text presents a unified approach to the constitutive modeling of SMAs, including modeling of magnetic and high temperature SMAs. Shape Memory Alloy Engineering introduces materials, mechanical, and aerospace engineers to shape memory alloys (SMAs), providing a unique perspective that combines fundamental theory with new approaches to design and modeling of actual SMAs as compact and inexpensive actuators for use in aerospace and other applications. With this book readers will gain an understanding of the intrinsic properties of SMAs and their characteristic state diagrams, allowing them to design innovative compact actuation systems for applications from aerospace and aeronautics to ships, cars, and trucks. The book realistically discusses both the potential of these fascinating materials as well as their limitations in everyday life, and how to overcome some of those limitations in order to achieve proper

design of useful SMA mechanisms. Discusses material characterization processes and results for a number of newer SMAs Incorporates numerical (FE) simulation and integration procedures into commercial codes (Msc/Nastran, Abaqus, and others) Provides detailed examples on design procedures and optimization of SMA-based actuation systems for real cases, from specs to verification lab tests on physical demonstrators One of the few SMA books to include design and set-up of demonstrator characterization tests and correlation with numerical models This book is compiled into three parts. Part 1 describes the functional properties of shape memory alloy, such as, the shape memory effect and superelasticity, the constitutive equation for thermomechanical properties, the bi-axial tensile-torsional behavior, influence of strain rate on deformation behavior, cyclic deformation properties, micromechanical model of polycrystalline SMAs, application of thermomechanical model to tension-compression behavior, the transformation-induced creep and stress relaxation, and the torsional deformation of thin tape. Part 2 contains the advanced functions of shape-memory alloy and polymer such as the shape-retaining control using SMA system, the micromechanical model of shape memory polymer, performance of shape memory polymer composite, enhancement of fatigue life of SMA by ultrasonic shot

peening and nitrogen ion implantation , enhancement of corrosion fatigue life of SMA , development of functionally-graded shape-memory alloy and polymer, development of shape memory composites and development of 3D-printing of shape memory polymer. Part 3 deals with the applications of shape-memory alloy and polymer such as the development of application model in engineering filed, the smart vortex generator for aircraft, the smart morphing flap driven by SMA wires and the development of application models of SMA brain spatula in medical engineering filed, the working support device in nursing care field and the energy conversion teaching material in education. This book will be interested to graduate students, engineers, materials scientists and designers who are working in the field of mechanical and electric engineering, medical engineering, nursing care technology, aerospace engineering, robots, automatic machines, clothes and recycling for research, design, manufacturing and fabrication. A comprehensive account of shape memory materials, now available in paperback. This short monograph presents an analysis and design methodology for shape memory alloy (SMA) components such as wires, beams, and springs for different applications. The solid-solid, diffusionless phase transformations in thermally responsive SMA allows them to demonstrate unique characteristics like

superelasticity and shape memory effects. The combined sensing and actuating capabilities of such materials allows them to provide a system level response by combining multiple functions in a single material system. In SMA, the combined mechanical and thermal loading effects influence the functionality of such materials. The aim of this book is to make the analysis of these materials accessible to designers by developing a "strength of materials" approach to the analysis and design of such SMA components inspired from their various applications with a review of various factors influencing the design process for such materials. Shape memory and superelastic alloys possess properties not present in ordinary metals meaning that they can be used for a variety of applications. Shape memory and superelastic alloys: Applications and technologies explores these applications discussing their key features and commercial performance. Readers will gain invaluable information and insight into the current and potential future applications of shape memory alloys. Part one covers the properties and processing of shape memory effect and superelasticity in alloys for practical users with chapters covering the basic characteristics of Ti-Ni-based and Ti-Nb-based shape memory and superelastic (SM/SE) alloys, the development and commercialisation of TiNi and Cu-based alloys, industrial processing and

device elements, design of SMA coil springs for actuators before a final overview on the development of SM and SE applications. Part two introduces SMA application technologies with chapters investigating SMAs in electrical applications, hot-water supply, construction and housing, automobiles and railways and aerospace engineering before looking at the properties, processing and applications of Ferrous (Fe)-based SMAs. Part three focuses on the applications of superelastic alloys and explores their functions in the medical, telecommunications, clothing, sports and leisure industries. The appendix briefly describes the history and activity of the Association of Shape Memory Alloys (ASMA). With its distinguished editors and team of expert contributors, Shape memory and superelastic alloys: Applications and technologies is be a valuable reference tool for metallurgists as well as for designers, engineers and students involved in one of the many industries in which shape memory effect and superelasticity are used such as construction, automotive, medical, aerospace, telecommunications, water/heating, clothing, sports and leisure. Explores important applications of shape memory and superelastic alloys discussing their key features and commercial performance Assesses the properties and processing of shape memory effect and superelasticity in alloys for practical users with chapters covering the

basic characteristics Introduces SMA application technologies investigating SMAs in electrical applications, hot-water supply, construction and housing, automobiles and railways and aerospace engineering This book consists of five parts. Part 1 deals with the mechanism of shape memory and the alloys that exhibit the effect; Part 2 deals primarily with constrained recovery but to some extent with free recovery; Part 3 and 4 deal with actuators with part 3 introducing engineering principles and part 4 several specific examples; Part 5 deals with superelasticity. This book is devoted to the development of the shape memory materials and their applications. It covers many aspects of smart materials. It also describes the method on how we can obtain not only large recovery strains but also high recovery stress, energy storage and energy dissipation in applications. This volume treats the mechanical properties of shape memory alloys, shape memory polymers and the constitutive equations of the materials which are necessary to design the shape memory elements in applications. It also deals with the fatigue properties of materials, the method to design the shape memory elements, and the shape memory composites. The authors are international experts on shape memory alloys and shape memory polymers in the metallurgical, chemical, mechanical and engineering fields. The book will be of

interest to graduate students, engineers, scientists and designers who are working in the field of electric and mechanical engineering, industries, medical engineering, aerospace engineering, robots, automatic machines, clothes and recycling for research, design and manufacturing. Ni-free Ti-based Shape Memory Alloys reviews the fundamental issues of biomedical beta-type Ti base shape memory and superelastic alloys, including martensitic transformation, shape memory and superelastic properties, alloy development, thermomechanical treatment and microstructure control, and biocompatibility. Some unique properties, such as large nonlinear elastic behavior and low Young's modulus, observed in metastable Ti alloys are discussed on the basis of phase stability. As it is expected that superelastic Ti alloys will further expand the applications of shape memory alloys within the biomedical field, this book provides a comprehensive review of these new findings in Ti-base shape memory and superelastic alloys. Includes coverage of phase transformations in titanium alloys Discusses mechanical properties and alloy development Presents a review of Ti-based shape alloys and their applications Since their discovery in the 1960s, shape memory alloys have been developed for a range of applications. Since the 1970s, many clinical functions have been looked into, all of which

use the Nickel-Titanium (Ni-Ti) shape memory alloy. The book includes the mechanics of the shape memory effect.