Advanced Ceramics For Dentistry Chapter 2 Teeth

Microstructure characterization of advanced ceramics involves qualitative and quantitative analysis of surface topography, porosity, crystal defects, and interfaces. The structure of the surface controls interaction of ceramics with its surroundings, such as adhesion, gas adsorption, and electron exchange, which play an important role in determining overall properties of a material. Pores in ceramic materials originate from incomplete densification during the sintering process. Their presence interferes with functional properties such as mechanical strength, optical transparency, electrical conductivity, and dielectric response. Crystal defects mostly form either as a result of imperfections during the crystal growth process or as a consequence of structural phase transitions. They generally affect most functional properties of materials. So-called extended defects are interfaces that are boundaries between two solids. The most widespread tools for characterization of ceramic microstructures are microscopic techniques involving optical microscopy, different types of electron microscopy, and various scanning-probe methods. This chapter gives a brief introduction of the features of ceramic microstructure and the corresponding techniques for characterizing them. Fractographic analysis is a useful tool for finding fracture origins that is necessary for improving the reliability of ceramic restorations. The general analysis begins with the determination of fracture patterns and origins. The crack propagation markings found

by examination of fracture surfaces allow one to follow crack paths and to trace back to an origin, including fracture mirror, hackle, Wallner line, arrest line, and compression curl. This method is introduced and applied to define the origins of common clinical failures of ceramic dental prostheses. They are classified as several major types, namely, cracking initiated at the margin or at occlusal contacts, and porcelain chipping or delamination. The fracture origin is always found near the spot where the highest tensile stress concentration accumulates, and/or microscopic defects or flaws are located nearby. The fracture of ceramic dental restorations may initiate at micro-defects in the porcelain or ceramic body that are introduced during the materials fabrication process or after clinical adjustment.

This book highlights the latest, cutting-edge advances in implantable biomaterials. It brings together a class of advanced biomaterials in two highly active research areas, namely implants and tissue scaffolds, to underline their respective functional requirements for further development. It is unique in providing a full range of methodological procedures, including materials syntheses, characterisation, cellular tests and mathematical modelling. Covering metallic, ceramic, polymeric and composite materials commonly used in biological applications and clinical therapeutics, it is a valuable resource for anyone wanting to further their understanding of the latest developments in implantable biomaterials. Focusing on biomedical applications in implants and scaffolds, it provides methodological guides to this rapidly growing field.

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"This book gives insight into technological advances for dental practice, research and education, for general dental clinician, the researcher and the computer scientist"--Provided by publisher.

The additive manufacturing (AM) family of techniques has been developed during the last few decades. The techniques are used in order to fabricate 3D parts, layer-by-layer, directly from CAD data. Instrument development has come to the point where they are now used as production facilities for individually designed components, mostly in the fields of organic polymers and metallic alloys. Application of these techniques to the manufacture of ceramic parts is much more challenging. Its feasibility for the future production of customized ceramic parts in restorative dentistry will be determined by the progress in control of dimensional tolerance, the residual stress, and their characteristic heterogeneous microstructures. This chapter introduces the basic principles of the AM family of techniques.

Ceramic materials are currently applied to two categories of restorative dentistry, as all-ceramic fixed-partial dentures and as implantable components. While the former demands mainly integrated and balanced properties of mechanical and aesthetic origins, the latter also relies strongly on the material’s bio-oriented properties. This chapter discusses the material demands for solving the problems encountered in

current practice that indicate the direction for future developments. This is done by bearing in mind both process restrictions and compatibilities. Focus is placed on developing materials that have the potential for improving aesthetics, for preserving a healthy situation to secure a prolonged treatment survival, and for improving the durability and reliability of the restorations while also simplifying the procedures of materials manufacture and clinical operation. Biomimetic materials and processes related to them are topics of general importance from a long perspective.

Biomaterials created from innovative glass and bioceramic research are emerging as a precursor to several developments useful for solving a wide variety of industry and health related issues. Current Trends on Glass and Ceramic Materials is a review on the latest developments in glass and ceramic materials for technological applications along with biomedical applications in vivo. The volume serves as a useful reference to readers interested in learning about this area of materials science and its multidisciplinary array of applications

Get an in-depth understanding of the dental materials and tasks that dental professionals encounter every day with Dental Materials: Foundations and Applications, 11th Edition. Trusted for nearly 40 years, Powers and Wataha's text walks readers through the nature, categories, and uses of clinical and laboratory dental materials in use today. Increased coverage of foundational basics and clinical applications and an expanded art program help make complex content easier to grasp. If you're looking to

effectively stay on top of the rapidly developing field of dental materials, look no further than this proven text. Comprehensive and cutting-edge content describes the latest materials commonly used in dental practice, including those in esthetics, ceramics, dental implants, and impressions. Approximately 500 illustrations and photographs make it easier to understand properties and differences in both materials and specific types of products. Review questions provide an excellent study tool with 20 to 30 self-test questions in each chapter. Quick Review boxes summarize the material in each chapter. Note boxes highlight key points and important terminology throughout the text. Key terms are bolded at their initial mention in the text and defined in the glossary. Expert authors are well recognized in the fields of dental materials, oral biomaterials, and restorative dentistry. A logical and consistent format sets up a solid foundation before progressing into discussions of specific materials, moving from the more common and simple applications such as composites to more specialized areas such as polymers and dental implants. Learning objectives in each chapter focus readers' attention on essential information. Supplemental readings in each chapter cite texts and journal articles for further research and study. Conversion Factors on the inside back cover provides a list of common metric conversions. NEW! Foundations and Applications subtitle emphasizes material basics and clinical applications to mirror the educational emphasis. NEW! More clinical photos and conceptual illustrations help bring often-complex material into context and facilitate comprehension.

Ceramic materials are frequently and increasingly used in dentistry. However, they are very brittle, the tensile strength has a large scatter, and their total fracture strain is very low. The strength depends on the loaded volume and on time under load. These properties cause special needs with respect to design, manufacturing tolerances, and handling, in production as well as in application. In ceramics, strength is limited by small flaws that are either caused by the processing of the material or by the machining of surfaces of specimens and components. This chapter introduces the principles of linear elastic fracture mechanics as the basis for understanding brittle fracture, and then presents fracture statistics. These topics are followed by an example for designing with ceramics. In subsequent sections, several other damage mechanisms and their relevance in dental applications will be discussed. The chapter closes with sections that deal with mechanical testing of ceramics and fractography.

This thoroughly revised text covers the most current dental materials available. Among the features are hundreds of high-quality illustrations and clinical photos to aid in learning the step-by-step process of important procedures.

This book presents an introduction to biomaterials with the focus on the current development and future direction of biomaterials and medical devices research and development in Indonesia. It is the first biomaterials book written by selected academic and clinical experts experts on biomaterials and medical devices from various institutions and industries in Indonesia. It serves as a reference source for researchers starting new projects, for companies developing and marketing products and for governments setting new policies. Chapter one covers the fundamentals of biomaterials, types of biomaterials, their structures and properties and the relationship between them. Chapter two discusses unconventional processing of

biomaterials including nano-hybrid organic-inorganic biomaterials. Chapter three addresses biocompatibility issues including in vitro cytotoxicity, genotoxicity, in vitro cell models, biocompatibility data and its related failure. Chapter four describes degradable biomaterial for medical implants, which include biodegradable polymers, biodegradable metals, degradation assessment techniques and future directions. Chapter five focuses on animal models for biomaterial research, ethics, care and use, implantation study and monitoring and studies on medical implants in animals in Indonesia. Chapter six covers biomimetic bioceramics, natural-based biocomposites and the latest research on natural-based biomaterials in Indonesia. Chapter seven describes recent advances in natural biomaterial from human and animal tissue, its processing and applications. Chapter eight discusses orthopedic applications of biomaterials focusing on most common problems in Indonesia, and surgical intervention and implants. Chapter nine describes biomaterials in dentistry and their development in Indonesia.
Accepted worldwide as one of the most important new areas in clinical dentistry, esthetic dentistry is undergoing constant expansion and advancement. Here is the first complete practitioner's guide to the field, with key techniques for improving, restoring, or rebuilding single teeth with a wide range of ceramic systems. Written by a renowned international team who has pioneered several of the techniques in use today, the book covers both basic principles and clinical and laboratory procedures, with dozens of case examples and before-and-after photographs. This book provides all the information needed to understand and implement esthetic procedures into daily practice -- plus the key observation, analysis and decision-making skills that will lead to the best results. This book distributed by Thieme for Martin Dunitz Publishers in the United States and Canada. For orders in the rest of the world, please contact

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"Advances in Nanomaterials in Biomedicine" provided a platform for more than 110 researchers from different countries to present their latest investigations in various fields of nanotechnology, new methods and nanomaterials intended for medical applications. Modern achievements in the field of nanoparticle-based diagnostics, drug delivery and the use of various nanomaterials in the treatment of diseases are presented in 11 original articles. The published reviews provide a comprehensive analysis of the current information on the use of nanomedicine in the treatment and diagnosis of cancer and liver fibrosis, in the field of solid tissue engineering and in drug delivery systems.

This book provides a comprehensive coverage on nanobioceramics and their potential applications in healthcare. Ground-breaking new discoveries in bioceramics and their properties have meant an increasing interest in the development of how this can be related to nanobiomaterials, and in treating various conditions from osteoporosis to surgical dentistry. Research has also been driven by ageing global populations, where better restorative and reparative treatments are needed. As a consequence of this change in demographics, the research of nanobioceramics for application in healthcare is a field that is advancing at a considerable pace. Individual chapters give the reader an in-depth coverage on the synthesis and characterization of various nanobioceramics including silica, calcium phosphates, bioglass, and glass-ceramics. Through reviewing and analysing current literature, this book provides a rich source of valuable information on nanobioceramics for any professionals and

students in materials science and engineering. It is also aimed at medical professionals searching for state-of-the-art techniques and treatments available and made possible through this particular field of innovation.

The growth of implant and fixed prosthodontics practices in dentistry has created a rapidly increasing demand for advanced ceramics and ceramic processes. Innovations in ceramics and ceramic processes are vital to ensure reliable and affordable dental-restoration solutions with aesthetically pleasing outcomes. The work aims to engage the bioceramics and engineering communities to meet the challenges of modern dental restoration using advanced ceramics. Incorporating fundamental science, advanced engineering concepts, and clinical outcomes, the work is suitable for bioceramicists, ceramics manufacturers, dental clinicians and biologists. State-of-the-art-coverage encompasses bioresorbable ceramics for bone regeneration and bioactivating surfaces of inert, high-strength ceramics for implantation, keeping research knowledge appropriately updated Discusses transition from the baseline stable and physically stiff ceramics research into engineering of highly coherent laminate composites for prosthetic crowns and bridges Showcases current feasible techniques for producing, in cost-effective and materials-saving ways, long-lasting individualized ceramic components with biocompatibility, complexity and high precision

This book examines exciting advancements in the field of ceramics, including nanotechnology, clean energy, and tribology as well as fundamental concepts like defects and structure. It is a comprehensive discussion on how today’s ceramics are processed and used in many of today’s critical technologies. It discusses current techniques for synthesizing durable and cost-effective ceramic components with biocompatibility, complexity, and high precision. This book

is a comprehensive reference for researchers, engineers, dental clinicians, biologists, academics, and students interested in ceramics.

Teeth are vital organs of vertebrates of which the main function is to bite and chew food into pieces. Human teeth are always an essential concern in appearance and beauty, and they play an important role in everything from word pronunciation to the protection of support organs. The right anatomical shape and arrangement of teeth are the basis for these functions. Each tooth contains three hard calcified tissues, including enamel, dentin, and cementum, and one soft tissue, pulp, which contains blood vessels, nerves, and is connected with the periodontal tissue by a narrow root canal. The development, formation, composition, microstructure, optical and mechanical properties, and common defects of and damages to human teeth are reviewed in this chapter. This knowledge is of importance in restorative dentistry for designing preventive treatments to maintain tissue integrity and to replace damaged tissues with synthetic materials (e.g. ceramics, which mimic the natural appearance and performance of teeth).

Bioactive ceramics are used as bulk, porous bodies, or surface-active layers on dental implants and as morphogenetically active scaffolds inserted into the jawbone. While the former has been popularly applied as artificial dental roots for recovering the function of lost teeth, the latter are increasingly used for regenerating bone tissue. In both cases, the common fundamental basis is to understand how the new bone is formed on the surfaces of introduced foreign bodies, integrated together with the autologous bone through complex biological processes and cell-materials interactions. Efforts are thus made in this chapter to elucidate the biological origins of those phenomenological terms that have often eluded satisfactory scientific definition on this particular topic of practice-motivated science. Bone-growth mechanisms are

discussed together with possible characterization and quantification methods. The role of surface morphology and multi-scale structures in promoting bone growth is emphasized. Based on the state-of-the-art understanding all the way down to molecular, cellular, and genetic levels, bioactive ceramics are categorized and presented in relation to their potential applications in dentistry. The design concept of implants for enhancing early healing and for enabling immediate loading is also discussed.

The mechanical reliability and aesthetic appearance of ceramic dental prostheses are strongly influenced by the presence of defects. When several processes are used during fabrication of ceramic dental prostheses, additional defects are unavoidably introduced in each process step; these are in addition to the ones that already exist in raw materials. To avoid the degeneration of material performance by the accumulated defect population, process optimization is needed to minimize the defects introduced. Standardized mechanical evaluations are usually performed on samples with carefully prepared surfaces in order to minimize the influence from the defects usually induced by fabrication processes. The results from such mechanical evaluation indicate the strength level that is achievable by the material with the given population of bulk defects. In order to avoid a reduction in the performance of the ceramic material by the additional defects normally induced by the fabrication process, it must be understood how these defects are introduced, and solutions must be found to reduce their size and frequency through modifications of the material and processes. The aim of this chapter is to elucidate the sources of defects that are common for ceramic dental prostheses and to determine how to minimize them.

In the early 1980s the industrialization of products based on the osseointegration principle

discovered by Professor Per-Ingvar Brånemark started. The industrialization system has since gone through digitalization and automation, where now computer-aided imprisoning, design, and milling are standard features of a highly flexible production process for customized products. Lab production and central production are two ways of producing dental products. The central production principle offers the potential for better economy of scale and turnover of products, and the local dental lab can offer a higher degree of customization and personal service. Quality of dental products has always been of central importance and continues to grow. New technology and a highly digital treatment process are open for even better quality by the use of production simulations and tolerance analysis in all parts of the manufacturing process.

The main sections/chapters of the book focus on the composition of nine types of bioceramics, other simple oxides and more and the medical applications of these materials in orthopaedics, dentistry and the treatment of cancerous tumors.

Advanced Ceramics for DentistryChapter 11. Alumina- and Zirconia-based Ceramics for Load-bearing ApplicationsElsevier Inc. Chapters

Based on the author's lectures to graduate students of geosciences, physics, chemistry and materials science, this didactic handbook covers basic aspects of ceramics such as composition and structure as well as such advanced topics as achieving specific functionalities by choosing the right materials. The focus lies on the thermal transformation processes of natural raw materials to arrive at traditional structural ceramics and on the general physical principles of advanced functional ceramics. The book thus provides practice-oriented information to readers in research, development and engineering on how to understand, make

and improve ceramics and derived products, while also serving as a rapid reference for the practitioner. The choice of topics and style of presentation make it equally useful for chemists, materials scientists, engineers and mineralogists.

-Detailed dental implant laboratory procedures for multiple clinical conditions with recent advances -Extensive chapter on virtual laboratory -Laboratory disinfection protocol for COVID-19 -Detailed discussion of metal ceramics and all ceramics -More than 3400 coloured photos and illustrations -More than 100 flowcharts and diagrams for easy understanding -Mouthguards and TMJ appliances -Digital version and videos for enhanced learning -Comprehensive laboratory reference for prosthodontists and clinicians

Titanium-based dental implants and abutments exhibit excellent biocompatibility and mechanical properties. Both early wound healing and bone formation and soft tissue healing towards abutments are well understood. This chapter elucidates whether ceramic surfaces provide appropriate conditions for soft and hard tissue healing.

Tooth defects and missing teeth are common oral diseases that threaten the patient’s health, aesthetics, and self-confidence. Prosthodontics is a dental specialty with a long history of providing artificial prostheses to restore or replace the damaged or missing teeth and dentition of patients. Based on type and degree, there are three main categories of tooth damage: tooth defect, partial edentulism, and complete edentulism. Various prosthetic treatments are available

for restoration, and each of them has its specific advantages and limitations. This means thect, the patient's oral and general health condition, and the individual's expectation. In thiat the decision to pursue prosthetic treatment should be made by fully understanding the characteristics of the defs chapter, background knowledge of the characteristics of tooth defects and edentulism are introduced in combination with commonly used prostheses. Despite the fact that there are no omnipotent prostheses, some general guidelines of prostheses selection are given.

Applications of Advanced Ceramics in Science, Technology, and Medicine explores a broad range of advanced ceramic materials and their innovative applications in distinct fields. Chapters cover applications such as actuators, energy storage, environmental health and monitoring, 3D printing, electronics, biomedical engineering and EMI shielding. Chapters provide readers with an overview of the structural and fundamental properties, synthesis strategies and versatile applications of advanced ceramic materials and their composites. The information in the volume will be beneficial for students, research scholars, faculty members and R&D specialists working in the area of material science, nanotechnology, solid-state science, chemical engineering, power sources and renewable energy storage.

Rev. ed. of: Phillips' science of dental materials / [edited by] Kenneth J. Anusavice. 11th ed. c2003.

Feldspathic porcelains, leucite, and lithium disilicate glass-ceramics are important materials used in restorative dentistry for their biocompatibility, excellent aesthetic properties, good mechanical strength, and relative ease of use. As a general rule in clinical practice, the choice of material should be dictated by the specific clinical situation. It depends on the space available to build the aesthetic and functional restoration, but also on the nature of the underlying tooth or restorative structure. The best aesthetic results are obtained with feldspathic porcelain restorations directly resin-bonded to the tooth, whereas the best function is obtained with the stronger and tougher fully anatomical or veneered glass-ceramic crowns and bridges. The main limitation with these ceramics is their insufficient strength for use as posterior crowns and bridges. Possible means to obtain aesthetically pleasing and long-term performing posterior restorations are the development of stronger glass-ceramics, the use of translucent colored zirconia, or the use of the new class of more elastic hybrid polymer-ceramic materials.

This is the Proceedings of III Advanced Ceramics and Applications conference, held in Belgrade, Serbia in 2014. It contains 25 papers on various subjects

regarding preparation, characterization and application of advanced ceramic materials.

This book covers the area of advanced ceramic composites broadly, providing important introductory chapters to fundamentals, processing, and applications of advanced ceramic composites. Within each section, specific topics covered highlight the state of the art research within one of the above sections. The organization of the book is designed to provide easy understanding by students as well as professionals interested in advanced ceramic composites. The various sections discuss fundamentals of nature and characteristics of ceramics, processing of ceramics, processing and properties of toughened ceramics, high temperature ceramics, nanoceramics and nanoceramic composites, and bioceramics and biocomposites.

Titanium and titanium alloys are considered standard materials for dental implants with very well documented, high rates of success and survival. Potential immunologic and aesthetic drawbacks associated with titanium implants have resulted in the development of alternatives like zirconia-based dental implants. Zirconia seems to be a suitable implant material because of its tooth-like color, mechanical properties, biocompatibility, and low plaque affinity. However, the use of zirconia in clinical implant dentistry is still controversial. The aim of this chapter

is to review clinical and research articles conducted on zirconia dental implants, and to provide information on zirconia dental implant osseointegration, mechanical strength, and microbiology. Compared to titanium-based dental implants zirconia implants show promising results in clinical studies. However, there are a limited number of long-term studies on the outcome of zirconia implants and additional clinical research needs to be done to fully appraise zirconia-based dental implants.

This new handbook will be an essential resource for ceramicists. It includes contributions from leading researchers around the world and includes sections on Basic Science of Advanced Ceramics, Functional Ceramics (electro-ceramics and optoelectro-ceramics) and engineering ceramics. Contributions from more than 50 leading researchers from around the world Covers basic science of advanced ceramics, functional ceramics (electro-ceramics and optoelectro-ceramics), and engineering ceramics Approximately 750 illustrations

This chapter gives an introduction to advanced ceramics from the perspective of restorative dentistry. Fundamentals of composition and functionality are used for defining and classifying advanced ceramics. A historical overview helps differentiate advanced ceramics from traditional ceramics. The focus of the chapter is on linking ceramic properties to their compositions and structures described hierarchically from the atomic level onward.

This chapter reviews the structure, mechanical properties, and biocompatibility of load-bearing ceramics used in dentistry. The development of this class of ceramic biomaterials is traced from the late sixties when alumina was introduced in dentistry. The literature on both polycrystalline and single crystal alumina dental implants is reviewed. The use of alumina declined when zirconia-toughened ceramics were introduced in orthopedics in the eighties. The use of yttria partially-stabilized tetragonal zirconia (Y-TZP) in dentistry allowed the production not only of dental implants and abutments, but also a broad range of load-bearing fixed partial dentures, such as multi-unit bridges and crowns, thanks to the development of CAD/CAM technology. Today, the trend is to use alumina and zirconia ceramics for making more aesthetic parts by improving their optical translucency.

High-performance bioceramics, such as zirconia, alumina, and their composites, are attractive materials for the fabrication of load-bearing bone implants because of their outstanding mechanical properties, biocompatibility, corrosion resistance, and aesthetic quality. However, a lot of additional work is still needed on these ceramics before their full potential as implant materials can be exploited, especially in the area of surface optimization. The two most important issues relating to the surface of ceramic implants that need to be addressed are surface chemistry and topography. They both have an influence on protein adsorption and cell behavior and play a key role in providing sufficient biomechanical stability for the long-term success of implants. Therefore,

extensive studies have been performed that are aimed at a better understanding of how specific surface modifications affect the biological response. In this chapter, various surface-modification techniques are described and their potential for improving the osseointegration of ceramic implants is discussed.

The chapter is focused on the processing of bulk advanced ceramics. A general overview of ceramic processes is presented with the focus on processes relevant to advanced ceramics in dentistry. The processing of ceramics is divided into four parts that describe the basic steps: powder treatment, shaping of ceramic green bodies, drying and binder removal, and sintering. The first part discusses the reasons for powder treatment. The causes of powder agglomeration are explained and possible dispersion techniques are given. The principles of the most important methods of dry, wet, and plastic shaping, and consolidation of green bodies are explained. The mechanisms of solvent drying and binder removal from consolidated green bodies are discussed and the potential problems of this processing step are highlighted. The densification of green bodies via sintering is explained and possible sintering techniques are described. Advantages and disadvantages of particular sintering methods are discussed.