A Nano Approach

Edited by Paul King

Biomaterials: A Nano Approach

You are an upward-striving (of course) biomedical engineer, and you pass by a line of books. One title in particular catches your eyes: Biomaterials: A Nano Approach. The nanoapproach—that’s something you should know more about. Nano is in the forefront of engineering and physics research and development. So you charge US$100 to your credit card and buy the book.

Upon opening the book, you may be disappointed, because only two chapters out of ten (Chapters 5 and 10) are devoted to nanobiomaterials. Some of the other chapters have sections that discuss nanobiomaterials. But herein lies the strength of the book: It thoroughly reviews all biomaterials. The nano in the title is a marketing maneuver.

The four authors of this CRC Press volume are S. Ramakrishna (National University of Singapore), M. Ramalingam (WPI Advanced Institute for Materials Research, Tohoku University, Japan), T.S.S. Kumar (Indian Institute of Technology, Madras, India), and W.O. Soboyejo (Princeton University, Princeton, NJ). There is a foreword by S.M. Best (University of Cambridge, United Kingdom).

What is a biomaterial? “Any synthetic material that is biocompatible with the tissues and the body upon implantation. It can be a metal, ceramic, polymer, and a composite of each” (p. 29).

What is a nanodimension? Between $10^{-9}$ and $10^{-7}$ m, or 1–100 nm, or 10 to 1,000 Å. The size doesn’t go below 1 nm because that gets into the dimensions of molecules. (A water molecule has a diameter of 3 Å = 0.3 nm = $3 \times 10^{-10}$ m.)

Each of the ten chapters stands alone, with almost no reference to any other chapter. Each chapter has an introduction followed by text, a summary, glossary, exercises (without answers), a good set of references and, in Chapters 2–5, further reading references. There are a few equations, but the text overwhelmingly consists of the characteristics of a large number of biomaterials (and human anatomy is not neglected). The characteristics are illuminated by 46 tables and 125 figures. One of the tables, “List of a Few Electrospun Polymers,” with 44 polymers, is spread for more than six pages.

The book is in black and white. The text is somewhat repetitious, which is certainly an advantage because, instead of referring the reader to chapter and page so-and-so, the material is simply repeated.

Here are the chapters, with a brief description of each:

- Chapter 1: Overview of Biomaterials. Some history; metallic, ceramic, polymeric, and composite biomaterials; surface modification; sol–gel and biomimetic processing of nanobiomaterials.
- Chapter 2: Basics of Human Biology. Structure and function of the human body; chemical, cellular, tissue, organ, and system level.
- Chapter 3: Degradation and Corrosion of Biomaterials. Surface properties; galvanic, crevice, pitting, intergranular, stress, and fretting corrosion; in vitro and in vivo test methods; case studies.
- Chapter 4: Failure and Tribology of Biomaterials. Elastic and plastic deformation; brittle and ductile fracture; brittle to ductile transition; friction and wear tribology; case studies.
- Chapter 6: Metallic Biomaterials. Stainless steels; cobalt–chromium, titanium and titanium-based, shape memory, and dental amalgam alloys; noble and other metals; nanostructured metallic implants; case studies.
- Chapter 7: Ceramic Biomaterials. Nearly inert, porous, and bioactive bioceramics; bioresorbable bioceermics; synthesis and characterization of nanoalumina and nanocalcium phosphate ceramics; case studies.
- Chapter 8: Polymeric Biomaterials. Addition and condensation polymerization; molecular weight, molecular structures, intermolecular forces, and polymer crystallinity; polymers as biomaterials; collagen, gelatin, and chitosan; methyl methacrylate, ethylene, and ethylene terephthalate; lactic, glycolic, and lactic-co-glycolic acid; processing of polymer nanofibers; electrospun polymer nanofibrous scaffolds; biomedical applications of polymer nanofibers.
Chapter 9: Composite Biomaterials. Fibrous and particulate biomaterials; bone fracture repair, joint replacements, bone graft materials, and dental applications; conventional, biomimetic, and tissue-engineered nanocomposites.

Chapter 10: Nanobiomaterials for Tissue Regeneration. Concept of tissue engineering; mesenchymal stem cells; ceramic and polymeric nanobiomaterials; tissue-engineered ceramic and polymeric nanobiomaterials; chemical and typographical patterning; artificial skin and cartilage; case studies.

The exercises are essay types, such as “What are the preliminary characterizations to be carried out for the study of in vitro and in vivo biological responses to biomaterials?” (p. 54). I would hate to have to grade this type of question on an exam (especially since I don’t know the answer).

There is a 16-page index. The volume covers a large number of biomaterials. They can be referred to by name or, for sophisticated readers, by chemical formula. In either event, we are likely to get a long tongue twister. An equivalent acronym is a natural addition. Alas, the large index falls short where acronyms are concerned. Very often, the name is listed without the acronym; very often, the biomaterial is omitted altogether.

There are mostly minor typographical errors; but commas in general, to clarify sentence structure, are in short supply.

This book, painstakingly assembled, omits very little. It should become a standard reference text in every biomedical engineer’s library.

Sid Deutsch

A LOOK AT (continued from page 48)

abstract of their lectures) and the participants and 2) a CD-ROM gathering all the materials related to the lectures, including original introductions by each lecturer and selected papers.

The organization of this ninth edition of the Summer School would not have been possible without the help of numerous persons and sponsors. The lecturers have been heavily involved in the preparation of the proceedings and their presentations and very keen on spending time and energy during the various informal and interactive periods. The students who, as always, have created a unique atmosphere of motivation and fun. Several contributions were instrumental in the organization of this edition of the Summer School, in particular, those of Katell Morin-Hernandez (Rennes) and Gwenaël Brunet (Brest).

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The ninth International School was an excellent opportunity not only to bring imaging fundamentals but also to provide some insights on the emerging technologies, their new targets, and needs. It is thought that most has still to be achieved when dealing with biomedical imaging and that engineering should contribute to the expected breakthroughs. The ways to follow are so many that anybody, as far as a well-posed question is set (either based on biological or clinical concerns), can find her or his path.

After all, in its highest meaning, life is learning, creating, and innovating, and the EMBS Summer School on Biomedical Imaging has been designed to only serve such objective. The school relies on volunteering contributions and, thanks to the lecturers for this 2010 edition and many others in the past, it will continue. Christian Roux and his team will make it alive for 2012 (22–30 June). Any information can be obtained by contacting Valérie Burdin (valerie.burdin@telecom-bretagne.eu). The Web site is http://ieeess.enst-bretagne.fr.