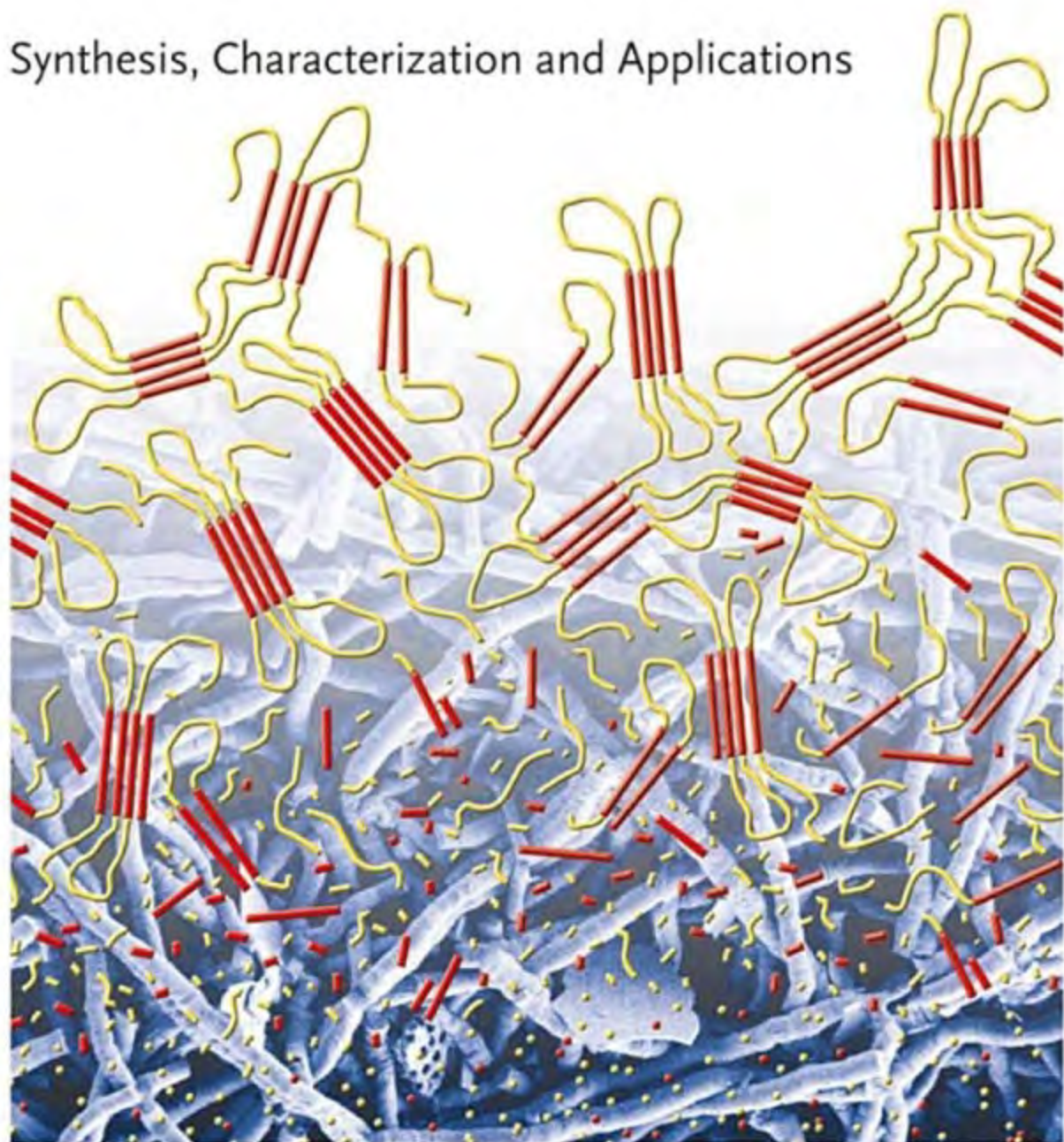


Edited by
Andreas Lendlein and Adam Sisson

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Handbook of Biodegradable Polymers

Synthesis, Characterization and Applications



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Adam Sisson

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Preface

Degradable polyesters with valuable material properties were pioneered by Carothers at DuPont by utilizing ring-opening polymerization approaches for achieving high molecular weight aliphatic poly(lactic acid)s in the 1930s. As a result of various oil crises, biotechnologically produced poly(hydroxy alkanoates) were keenly investigated as greener, non-fossil fuel based alternatives to petrochemical based commodity plastics from the 1960s onwards. Shortly afterwards, the first copolyesters were utilized as slowly drug releasing matrices and surgical sutures in the medical field. In the latter half of the 20th century, biodegradable polymers developed into a core field involving different scientific disciplines such that these materials are now an integral part of our everyday lives. This field still remains a hotbed of innovation today. There is a burning interest in the use of biodegradable materials in clinical settings. Perusal of the literature will quickly reveal that such materials are the backbone of modern, biomaterial-based approaches in regenerative medicine. Equally, this technology is central to current drug delivery research through biodegradable nanocarriers, microparticles, and erodible implants, which enable sophisticated controlled drug release and targeting. Due to the long historic legacy of polymer research, this field has been able to develop to a point where material compositions and properties can be refined to meet desired, complex requirements. This enables the creation of a highly versatile set of materials as a key component of new technologies. This collected series of texts, written by experts, has been put together to showcase the state of the art in this ever-evolving area of science.

The chapters have been divided into three groups with different themes. Chapters 1–8 introduce specific materials and cover the major classes of polymers that are currently explored or utilized. Chapters 9–14 describe applications of biodegradable polymers, emphasizing the exciting potential of these materials. In the final chapters, 15–16, characterization methods and modelling techniques of biodegradation processes are depicted.

Materials: Lendlein *et al.*, then Ienczak and Aragão, start with up-to-date reviews of the seminal polyesters and biotechnologically produced polyesters, respectively. Other chapters concern polymers with different scission moieties and behaviors. Domb *et al.* provide a comprehensive review of polyanhydrides, which is followed by an excellent overview of poly(ortho esters) contributed by Heller. Amino

acid- based materials and degradable polyurethanes make up the subject of the next two chapters by Katsarava and Gomurashvili, then Puiggali *et al.*, respectively. Synthetic polysaccharides, which are related to many naturally occurring biopolymers, are then described at length by Dumitriu, Dräger *et al.* To conclude the individual polymer-class section, biodegradable polyolefins, which are degraded oxidatively, and are intended as degradable commodity plastics, are covered by Wiles *et al.*

Applications: The two chapters by Ikada and Shakesheff give a critical update on the status of biodegradable materials applied in regenerative therapy and then in drug delivery systems. From there, further exciting applications are described; shape-memory polymers and their potential as implant materials in minimally invasive surgery are discussed by Lendlein *et al.*; Huh *et al.* highlight the importance of biodegradable hydrogels for tissue expander applications; Franke *et al.* cover how implants can be used to aid regenerative treatment of mucosal defects in surgery; Khandare and Kumar review the relevance of biodegradable dendrimers and dendritic polymers to the medical field.

Methods: Van der Zee gives a description of the methods used to quantify biodegradability and the implications of biodegradability as a whole; Watanabe and Kawai go on to explain methods used to explore degradation through modelling and simulations.

The aim of this handbook is to provide a reference guide for anyone practising in the exploration or use of biodegradable materials. At the same time, each chapter can be regarded as a stand alone work, which should be of great benefit to readers interested in each specific field. Synthetic considerations, physical properties, and erosion behaviours for each of the major classes of materials are discussed. Likewise, the most up to date innovations and applications are covered in depth. It is possible upon delving into the provided information to really gain a comprehensive understanding of the importance and development of this field into what it is today and what it can become in the future.

We wish to thank all of the participating authors for their excellent contributions towards such a comprehensive work. We would particularly like to pay tribute to two very special authors who sadly passed away during the production time of this handbook. Jorge Heller was a giant in the biomaterials field and pioneered the field of poly(ortho esters). Severian Dimitriu is well known for his series of books on biodegradable materials, which served to inspire and educate countless scientists in this area. Our sincerest thanks go to Gloria Heller and Daniela Dumitriu for their cooperation in completing these chapters. We also acknowledge the untiring administrative support of Karolin Schmäzlin, Sabine Benner and Michael Schroeter, and the expert cooperation from the publishers at Wiley, especially Elke Maase and Heike Nöthe.

Teltow, September 2010

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