Titanium Ti 6al 4v Grade 5 Annealed Ams 4928 Ams 4911

Comprehensive datasheets on more than 60 titanium alloys More than 200 pages on metallurgy and fabrication procedures Input from more than 50 contributors from several countries Careful editorial review for accuracy and usefulness. Materials Properties Handbook: Titanium Alloys provides a data base for information on titanium and its alloys, and the selection of specific alloys for specific applications. The most comprehensive titanium data package ever assembled provides extensive information on applications, physical properties, corrosion, mechanical properties (including design allowances where available), fatigue, fracture properties, and elevated temperature properties. The appropriate specifications for each alloy are included. This international effort has provided a broad information base that has been compiled and reviewed by leading experts within the titanium industry, from several countries, encompassing numerous technology areas. Inputs have been obtained from the titanium industry, fabricators, users, government and academia. This up-to-date package covers information from almost the inception of the titanium industry, in the 1950s, to mid-1992. The information, organized by alloy, makes this exhaustive collection an easy-to-use data base at your fingertips, which generally includes all the product forms for each alloy. The 60-plus data sheets supply not only extensive graphical and tabular information on properties, but the datasheets also describe or illustrate important factors which would aid in the selection of the proper alloy or heat treatment. The datasheets are further supplemented with back-ground information on the metallurgy and fabrication characteristics of titanium alloys. An especially extensive coverage of properties, processing and metallurgy is provided in the datasheet for the workhorse of the titanium industry, Ti-6Al-4V. This compendium includes the newest alloys made public. even those still under development. In many cases, key references are included for further information on a given subject. Comprehensive datasheets provide extensive information on: Applications, Specifications, Corrosion, Mechanical Design Properties, Fatigue and Fracture

Titanium Powder Metallurgy contains the most comprehensive and authoritative information for, and understanding of, all key issues of titanium powder metallurgy (Ti PM). It summarizes the past, reviews the present and discusses the future of the science and technology of Ti PM while providing the world titanium community with a unique and comprehensive book covering all important aspects of titanium powder metallurgy, including powder production, powder processing, green shape formation, consolidation, property evaluation, current industrial applications and future developments. It documents the fundamental understanding and technological developments achieved since 1937 and demonstrates why powder metallurgy now offers a cost-effective approach to the near net or net shape fabrication of titanium, titanium alloys and titanium metal matrix composites for a wide variety of industrial applications. Provides a comprehensive and in-depth treatment of the science, technology and industrial practice of titanium powder metallurgy Each chapter is delivered by the most knowledgeable expert on the topic, half from industry and half from academia, including several pioneers in the field, representing our current knowledge base of Ti PM. Includes a critical review of the current key fundamental and technical issues of Ti PM. Fills a critical knowledge gap in powder metal science and engineering and in the manufacture of titanium metal and alloys

Provides comprehensive coverage of the research into and clinical uses of bioceramics and biocomposites Developments related to bioceramics and biocomposites appear to be one the most dynamic areas in the field of biomaterials, with multiple applications in tissue engineering and medical devices. This book covers the basic science and engineering of bioceramics and biocomposites for applications in dentistry and orthopedics, as well as the state-of-the-art aspects of biofabrication techniques, tissue engineering, remodeling, and regeneration of bone tissue. It also provides insight into the use of bionanomaterials to create new functionalities when interfaced with biological molecules or structures. Featuring contributions from leading experts in the field, Bioceramics and Biocomposites: From Research to Use in Clinical Practice offers complete coverage of everything from extending the concept of hemopoietic and stromal niches, to the evolution of bioceramic-based scaffolds. It looks at perspectives on and trends in bioceramics in endodontics, and discusses the influence of newer biomaterials use on the structuring of the clinician ' s attitude in dental practice or in orthopedic surgery. The book also covers such topics as biofabrication techniques for bioceramics and biocomposites; glass ceramics: calcium phosphate coatings; brain drug delivery bone substitutes; and much more. Presents the biggest trends in bioceramics and biocomposites relating to medical devices and tissue engineering products Systematically presents new information about bioceramics and biocomposites, developing diagnostics and improving treatments and their influence on the clinicians' approaches Describes how to use these biomaterials to create new functionalities when interfaced with biological molecules or structures Offers a range of applications in clinical practice, including bone tissue engineering, remodeling, and regeneration Delineates essential requirements for resorbable bioceramics Discusses clinical results obtained in dental and orthopedic applications Bioceramics and Biocomposites: From Research to Use in Clinical Practice is an excellent resource for biomaterials scientists and engineers, bioengineers, materials scientists, and engineers. It will also benefit mechanical engineers and biochemists who work with biomaterials scientists.

This handbook is an excellent reference for materials scientists and engineers needing to gain more knowledge about these engineering materials. Following introductory chapters on the fundamental materials properties of titanium, readers will find comprehensive descriptions of the development, processing and properties of modern titanium alloys. There then follows detailed discussion of the applications of titanium and its alloys in aerospace, medicine, energy and automotive technology.

Fundamentals and Applications

Titanium Alloys

Heat Treater's Guide

Innovative Processes and Materials in Additive Manufacturing

Titanium and Titanium Alloys

Light Structural Alloys

Innovative Processes and Materials in Additive Manufacturing explains game-changing interdisciplinary applications of recent research breakthroughs in additive manufacturing technology. The number of research publications addressing additive manufacturing has soared in recent years as a range of disciplines explore the possibilities that this technology can provide. This book acts as a bridge between this high-level research and the large number of academics and practitioners looking to additive manufacturing for innovative solutions, providing them with practical and approachable information. Applications in aerospace, automotive, medical, construction, and food industries are addressed, featuring

technical details that will help successful implementation. This unique book also provides broad coverage of the theory behind this emerging technology, including material development, as well as the technical details required for readers to investigate the novel applications of the involved methods for themselves. Includes case studies from the aerospace, construction and medical industries Features innovations in the integration of additive manufacturing processes with other manufacturing technologies Identifies exciting routes for future research and application areas of additive manufacturing

The friction surfacing process is a relatively novel and promising surface modification technology, by which coatings can be deposited as a protection or surface repair method. The main feature of this process, compared with other technologies, is that the coatings are deposited in solid state phase. Therefore, the induced massive deformation alters the initial microstructure of the materials, resulting in a fully recrystallised microstructure of the coatings. Typically, the grain size of the coating is smaller than that of the raw material, which leads to improved mechanical properties. Since the process is a relatively new technology, several possible material combinations in similar or dissimilar configurations are unexplored. Titanium alloys are rather expensive. Therefore, new technologies are required to keep the production cost at an acceptable level and offer an additional cladding process that is environmental friendly. The aim of the current work was to deposit coatings from the titanium alloys by friction surfacing. Process development for Ti-6Al-4V alloy and Ti-Gr.1 as coating materials to be deposited by friction surfacing was carried out. At high temperatures titanium alloys exhibit complex deformation behaviour, particularly when passing through the alpha-beta phase transformation and in the beta phase state. Strain rate sensitivity and flow instabilities are characteristics of Ti-based materials that may hinder the deposition process. These difficulties were overcome by the selection of an adequate process control method and a systematic choice of process parameter combinations. A broad range of parameter sets for titanium depositions has been established, whereby two different acting rotational speed regimes were observed. The low rotational speed regime revealed variations in the process temperature, which influenced the material flow behaviour leading to flash generation at the coating. The microstructure in this regime consists of refined dynamically recrystallised grains. In contrast, the high rotational speed regime revealed a higher resulting temperature, which did not vary in this range. This constant temperature led to stable material flow behaviour and flash-free coatings were deposited. However, the high temperature influenced the grain size of the coatings resulting in coarse grains. Still, these differences in the grain size did not influence the fretting wear behaviour of the coatings. The investigation of fretting wear experiments exposed a similar behaviour of friction surfacing coatings and the base material. In micro tensile tests the coatings exhibited an increase in strength but a decrease in ductility, which is typical for dynamically recrystallised materials, which contain residual deformation. Therefore, it could be shown that friction surfacing can be considered as a repair method for titanium parts.

Continuing to provide excellent, state-of-the-art information on corrosion and practicalsolutions for reducing corrosion, the Second Edition contains valuable suggestionson how to select the best construction material for a specific application . . . choose anappropriate initial design to avoid inherent corrosion pitfalls . .. determine whatcorrosion problems may exist or develop, as well as the possible extent of the problems. .. and establish practices to monitor corrosion of existing equipment.In addition

to significantly revising and expanding all chapters to reflect recent progressin the field, such as the development of materials for pollution control and methods ofcontrolling/preventing corrosion, Corrosion and Corrosion ProtectionHandbook, Second Edition features detailed discussions on such new topics asatmospheric corrosion, designing to prevent corrosion, sheet linings, and corrosioninhibitors.

Ti-6Al-4V (Ti-64) is the most popular titanium grade used in industry today with a large application window due to its properties (i.e., high strength-to-weight ratio, excellent corrosion resistance, and good biocompatibility). However, titanium and titanium alloys are notoriously expensive materials that are also costly to produce and replace. Thus, the ability to manufacture and repair Ti-64 components with additive manufacturing techniques could significantly decrease the cost of these components. Cold spray is a recent addition to the additive manufacturing industry and shows promise for this application. Unfortunately, Ti-64 depositions produced with nitrogen gas contain high porosity (5 –20%) and, consequently, exhibit poor strength and ductility. It is theorized that fully dense Ti-64 deposits would exhibit mechanical properties comparable to wrought Ti-64 specimens. Thus, the focus of this research was to utilize novel post-processing methods to consolidate Ti-64 cold spray deposits. Hot isostatic pressing (HIP) and ultrasonic processing were applied to Ti-64 nitrogen deposits to determine if either could be an effective method of consolidation. HIP processing did not result in any significant improvement to the samples. Porosity of as-deposited samples saw an average porosity of 13.1% before HIP and 13.7% after HIP processing. Additionally, average tensile and hardness values did not improve after HIP. It is believed that interconnected porosity within the cold spray samples was a major contributing factor to the failure of HIP processing to consolidate the deposits. Ultrasonic processing resulted in a full consolidation of the cold sprayed material to a depth of 500 ?m and exhibited significantly improved properties. Porosity was reduced from 20.0% to 0.2% and average hardness was increased from 220 HV to over 390 HV. These results indicate that ultrasonic processing could be a meaningful addition to the cold spray process and result in fully dense coatings and deposits that exhibit near bulk properties.

Annual Meeting, Supplemental Proceedings

Materials Performance

Trends In Welding Research

TMS 2014 143rd Annual Meeting and Exhibition

Titanium - 1966

Proceedings of the 13th World Conference on Titanium

Tribology in Materials and Manufacturing - Wear, Friction and Lubrication brings an interdisciplinary perspective to accomplish a more detailed understanding of tribological assessments, friction, lubrication, and wear in advanced manufacturing. Chapters cover such topics as ionic liquids, non-textured and textured surfaces, green tribology, lubricants, tribolayers, and simulation of wear.

The book contains six chapters and covers topics dealing with biomedical applications of titanium alloys, surface treatment, relationships between microstructure and mechanical and technological properties, and the effect of radiation on the structure of the titanium alloys.

The material is contained in more than 500 datasheet articles, each devoted exclusively to one particular alloy. The datasheets are arranged by alloy groups: nickel, aluminium, copper, magnesium, titanium, zinc and superalloys.

This book contains the Proceedings of the 13th World Conference on Titanium.

Basic Theory with Engineering Applications

Proceedings of the 3rd Pan American Materials Congress

Titanium in Medical and Dental Applications

A Concise Desktop Reference

ICAF 2019 – Structural Integrity in the Age of Additive Manufacturing

Corrosion and Corrosion Protection Handbook

Designed to support the need of engineering, management, and other professionals for information on titanium by providing an overview of the major topics, this book provides a concise summary of the most useful information required to understand titanium and its alloys. The author provides a review of the significant features of the metallurgy and application of titanium and its alloys. All technical aspects of the use of titanium are covered, with sufficient metals property data for most users. Because of its unique density, corrosion resistance, and relative strength advantages over competing materials such as aluminum, steels, and superalloys, titanium has found a niche in many industries. Much of this use has occurred through military research, and subsequent applications in aircraft, of gas turbine engines, although more recent use features replacement joints, golf clubs, and bicycles.Contents include: A primer on titanium and its alloys, Introduction to selection of titanium alloys, Understanding titanium's metallurgy and mill products, Forging and forming, Castings, Powder metallurgy, Heat treating, Joining technology and practice, Machining, Cleaning and finishing, Structure/processing/property relationships, Corrosion resistance, Advanced alloys and future directions, Appendices: Summary table of titanium alloys, Titanium alloy datasheets, Cross-reference to titanium alloys, Listing of selected specification and standardization organizations, Selected manufacturers, suppliers, services, Corrosion data, Machining data.

Contains more than 500 fatigue curves for industrial ferrous and nonferrous alloys. Also includes an explanation of fatigue testing and interpretation of test results. Each curve is presented independently and includes an explanation of its particular importance.

Titanium alloys, due to unique physical and chemical properties (mainly high relative strength combined with very good corrosion resistance), are considered as an important structural metallic material used in hi-tech industries (e.g. aerospace, space technology). This book provides information on new manufacturing and processing methods of single- and two-phase titanium alloys. The eight chapters of this book are distributed over four sections. The first section (Introduction) indicates the main factors determining application areas of titanium and its alloys. The second section (Manufacturing, two chapters) concerns modern production methods for titanium and its alloys. The third section (Thermomechanical and surface treatment, three chapters) covers problems of thermomechanical processing and surface treatment used for single- and two-phase titanium alloys. The fourth section (Machining, two chapters) describes the recent results of high speed machining of Ti-6Al-4V alloy and the possibility of application of sustainable machining for titanium alloys.

Plasma electrolytic oxidation (PEO), also known as micro-arc oxidation (MAO), functionalizes surfaces, improving the mechanical, thermal, and corrosion performance of metallic

substrates, along with other tailored properties (e.g., biocompatibility, catalysis, antibacterial response, self-lubrication, etc.). The extensive field of applications of this technique ranges from structural components, in particular, in the transport sector, to more advanced fields, such as bioengineering. The present Special Issue covers the latest advances in PEO-coated light alloys for structural (Al, Mg) and biomedical applications (Ti, Mg), with 10 research papers and 1 review from leading research groups around the world.

The Material and Biological Issues

Advances in Properties Control

Introduction to Biomaterials

Friction Stir Welding and Processing

Titanium

Volume 1: Aerospace Materials

This book gathers papers presented at the 36th conference and 30th Symposium of the International Committee on Aeronautical Fatigue and Structural integrity. Focusing on the main theme of "Structural Integrity in the Age of Additive Manufacturing", the chapters cover different aspects concerning research, developments and challenges in this field, offering a timely reference guide to designers, regulators, manufacturer, and both researchers and professionals of the broad aerospace community.

This memorandum reproduces thirteen lectures delivered at a Titanium Symposium held on March 28-29, 1966, at Hawthorne, California, under the auspices of the Norair Division of the Northrop Corporation. These lectures follow a logical sequence of topics including production aspects, metallurgy, manufacturing technology, and the design of titanium parts for aircraft and aerospace applications. (Author).

These papers present advancements in all aspects of high temperature electrochemistry, from the fundamental to the empirical and from the theoretical to the applied. Topics involving the application of electrochemistry to the nuclear fuel cycle, chemical sensors, energy storage, materials synthesis, refractory metals and their alloys, and alkali and alkaline earth metals are included. Also included are papers that discuss various technical, economic, and environmental issues associated with plant operations and industrial practices.

This book is the definitive reference source for professionals involved in the conception, design and specification stages of a construction project. The theory and practical aspects of each material is covered, with an emphasis being placed on properties and appropriate use, enabling broader, deeper understanding of each material leading to greater confidence in their application. Containing fifty chapters written by subject specialists, Construction Materials Reference Book covers the wide range of materials that are encountered in the construction process, from traditional materials such as stone through masonry and steel to advanced plastics and composites. With increased significance being placed on broader environmental issues, issues of whole life cost and sustainability are covered, along with health and safety aspects of both use and installation.

Titanium, Niobium, Zirconium, and Tantalum for Medical and Surgical Applications

Materials Properties Handbook
TMS 2014 143rd Annual Meeting & Exhibition, Annual Meeting Supplemental Proceedings
Handbook of Metal Injection Molding
Cardiovascular
Medical Applications of Titanium and Its Alloys

A succinct introduction to the field of biomaterials engineering, packed with practical insights.

Dental Biomechanics provides a comprehensive, timely, and wide-reaching survey of the relevant aspects of biomechanical investigation within the dental field. Leading the reader through the mechanical analysis of dental problems in dental implants, orthodontics, and natural tooth mechanics, this book covers an increasingly important and popular sub

A compilation of information and tables of fatigue data for light structural alloys, useful as a supplement to the publisher's Atlas of Fatigue Curves . Contains sections on aluminum, magnesium, and titanium alloys, with information on the chemistry and identity of various forms of the alloys, corro

This report represents a portion of the information contained in the March, 1967, revised edition of the 'Aircraft Designer's Handbook for Titanium and Titanium Alloys' which was prepared by the Defense Metals Information Center under the joint sponsorship of the U.S. Air Force Research and Technology Division, and the Federal Aviation Agency. The important techniques discussed include; (1) brake forming, (2) stretch forming, (3) deep drawing, (4) trapped-rubber forming, (5) tube bulging, (6) bending, (7) drop-hammer forming, (8) roll forming, (9) roll bending, (10) spinning, (11) shear forming, (12) dimpling, (13) joggling, and (14) hot sizing. Auxiliary metalworking operations, preparation for forming, blank heating methods, lubricants for forming and tooling materials are discussed. Other data available in the open literature have been summarized and referenced to present a comprehensive picture on the state of the art of these fabrication methods as related to titanium and its alloys. (Author).

Plasma Electrolytic Oxidation (PEO) Coatings

Proceedings of the 7Th International Conference
Fatigue Data Book
Lectures Given at a Norair Symposium, March 28-29, 1966
Tribology in Materials and Manufacturing

Thirty papers presented at a 1994 symposium cover the basic materials science issues regarding the processing of titanium alloys, and the controversy regarding their use in medicine. Coverage includes orthopaedic, dental, and cardiovascular applications, with a primary focus on the orthopaedic. Info

This book covers the rapidly growing area of friction stir welding. It also addresses the use of the technology for other types of materials processing, including superplastic forming, casting modification, and surface treatments. The book has been prepared to serve as the first general reference on friction stir technology,. Information is provided on tools, machines, process modeling, material flow, microstructural development and properties. Materials addressed include aluminum alloys, titanium alloys, steels, nickel-base alloys, and copper alloys. The chapters have been written by the leading experts in this field, representing leading industrial companies and university and government research insititutions.

This book presents a collection of examples illustrating the resent research advances in the machining of titanium alloys. These materials have excellent strength and fracture toughness as well as low density and good corrosion resistance; however, machinability is still poor due to their low thermal conductivity and high chemical reactivity with cutting tool materials. This book presents solutions to enhance machinability in titanium-based alloys and serves as a useful reference to

professionals and researchers in aerospace, automotive and biomedical fields.
"The Materials Information Society, MPMD-Materials and Processes for Medical Devices."
Atlas of Fatigue Curves
Aerospace Materials and Material Technologies
From Research to Clinical Practice
Forming of Titanium and Titanium Alloys
Wear, Friction and Lubrication
Materials Handbook

This collection covers a variety of materials science topics and has contributions from leading scientists and engineers representing 8 countries and 9 international materials, metals, and minerals societies. Papers are organized into the following sections:Advanced BiomaterialsAdvanced ManufacturingMaterials for Green Energy Materials for Infrastructure Materials for the Oil and Gas Industry Materials for Transportation and LightweightingMinerals Extraction and ProcessingNanocrystalline and Ultra-fine Grain Materials and Bulk Metallic Glasses Steels

Metal injection molding combines the most useful characteristics of powder metallurgy and plastic injection molding to facilitate the production of small, complex-shaped metal components with outstanding mechanical properties. Handbook of Metal Injection Molding, Second Edition provides an authoritative guide to this important technology and its applications. Building upon the success of the first edition, this new edition includes the latest developments in the field and expands upon specific processing technologies. Part one discusses the fundamentals of the metal injection molding process with chapters on topics such as component design, important powder characteristics, compound manufacture, tooling design, molding optimization, debinding, and sintering. Part two provides a detailed review of quality issues, including feedstock characterisation, modeling and simulation, methods to qualify a MIM process, common defects and carbon content control. Special metal injection molding processes are the focus of part three, which provides comprehensive coverage of micro components, two material/two color structures, and porous metal techniques. Finally, part four explores metal injection molding of particular materials, and has been expanded to include super alloys and precious metals. With its distinguished editor and expert team of international contributors, the Handbook of Metal Injection Molding is an essential guide for all those involved in the high-volume manufacture of small precision parts, across a wide range of high-tech industries such as microelectronics, biomedical and aerospace engineering. Provides an authoritative guide to metal injection molding and its applications Discusses the fundamentals of the metal injection molding processes and covers topics such as component design, important powder characteristics, compound manufacture, tooling design, molding optimization, debinding and sintering Comprehensively examines quality issues, such as feedstock characterization, modeling and simulation, common defects and carbon content control

The unique and practical Materials Handbook (third edition) provides quick and

easy access to the physical and chemical properties of very many classes of materials. Its coverage has been expanded to include whole new families of materials such as minor metals, ferroalloys, nuclear materials, food, natural oils, fats, resins, and waxes. Many of the existing families—notably the metals, gases, liquids, minerals, rocks, soils, polymers, and fuels—are broadened and refined with new material and up-to-date information. Several of the larger tables of data are expanded and new ones added. Particular emphasis is placed on the properties of common industrial materials in each class. After a chapter introducing some general properties of materials, each of twenty-four classes of materials receives attention in its own chapter. The health and safety issues connected with the use and handling of industrial materials are included. Detailed appendices provide additional information on subjects as diverse as crystallography, spectroscopy, thermochemical data, analytical chemistry, corrosion resistance, and economic data for industrial and hazardous materials. Specific further reading sections and a general bibliography round out this comprehensive guide. The index and tabular format of the book makes light work of extracting what the reader needs to know from the wealth of factual information within these covers. Dr. François Cardarelli has spent many years compiling and editing materials data. His professional expertise and experience combine to make this handbook an indispensable reference tool for scientists and engineers working in numerous fields ranging from chemical to nuclear engineering. Particular emphasis is placed on the properties of common industrial materials in each class. After a chapter introducing some general properties of materials, materials are classified as follows. ferrous metals and their alloys; ferroalloys; common nonferrous metals; less common metals; minor metals; semiconductors and superconductors; magnetic materials; insulators and dielectrics; miscellaneous electrical materials; ceramics, refractories and glasses; polymers and elastomers; minerals, ores and gemstones; rocks and meteorites; soils and fertilizers; construction materials; timbers and woods; fuels, propellants and explosives; composite materials; gases; liquids; food, oils, resin and waxes; nuclear materials. food materials

This book is a comprehensive compilation of chapters on materials (both established and evolving) and material technologies that are important for aerospace systems. It considers aerospace materials in three Parts. Part I covers Metallic Materials (Mg, Al, Al-Li, Ti, aero steels, Ni, intermetallics, bronzes and Nb alloys); Part II deals with Composites (GLARE, PMCs, CMCs and Carbon based CMCs); and Part III considers Special Materials. This compilation has ensured that no important aerospace material system is ignored. Emphasis is laid in each chapter on the underlying scientific principles as well as basic and fundamental mechanisms leading to processing, characterization, property evaluation and applications. This book will be useful to students, researchers and professionals working in the domain of aerospace materials.

Proceedings of the 30th Symposium of the International Committee on

Aeronautical Fatigue, June 2-7, 2019, Krakow, Poland
Machining of Titanium Alloys
Novel Aspects of Their Manufacturing and Processing
Nitriding of Titanium
Construction Materials Reference Book
Friction Surfacing of Titanium Grade 1 and Ti-6Al-4V

Titanium in Medical and Dental Applications is an essential reference book for those involved in biomedical materials and advanced metals. Written by well-known experts in the field, it covers a broad array of titanium uses, including implants, instruments, devices, the manufacturing processes used to create them, their properties, corrosion resistance and various fabrication approaches. Biomedical titanium materials are a critically important part of biomaterials, especially in cases where non-metallic biomedical materials are not suited to applications, such as the case of load-bearing implants. The book also covers the use of titanium for implants in the medical and dental fields and reviews the use of titanium for medical instruments and devices. Provides an understanding of the essential and broad applications of Titanium in both the medical and dental industries Discusses the pathways to manufacturing titanium into critical biomedical and dental devices Includes insights into further applications within the industry

Consolidation of Cold Spray Ti-6Al-4V Deposits
Materials and Coatings for Medical Devices
Dental Biomechanics
Titanium Powder Metallurgy
Consolidation of Cold Spray Ti-6Al-4V Deposits
Chip Formation of Titanium
A Technical Guide, 2nd Edition