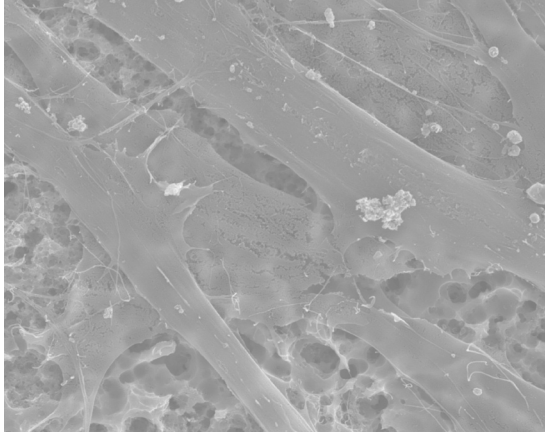




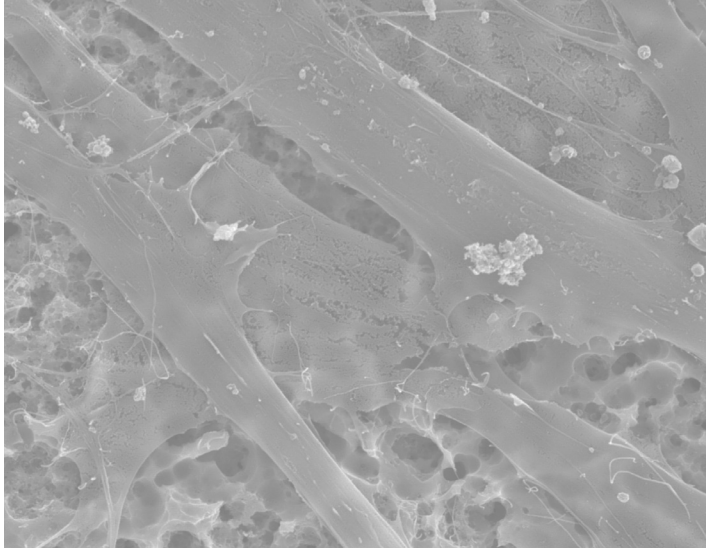
Edited by
Mieczyslaw Jurczyk

Bionanomaterials for Dental Applications





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Preface

Nanotechnology involves the precise manipulation and control of atoms, the building elements of all matter, to create new materials. It is widely accepted that this technology is developing into a major driver for commercial success in the 21st century. Over the last decade, the use of nanostructured metallic and ceramic materials has already changed the approach to materials design in many applications, by seeking structural control at the atomic level and by the tailoring of the mechanical engineering, physico-chemical, and biological properties. Today, it is possible to prepare metal and ceramic nanocrystals with nearly monodispersive size distribution. Nanomaterials demonstrate novel properties compared with conventional (microcrystalline) materials owing to their nanoscale features.

Recently, the mechanical alloying method and the powder metallurgy process for the fabrication of metal/alloy-ceramic nanocomposites with a unique microstructure have been developed. The processes permit the control of microstructural properties such as the size of pore openings, surface properties, and the nature of the base metal/alloy. The availability of large amounts of specifically tailored nanostructured metal/alloy-based powders is crucial for the successful development of new dental implants.

One of the potential applications of nanostructured materials is dentistry. Although Ti is widely used for clinical purposes, some unresolved issues still remain. The clinical failure rate for implant materials occurs in the range from a few to over 10%.

The lack of sufficient bonding of synthetic implants to surrounding body tissues has led to the investigations of novel material formulations. Nanomaterials can be used to synthesize implants with surface roughness similar to that of natural tissues. The mechanical properties are improved, and what is more, the book highlights the enhanced cytocompatibility of the nanomaterials, leading to increased tissue regeneration.

The present research aims to fabricate porous scaffolds to promote bone or tissue ingrowth into pores and provide biological anchorage. Several factors have shown their influence on bone

ingrowth into porous implants, such as porous structure (pore size, pore shape, porosity, and interconnecting pore size) of the implant, duration of implantation, biocompatibility, implant stiffness, and micromotion between the implant and the adjacent bone. The architecture of a porous implant has been suggested to have a great effect on implant integration by newly grown bone.

This book is our contribution to this innovative area of bionanomaterials and bionanocomposites for dental applications. Wherever possible, we used our own results to illustrate the discussed subject. The content of this book is classified into 13 chapters. The first chapter emphasizes the motivation for the transformation to the bionanomaterials and synthesis of nanomaterials, aiming at describing the principles and approaches of the synthesis techniques. We provide a comprehensive history of the development of biomaterials, including the existing fabrication methods, with special emphasis on ball milling in high-energy mills. The second chapter focuses on the stomatognathic system. In Chapters 3 and 4, we review the properties of selected biomaterials and the application of nanotechnology in dental materials. Chapter 5 presents a thorough review of the corrosion of metallic biomaterials and implants. The book also describes Ni-free austenitic stainless steel–hydroxyapatite nanocomposites (Chapter 6), Ti-based ceramic nanocomposites (Chapter 7), and shape memory Ni–Ti materials (Chapter 8). Chapters 9 and 10 provide information on the surface treatment of Ti-based nanocrystalline biomaterials and carbon materials. The present state of knowledge related to nanomaterials in preventive dentistry and osteoblast behavior on nanostructured metal implants are presented in Chapters 11 and 12. Chapter 13, the last chapter, focuses on the application of bulk nanostructured materials in dentistry. The objective is to show their unique properties.

Our goal is to provide comprehensive and complete knowledge about bionanomaterials for dental applications to graduate students and researchers, whose background can be in chemistry, physics, chemical engineering, materials science, biomedical science, or even dental science.

I express my appreciation to all of the authors for their contributions.

Mieczysław Jurczyk