





Editorial

The Importance of Synthesis and Characterization of Biomedical Materials for the Current State of Medicine and Dentistry

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*"Noble health,
no one will know
what you taste
like until you break down"*

*"Ślachtetne zdrowie,
nikt się nie dowie,
jako smakujesz,
aż się zepsujesz"*
(in Polish)

Jan Kochanowski (1530–1584)



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From time immemorial to the present day, health has been considered to be of the highest value. In the writings of the father of medicine, Hippocrates (460–377 BC), known as *"The Hippocratic Corpus"* (Latin: *"Corpus Hippocraticum"*), or *Hippocratic Collection* [1,2], collected 100 years after his death and first translated and printed in 1525 in Venice, Italy, we can find the sentence "A wise man should know that health is his most precious possession and he should learn how to heal his diseases himself." Aulus Cornelius Celsus (53 BC to around 7 AD), a Roman scholar and encyclopedist, in his work *"De medicina libri VIII"* [3,4], published first in Florence in 1478, in turn, wrote that "It is not important what causes disease, but what removes it". In the Middle Ages in Poland, Jan Kochanowski (1530–1584), a poet and one of the greatest authors of the Renaissance in Europe, who contributed most to the development of the Polish literary language, wrote in his trifle poem the words we have chosen as the motto of this book [5]. We personally translated them into English, but unfortunately, we were unable to recreate either the rhythm or the rhyme of this fragment of the poem. Undoubtedly, the poet was already writing about the extraordinary value of human health. Today, the right to healthcare and maintaining good health is one of the primary and inalienable human rights. It is of particularly special value in the era of the global COVID-19 pandemic.

Modern medicine uses progress not only in basic sciences but also in technical and physicochemical sciences [6,7]. One of the best examples of such a combination of competencies is in biomaterials [8–19]. A biomaterial is a substance that is designed to interact with biological systems for therapeutic purposes. Biomaterials are used in various fields of medicine, especially in regenerative medicine, surgery, and dentistry, for the treatment, repair, or replacement of body tissues, for the improvement or restoration of tissue function, and for diagnostic purposes. Therefore, biomaterials used in contact with living tissues, organisms, or microorganisms must consider various issues related not only to medicine but also biology, chemistry, tissue engineering, and materials engineering. Biomaterials can be derived from nature or synthesized in a laboratory using a variety of methods involving metals, polymers, ceramics, or composites, as well as porous materials and biological-engineering materials [18]. Often the expected properties of biomaterials are

obtained by surface engineering methods [20]. Biomaterials are often used or adapted for medical applications, and thus, include all or part of a living biomedical structure or device that performs, enhances, or replaces a natural function. Such functions can be relatively passive, such as in the case of a heart valve, or bioactive and more interactive, as in the case of hip implants. Biomaterials are also widely used in dental, surgery, and drug delivery applications, e.g., in the form of pharmaceutical products that are placed in the body to release the drug over long periods. The biomaterials can be autografts, allografts, or xenografts used as transplant materials. Biomaterials are used, among others, for the replacement of joints, bone plates, bone cement, surgical sutures, clips and staples for closing wounds, pins and screws for stabilizing fractures, surgical meshes, breast implants, artificial ligaments and tendons, dental implants, stabilizers, vascular prostheses blood vessels, heart valves, vascular grafts, stents, nerve cables, skin repair devices, intraocular lenses for eye surgery, contact lenses, and drug delivery systems. Biomaterials must be compatible with the organism, and biocompatibility issues must be resolved before the product can be used in a clinical setting. For this reason, biomaterials are usually subjected to numerous tests, and the technologies for their evaluation must be certified.

Currently, the manufacturing and synthesis of biomaterials require the use of various technologies and methods. Often, these are methods that allow obtaining the correct material, which is then processed using advanced material processing technologies to manufacture a specific prosthesis or other types of implant. Often, however, it is necessary to directly manufacture a specific product with individualized geometric features and properties tailored to the requirements of a particular patient. Special technologies are required for diagnostic materials as well as for long-term drug release systems. Technologies in the current stage of the industrial revolution, Industry 4.0, are increasingly used in the biomaterial production cycle [21–35].

This book, including this Editorial on “The Importance of Synthesis and Characterization of Biomedical Materials for the Current State of Medicine and Dentistry” by Leszek A. Dobrzański, Anna D. Dobrzańska-Danikiewicz, Lech B. Dobrzański, and Joanna Dobrzańska as Editors [36], contains 20 chapters. The book aims to summarize the latest achievements in the development and manufacturing of modern biomaterials used in modern medicine and dentistry; for example, in cases where as a result of a traffic or sports accident, aging, resection of organs after oncological surgery, or dangerous inflammation, there is a need to replace lost organs, tissues, and parts of the human body. The book also includes chapters on the design of biomaterials and related technologies, including computer-aided design and manufacturing CAD/CAM methods, and research on their structure and properties, including biological research characterizing the reactions of the human body to the implantation or introduction of various types of biomaterials, both in the field of regenerative medicine and regenerative dentistry. A large part of the content contained in the next few chapters concerns dentistry and the issues mentioned above related to this particular branch of medicine, as well as implantation and prosthetic restorations of teeth.

After this introductory chapter, the first is a chapter by Leszek A. Dobrzański, Anna D. Dobrzańska-Danikiewicz, and Lech B. Dobrzański from Poland entitled “Effect of Biomedical Materials in the Implementation of a Long and Healthy Life Policy” [37]. Its purpose is a literature review showing the importance of bioengineering and the global production of biomaterials required for the level of health care in the world. All the considerations in this chapter are preceded by a discussion of health and diseases and the general well-being of societies. It turns out that the views of neither doctors nor philosophers as to the definition of these concepts are still not fully consistent; therefore, the intuitive definition contained in the Constitution of the World Health Organization decided at the founding meeting of this organization in 1948 should be adopted. Particular attention is paid to the relationship of health with the highly developed industry of the Industry 4.0 stage and the role assigned to biomaterials in this process. The need to support medicine on an ongoing basis through engineering activities is emphasized; largely applying to a wide

group of medical devices including implants, implant-scaffolds, scaffolds, and prostheses, as well as the synthesis of entire systems by engineers and various methods of drug delivery, which by definition are not medical devices. There are strict rules on the use of medical devices, and adherence to strict moral imperatives is the responsibility of doctors and engineers working together. A far-reaching simplification is a commonly known principle of “do no harm first” because the ethical principles followed by engineers and doctors resulting from the so-called “Hippocratic oath” come down to a total of nine main findings discussed in the chapter. The tenth principle concerns the obligation to present to the patient the truth about his/her health condition and the therapeutic activities undertaken. It is crucial to consider the COVID-19 coronavirus pandemic, which is currently determining the health situation in the world. Hence, the need to introduce systemic measures to protect the health of both patients and medical staff against the spread of the lethal SARS-CoV-2 virus is also discussed, which has greatly expanded the scope of cooperation between medical and engineering activities. The next part of the chapter concentrates on the issues of bioengineering, mainly medical and dental engineering, taking into account the current stage of the Industry 4.0 industrial revolution implemented in these areas. Analogous to the concept of Dentistry 4.0, a general approach to Bioengineering 4.0 has been proposed. The basics of production management and the quality loop in the product life cycle are analyzed. The chapter contains an analysis of the synthesis and characteristics of biomedical materials supporting medicine and dentistry, with particular emphasis on the methods of additive manufacturing. Numerous examples of clinical applications are presented to support the consideration of biomedical materials. The economic conditions for implementing various groups of biomedical materials are supported by forecasts for the development of global markets for biomaterials, regenerative medicine, and tissue engineering. In Part Seven, the summary and concluding remarks are made against the background of a historical retrospective, which emphasizes that the technological processes of manufacturing and processing show a systematic increase in the global production of biomedical materials. The increase is a strong determinant for the implementation of policy for a long and healthy life around the world—one of the 17 sustainable development goals selected by the United Nations. The chapter is an extensive substantive introduction to the broad issues of biomedical materials and related technological processes presented in the book.

Looking at the 18 articles of this book, the first group concerns biomaterials used in dentistry and their relevant technological processes.

“The Concept of Sustainable Development of Modern Dentistry” [38] is presented in the next chapter by Leszek A. Dobrzański, Lech B. Dobrzański, Anna D. Dobrzańska-Danikiewicz, and Joanna Dobrzańska, the editors of this book. The paper concerns an assessment of the current state of dentistry in the world and the prospects of its sustainable development. A traditional Chinese censer was adopted as the pattern, characterized by strong and stable support on three legs. The dominant diseases of the oral cavity are caries and periodontal diseases, with the inevitable consequence of toothlessness. An estimated 3.5–5 billion people suffer from caries. Moreover, each of these diseases has a wide effect on the development of systemic complications. The territorial range of these diseases and their significant differentiation in severity in different countries and their impact on disability-adjusted life years index (DALY) are presented. Edentulousness has a significant impact on the oral health-related quality of life (OHRQoL). The etiology of these diseases is presented, as well as the preventive and therapeutic strategies undertaken as a result of modifying the Deming circle through the “fives’ rules” idea. The state of development of Dentistry 4.0 is an element of the current stage of the industrial revolution Industry 4.0 and the great achievements of modern dental engineering. Dental treatment examples from the authors’ own clinical practice are given. The systemic safety of a huge number of dentists in the world is discussed, in place of the passive strategy of using more and more advanced personal protective equipment (PPE), introducing the authors’ own strategy for the active prevention of the spread of pathogenic microorganisms, including SARS-CoV-2. The ethical aspects of dentists’ activity towards their own patients and the

ethical obligations of the dentist community towards society are discussed in detail. This paper is a polemic, arguing against the view presented by a group of eminent specialists in the middle of the previous year in *The Lancet*. It is impossible to disagree with these views when it comes to waiting for egalitarianism in dental care, increasing the scope of prevention, and eliminating discrimination in this area on the basis of scarcity and poverty. The views on the discrimination of dentistry in relation to other branches of medicine are far more debatable. Therefore, relevant world statistics for other branches of medicine are presented. The authors of this paper do not agree with the thesis that interventional dental treatment can be replaced with properly implemented prophylaxis. The final remarks, therefore, present a discussion on the prospects for the development of dentistry based on three pillars, analogous to the traditional Chinese censer obtaining a stable balance thanks to its three legs. The Dentistry Sustainable Development (DSD) > 2020 model, consisting of Global Dental Prevention (GDP), Advanced Interventionist Dentistry 4.0 (AID 4.0), and Dentistry Safety System (DSS), is presented.

The next chapter deals with a very special aspect of dentistry—the safety of medical staff during dental procedures. The chapter entitled “Non-Antagonistic Contradictoriness of the Progress of Advanced Digitized Production with SARS-CoV-2 Virus Transmission in the Area of Dental Engineering” [39] was written by a team of six, composed of Leszek A. Dobrzański, Lech B. Dobrzański, Anna D. Dobrzańska-Danikiewicz, Joanna Dobrzańska, Karolina Rudziarczyk, and Anna Achtełik-Franczak from the ASKLEPIOS Center in Gliwice, Poland. The general goals of advanced digitized production in the Industry 4.0 stage of the industrial revolution are presented along with the extended holistic model of Industry 4.0, introduced by the authors, indicating the importance of material design and the selection of appropriate manufacturing technology. The effect of the global lockdown caused by the SARS-CoV-2 virus transmission pandemic was a drastic decrease in production, resulting in a significant decrease in the gross domestic product (GDP) in all countries, and huge problems in health care, including dentistry. Dentists belong to the highest risk group because the doctor works in the patient’s respiratory tract. This chapter presents a breakthrough authors’ solution, implemented by the active SPEC strategy (System-Prevention-Efficiency-Cause), and aims to eliminate clinical aerosol at the source by negative pressure aspirating bioaerosol at the patient’s mouth line. The comparative benchmarking analysis and its results show that only the proprietary solution with a set of devices eliminates the threat at the source, while the remaining known methods do not meet the expectations. The details of this solution are described. Photopolymer materials and additive digital light printing (DLP) technology were used.

The next chapter covers “Dentistry 4.0 Concept in the Design and Manufacturing of Prosthetic Dental Restorations” [40]. The chapter was prepared by Leszek A. Dobrzański and Lech B. Dobrzański from Poland. It presents an overview of work on the current trends in the development of technical support for dental prosthetics under the name Dentistry 4.0, similar to the concept of the highest stage of Industry 4.0 of the industrial revolution. A new model of cooperation between dentists and dental engineers was formed. The research on the importance of cone-beam computed tomography CBCT in the planning of prosthetic treatment as well as in the design and manufacturing of prosthetic restorations is described. Procedures and technologies of implant preparation with the use of computer-aided design and manufacturing (CAD/CAM) methods and additive manufacturing technologies (AM), including selective laser sintering (SLS). Examples of this approach for several types of prosthetic restorations have been described.

Another chapter on “Virtual Approach to the Comparative Analysis of Biomaterials Used in Endodontic Treatment” [41] was developed by a team consisting of Joanna Dobrzańska, Lech B. Dobrzański, Klaudiusz Gołombek, Leszek A. Dobrzański, and Anna D. Dobrzańska-Danikiewicz from Poland. The importance of endodontics is presented within the framework of the own concept of Sustainable Development of Dentistry (DSD), presented previously. The materials and methods of clinical management in endodontic procedures are characterized, as well as forecasts for the development of the global

endodontic market. A detailed methodological approach is presented to objectify the assessment of endodontic treatment with the use of procedural benchmarking methods and contextual matrices. In practice, the so-called “digital twins” approach to virtual benchmarking in endodontic treatment. The selection of materials, techniques for developing and filling root canals, and methods for assessing the effectiveness of fillings are virtually optimized. The full usefulness of the research on the effectiveness and tightness of root canal filling with the use of a scanning electron microscope is indicated.

The next chapter, entitled “Application Solid Laser-Sintered or Machined Ti6Al4V Alloy in Manufacturing of Dental Implants and Dental Prosthetic Restorations According to Dentistry 4.0 Concept” [42] was developed by a team consisting of Leszek A. Dobrzański, Lech B. Dobrzański, Anna Achtełik-Franczak, and Joanna Dobrzańska from Poland. The influence of milling technology in a numerically controlled computer machining center (CNC) and selective laser sintering (SLS) on the properties of the Ti6Al4V solid titanium alloy are compared. Even slight changes in the technological conditions in the SLS manufacturing can cause a difference of almost 2.5 times in the properties of the obtained material. The strength after milling is approx. 30% lower than in the case of additive manufacturing. At the same time, plug-and-play factory conditions can only provide approx. 60% of the actual and achievable strength properties, and therefore such a procedure cannot be approved. Biological tests with osteoblasts confirm a good tendency for the proliferation of living cells on the medium produced under optimal conditions. This chapter shows, based on the example of a specific biomaterial, how to practically implement the assumptions of the concept of Dentistry 4.0 in the production of dental prosthetics and implanted devices.

The chapter entitled “Corrosion Resistance of Cr-Co Alloys Subjected to Porcelain Firing Heat Treatment—In Vitro Study” [43] was prepared by the team of authors Dorota Rylska, Bartłomiej Januszewicz, Grzegorz Sokołowski, and Jerzy Sokołowski from Poland. This chapter describes the results of a comparative assessment of the effect of heat treatment used for firing dental ceramics on the corrosion properties of Co-Cr alloys manufactured by various methods: casting, milling of the compact, and its secondary sintering and selective laser sintering, which the authors call laser melting. Heat treatment under ceramic firing conditions was applied in all cases. Both the structure and the corrosion properties were investigated by means of electrochemical, potentiodynamic polarization tests. Among the heat-treated alloys, the material that was selectively laser sintered, then conventionally sintered after machining, showed the highest corrosion resistance, while the cast material turned out to be the least resistant. It is explained that this is related to the uniform distribution of the alloying elements in a homogeneous structure and the reduced porosity. The non-porosity increases the corrosion resistance and reduces the risk of crevice corrosion. The segregation of chemical elements, directly dependent on the manufacturing technology, has a fundamental impact on the corrosion behavior of the tested materials.

Chapter titled “Fretting Wear in Orthodontic and Prosthetic Alloys with Ti (C, N) Coatings” [44] was developed by a team consisting of Katarzyna Banaszek, Leszek Klimek, Jan. R. Dąbrowski, and Wojciech Jastrzębski. The aim of the presented research was to compare the fretting wear resistance of orthodontic and prosthetic Ni-Cr-Mo alloys coated with Ti (C, N) and without the coating. Samples with Ti (C, N) coatings showed higher resistance to fretting wear, and the wear in each case is more than twice lower. The use of coatings reduces the adverse effects of this type of wear by reducing the number of ions released during orthodontic treatment or wearing dentures.

The next chapter was developed by an eight-person team consisting of Katarzyna Mydłowska, Ewa Czerwińska, Adam Gilewicz, Ewa Dobruchowska, Ewa Jakubczyk, Łukasz Szparaga, Przemysław Ceynowa, and Jerzy Ratajski from Poland. The chapter is titled “Evolution of Phase Composition and Antibacterial Activity of Zr-C Thin Films” [45]. The results of extensive material science research, including electron microscopy, X-ray diffraction, and Raman spectroscopy, are presented. Zr-C coatings deposited on 304 L steel were tested by reactive magnetron sputtering from a Zr target in an Ar-C₂H₂ atmosphere at various acetylene flow rates. The concentration of C in the coatings ranged from 21 to

79%. Favorable mechanical properties of the coatings and relatively good antibacterial and anti-corrosive properties were obtained in the environment of artificial saliva where the concentration of C is greater than 50%. The Zr-C coatings obtained in this way can be used for medical purposes, especially in dentistry.

A large international team consisting of Sadaqat Ali, Ahmad Majdi Abdul Rani, Riaz Ahmad Mufti, Farooq I. Azam, Sri Hastuty, Zeeshan Baig, Murid Hussain, and Nasir Shehzad from Malaysia, Pakistan, and Indonesia prepared a chapter entitled “The Influence of Nitrogen Absorption on Microstructure, Properties and Cytotoxicity Assessment of 316 L Stainless Steel Alloy Reinforced with Boron and Niobium” [46]. In the past, 316 L stainless steel (SS) has been used in the manufacture of implants, although leaching of nickel ions limits its suitability for this purpose. The composition of the SS was modified by the addition of boron and niobium and then sintered under nitrogen for 8 h. X-ray diffraction (XRD) results showed the formation of strong nitrides, indicating nitrogen diffusion into the SS matrix and deposition of a nitride layer on the surface, making it difficult to wash out the nickel ions. Corrosion resistance in artificial saliva is improved and the developed upgraded stainless steels are compatible with living cells and can be used as implant materials.

“Optimization of Sintering Parameters of 316 L Stainless Steel for In-Situ Nitrogen Absorption and Surface Nitriding Using Response Surface Methodology” [47] is the title of a chapter prepared by a team from Malaysia and Indonesia composed of Sadaqat Ali, Ahmad Majdi Abdul Rani, Riaz Ahmad Mufti, Syed Waqar Ahmed, Zeeshan Baig, Sri Hastuty, Muhammad Al’Hapis Abdul Razak, and Abdul Azeez Abdu Aliyu. It is impossible not to notice that due to the nickel content, the possibilities of using this steel for medical purposes are limited. The simultaneous sintering and surface nitriding of 316 L stainless steel by powder metallurgy is discussed in this chapter. The developed technique of simultaneous sintering and surface nitriding could help improve the corrosion resistance of this material and control the leaching of metal ions for the potential use of this steel in biomedical applications.

The team consisting of Tsanka Dikova, Jordan Maximov, Vladimir Todorov, Georgi Georgiev, and Vladimir Panov from Bulgaria developed the chapter on “Optimization of the Photo-Polymerization Process of Dental Composites” [48]. The purpose of this chapter is to optimize the parameters of the photo-polymerization process of dental composites in order to obtain maximum hardness. Several alternative materials were considered, including a versatile light-curing composite, a bulk composite fill, and a flowable composite. The photo-polymerization of the samples was carried out under various conditions. For all composites, hardness regression models were determined on the upper and lower surfaces of the composite layer, for a total of 21 photo-polymerization modes that changed depending on the light intensity and exposure time. It turned out that the recommendations of the manufacturers of these materials were not confirmed by the test results. Therefore, Tables with recommended photo-polymerization regimes for the tested types of composites have been developed, which guarantee the high hardness of the composite filling. The research results developed in this way are of great practical importance as they can facilitate the daily work of dentists in dental clinics.

“Finite Element Analysis in Setting of Fillings of V-Shaped Tooth Defects Made with Glass-Ionomer Cement and Flowable Composite” [49] is the second chapter developed in Bulgaria by a team of Tsanka Dikova, Tihomir Vasilev, Vesela Hristova, and Vladimir Panov. Two different materials are used—resin reinforced self-curing glass ionomer cement (GIC) and flowable photocurable composite (FPC). There is an analogous non-uniform distribution of von Mises equivalent stresses on V-shaped cavity fillings made with GIC and FPC. Maximum stresses arise along the boundaries of the filling on the vestibular surface of the tooth and on the bottom of the filling. The von Mises equivalent stress values of the GIC fillings are higher than the FPC values. An experimental study of micro-leaks confirmed the adequacy of the models used in FEM.

The fourteenth chapter, does not concern dentistry anymore and was developed in Poland by the team of Anna Ślósarczyk, Joanna Czechowska, Ewelina Cichoń, and Aneta Zima. The title of the chapter is “New Hybrid Bioactive Composites for Bone Substitution” [50]. The chapter describes the results of optimization of the composition of hybrid inorganic–organic materials and covers the study of bio-micro-concrete containing hydroxyapatite (HAp)-chitosan (CTS) granules dispersed in a matrix of α -tricalcium phosphate (α TCP). The resulting materials proved to be promising bone substitutes for non-load-bearing applications.

A team from Portugal consisting of Basam A.E. Ben-Arfa and Robert C. Pullar prepared a chapter entitled “A Comparison of Bioactive Glass Scaffolds Fabricated by Robocasting from Powders Made by Sol-Gel and Melt-Quenching Methods” [51]. Bioactive glass scaffold is used in bone and tissue biomedical implants and their fabrication using additive manufacturing/3D printing techniques such as robocasting is of great interest. Most bioactive glasses are based on silica forming a glass network, with calcium and phosphorus content for new bone growth, and a glass modifier such as sodium. In relation to 4555 Bioglass, robocasting was used for the first time in 2013, and in 2019, sol-gel with high silica content (HSSGG) was used in 2019.

The chapter titled “Injectable Chitosan Scaffolds with Calcium β -Glycerophosphate as the Only Neutralizing Agent” [52] was developed by the team of Piotr Owczarz, Anna Rył, Marek Dziubinski, and Jan Sielski from Poland. A method of preparing thermosensitive hydrogel chitosan is described, using calcium β -glycerophosphate as the only pH neutralizing agent and supporting the cross-linking process. The presence of calcium ions instead of sodium ions is especially important for scaffolds in bone engineering. It is possible to enrich the obtained cell grids with calcium ions with the addition of calcium carbonate with a physiological ratio of calcium to phosphorus (1.6–1.8): 1.

“Green and Facile Synthesis of Dendritic and Branched Gold Nanoparticles by Gelatin and Investigation of Their Biocompatibility on Fibroblast Cells” [53] is another chapter prepared by a team from Vietnam consisting of Quoc Khuong Vo, My Nuong Nguyen Thi, Phuong Phong Nguyen Thi, and Duy Trinh Nguyen. Gold nanostar (AuNPs) and gold nano dendrites were synthesized by a one-pot and environmentally friendly method in the presence of gelatin. Subsequently, the influence of gelatin concentrations and reaction conditions on branched (AuNP) growth was investigated. Interestingly, the conversion of morphology between the dendritic and branched nanostructures can be achieved by changing the pH value of the gelatin solution. The role of gelatin as a protective agent through electrostatic and steric interaction is also disclosed. On the basis of the performed characteristics, it is possible to propose a growth mechanism explaining the evolution of the branched morphology of AuNP. Moreover, branched AuNPs are highly reliable at a concentration of 100 $\mu\text{g/mL}$ when performed in the SRB test with human foreskin fibroblast cells.

Another team from Poland, consisting of Jagoda Kurowiak, Agnieszka Kaczmarek-Pawelska, Agnieszka G. Mackiewicz, and Romuald Bedzinski prepared the chapter titled “Analysis of the Degradation Process of Alginate-Based Hydrogels in Artificial Urine for Use as a Bioresorbable Material in the Treatment of Urethral Injuries” [54]. Natural polymer hydrogels such as sodium alginate have great potential in regenerative medicine due to their biocompatibility, biodegradability, mechanical properties, bio-resorbability, and relatively low cost. Sodium alginate, a polysaccharide derived from brown algae, is the most widely researched and used biomaterial in biomedical applications. Alginate dressings are also useful as a delivery platform to provide a controlled release of therapeutic substances (e.g., analgesics, antibacterials, and anti-inflammatory agents). The process of alginate hydrogel degradation was analyzed. Hydrogels were prepared by the dip-coating method. An original hybrid cross-linking process using not one, but a mixture of two cross-linkers (calcium chloride and barium chloride) was also described. Various cross-linking agents allow the production of hydrogels with a spectrum of mechanical properties similar to that of the urethral tissue. The obtained hydrogels have a different degree of degradation

in artificial urine and can be used as a material for healing urethral injuries, especially urethral strictures, which have a significant impact on the quality of life of patients.

An international team from China and Canada consisting of Jiang Xu, Yuyan Chen, Xizhi Jiang, Zhongzheng Gui, and Lei Zhang presented a chapter titled “Development of Hydrophilic Drug Encapsulation and Controlled Release Using a Modified Nanoprecipitation Method” [55]. A novel drip nanoprecipitation method was developed that separates hydrophilic drugs and polymers into an aqueous phase (continuous phase) and an organic phase (dispersed phase), both individually and in a mixing process. This method successfully produced NPs loaded with ciprofloxacin-loaded NPs by Poly (d, l-lactic acid)-Dextran (PLA-DEX) and Polylactic acid-co-glycolic acid-Polyethylene glycol (PLGA-PEG) ensuring the ability to charge to 27.2 wt.% and sustained release in vitro for up to six days. The drug content in NP can be precisely adjusted by changing the initial concentration of ciprofloxacin. This modified nanoprecipitation method is a rapid, easy and reproducible technique to produce nanoscale drug delivery vehicles with high drug delivery capacity.

Twentieth in this book, so last but not least, but certainly compiled by the most numerous 11-person team from Vietnam: Ngoc-Tram Nguyen-Thi, Linh Phuong Pham Tran, Ngoc Thuy Trang Le, Minh-Tri Cao, The -Nam Tran, Ngoc Tung Nguyen, Cong Hao Nguyen, Dai-Hai Nguyen, Van Thai Than, Quang Tri Le, and Nguyen Quang Trung, is the chapter is entitled “The Engineering of Porous Silica and Hollow Silica Nanoparticles to Enhance Drug-loading Capacity” [56]. The hollow mesoporous silica nanoparticles (HMSN) are used to increase drug loading capacity. Porous nanosilica (PNS) and HMSN were prepared by sol-gel and matrix-assisted methods and then used for rhodamine (RhB) loading. Based on the results of the conducted research, it is suggested that the prepared HMSN nanocarriers can act as high-capacity carriers in drug delivery applications.

It is with personal satisfaction that we present this book to P.T (Pleno Titulo). Readers. We are deeply convinced that it will contribute to the popularization and the level of knowledge about biomaterials, which more and more often occupy an important place in modern medicine. As the Hippocratic Oath dictates, despite the fact that its text has been appropriately modified today, it is not enough to simply not harm the patient—that would be far too little. Maximum effort and knowledge should be made to actively help patients to ensure their long health and well-being, both mentally and physically. As we wrote at the beginning of this Editorial, engineers and their highly specialized knowledge of the possibility of using various biomaterials and the advanced technologies appropriate for them have a huge role to play in these activities. Just because in this area, as in many other areas of contemporary design and production of numerous products, the assumptions and achievements of the Industry 4.0 stage are increasingly used, more and more patients in the world after a serious illness or accident can live peacefully and healthily for subsequent and often many years, because doctors applied the required medical devices, most often implanted into the body, entirely conceived and manufactured by engineers, and precisely with the use of biomaterials.

The book will surely find an audience among practitioners, doctors, and engineers who can use the described experiences in their own daily clinical and technological practice, among scientists from both fields, inspiring them to their own research and scientific research, and as a valuable source of knowledge among Ph.D. students and students, both in medical and dental studies, as well as in engineering.

Both the authors and we, as editors, put a lot of effort and effort to make it materialize. We would like to thank all the authors for their cooperation, and special thanks to Ms. Tami Hu who supported us in terms of organization on behalf of the MDPI Branch in Beijing, China, without the inspiration and help of who this book could never have been written.

It, therefore, remains to wish PT Readers a pleasant and fruitful reading.

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