

AN INTRODUCTION TO

BIOCERAMICS

Second Edition

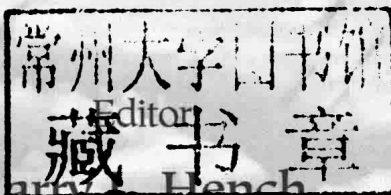
Editor

Larry L. Hench

Imperial College Press

AN INTRODUCTION TO --- **BIOCERAMICS**

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University of Florida, USA

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ICP

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DEDICATIONS

Dedicated to Gerry Merwin (1947–1992) and Bill Hall (1922–1992), clinicians and scientists who pioneered use of new biomaterials.

A special dedication of this second edition is to Dr. June Wilson Hench, co-editor of the first edition, who made so many important discoveries in the field of bioactive glasses and pioneered the technological transformation from the laboratory to FDA-approved clinical products. Her lifetime of contributions to the field of Bioceramics, her mentorship of many students and her creativity is a legacy that will be never forgotten. June is greatly missed!

This volume is also dedicated to the memory and pioneering contributions of Professor Raquel LeGeros, co-author of Chapter 17, who passed away during the final stages of publication of the book. She will be remembered always for her warm and gentle leadership in the field of calcium phosphate bioceramics.

Cover Acknowledgement

Colour enhanced scanning electron micrograph (SEM) of bone regeneration (green and yellow areas) around S53P4 bioactive glass particle (grey areas). Photo courtesy of Dr. Heimo Ylanen, Abo Akademi University, Turku, Finland.

PREFACE

Since the 1970s, when it was first realized that the special properties of ceramic materials could be exploited to provide better materials for certain implant applications, the field has expanded enormously. Initial applications depended on the fact that smooth ceramic surfaces elicited very little tissue reaction and provided wear characteristics suitable for bearing surfaces. Resultant orthopedic use has enjoyed forty years' clinical success, notably in Europe.

Today, as well as the so-called inert "bioceramics", materials have been developed that have properties which allow their use where bonding to soft or hard tissues is needed, where controlled degradation is required, where loads are to be borne, where tissue is to be augmented, or where the special properties of ceramics can be allied with those of polymers or metals to provide implant materials with advantages over each.

In all of these applications, and many others described in this text, the tissue reactions to, and properties of, these bioceramics have been increasingly carefully studied so that they can be controlled and, more importantly, predicted. This is the information which must be understood before they are applied clinically.

Assessment of the growth of the field of bioactive ceramics in the first edition in 1993 showed that the number of presentations on that subject at the first World Biomaterials Congress in 1980 formed 6% of the program. By the time of the fourth such congress in 1992, that figure was 23% of the whole. In 1980 presentations came from 12 centers in 5 countries, in 1992 from 88 centers in 21 countries. Research is international and continues to expand worldwide, as indicated by the breadth of contribution in this second edition.

The breadth of bioceramics also continues to expand, as illustrated by the addition of 21 additional chapters in this second edition. Much of the expanded growth of subject matter is in the field of bioactive materials. Bioactive materials can be divided into two major areas: one contains bioactive glasses and glass-ceramics, which develop biological hydroxyapatite at their surfaces after implantation; and the other, contains calcium phosphate-based ceramics, which are usually developed from chemical precursors.

Materials from both groups have been used as powders and sometimes as solids in applications where mechanical requirements are low, and as composites and coatings where mechanical requirements are high. Some have been designed specifically for high strength applications. As the behavior of bioceramics in both short- and long-term applications has become increasingly predictable and reliable, their clinical application has increased, as indicated by the large number of clinical applications chapters presented in the second edition.

The growth of bioceramics as a field and as a vital component of the healthcare industry parallels the increasing need for affordable and improved healthcare for an increasingly large and aging population. The chapters presented in the second edition provide the latest understanding of this important field and provide the basis for creating the next generation of biomaterials.

Please note the following regarding the contents of this second edition. Several chapters of the first edition have been included without alteration. This is based upon my judgment as Editor that these are “classic” reviews of the field and merit inclusion “as is”. Some other chapters, of equal importance, however, have been up-dated to include clinical results during the last twenty years in order to represent the growing clinical significance of the field of bioceramics. A few chapters have been greatly reduced in size because the content has not become clinically important. Because of their historical significance a short, edited version of the chapters has been included with key references. This decision has made it possible to keep within reasonable page limits for the second edition and still include a comprehensive up-dating of the field. I greatly appreciate these important new contributions from leaders of the field. I also hope that the authors of the chapters reduced in size will understand the rationale of my decision. Bioceramics has become one of the most important fields of the healthcare industry and I am pleased that this second edition represents this growing importance.

Larry L. Hench
Ft. Myers, FL
October 11, 2012

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* Denotes affiliation from the first edition.

** Denotes current affiliation/affiliation of new authors to the second edition.

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