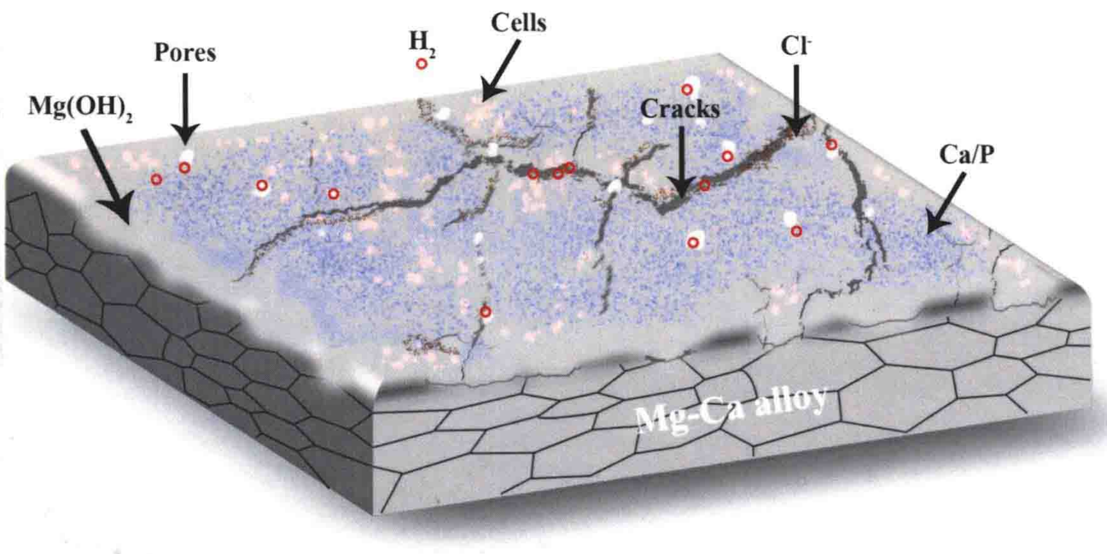
Magnesium Alloys as Degradable Biomaterials



Yufeng Zheng

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Preface

Biodegradable metals (BMs) are metals expected to corrode gradually in vivo, with an appropriate host response elicited by released corrosion products, then dissolve completely upon fulfilling the mission to assist with tissue healing with no implant residues (Zheng 2013). As the main force of the BM family, Mg and its alloys have been widely studied as potential biomaterials and have attracted the attention of biomaterial scientists and medical device societies. Up to the present, a full chain from material selection and properties optimization of Mg alloys, processing into semiproducts and surface treatment, device design, and manufacturing of the final devices to animal testing and clinical trials of the final Mg alloy implants have been conducted. Various medical device prototypes have been designed, including cardiovascular stents, bone staples, ACL screws, nonvascular stents, and clips, and some of them have been clinically trialed in Europe, China, and South Korea. One kind of Mg alloy device is now available on the European market as an implant for commercial sales. Every year since 2009, an international symposium on biodegradable metals for biomedical applications (http://www.biodegradablemetals.org/) has been held, and, moreover, scientific journals and patent databases have recorded a high increase in publications in this area.

The research on biodegradable Mg alloys designed as degradable metallic biomaterials has been mature, and this book aims to provide a comprehensive description of magnesium and its alloys designed as biodegradable metallic implant materials. The basic concepts of biodegradation mechanisms of Mg and its alloys, the strategy to control their biodegradation mode and rate, microstructure, mechanical property, corrosion resistance to body fluids, and in vitro and in vivo biocompatibility are introduced. Then various types of new biomedical Mg alloy systems will be enumerated with their special properties illustrated. Finally, the medical devices of biomedical Mg alloys will be designed and analyzed with numerical calculation and animal trials. The book provides a wealth of updated research information for graduate students, teachers, and research workers in the fields of materials science, biomedical engineering, and clinical medicine and dentistry and also for professionals involved in implantable medical device design and manufacturing.

I would like to thank colleagues working in the field of biodegradable metals all over the world and especially the majority of the attendants at the international symposiums on biodegradable metals from 2009 to the present. As a co-chair with Prof. Diego Mantovani, Prof. Frank Witte, and Prof. Mark Staiger, I get together with 120–150 scholars during the last week of August every year, sharing the research progress on biomedical Mg alloys with topics on new material fabrication, biodegradation, in vitro and in vivo testing, device design, and clinical trials, with a panel discussion on proposing international standardization on the materials and device evaluations. I get a lot of inspiration through listening and discussing with scholars from all over the world during the conferences.

Special thanks must given to my students at the Laboratory of Biomedical Materials and Devices, Department of Materials Science and Engineering, College of Engineering, Peking University (http://lbmd.coe.pku.edu.cn/) for helping me on the manuscript preparation, typing, and copyright licensing transaction. They are Yang Liu (Chapters 1, 4, and 9), Nan Li (Chapters 2, 12, and 14), Dong Bian (Chapters 5, 10, and 11), Yuanhao Wu (Chapters 6, 7, and 8), Zhen Zhen (Chapter 3), Xiaochen Zhou (Chapter 13), Meng Zhou (Chapter 2), and Weirui Zhou (Chapters 5 and 10). I am very grateful to the funding bodies including the National Basic Research Program of China (973 Program; Grant No. 2012CB619102), the National Science Fund for Distinguished Young Scholars (Grant No. 51225101), the National Natural Science Foundation of China (Grant No. 51431002 and 31170909), the NSFC/RGC Joint Research Scheme under Grant No. 51361165101, the Beijing Municipal Science and Technology Project (Z131100005213002), and the State Key Laboratory for Mechanical Behavior of Materials (Grant No. 20141615).

Author

Dr. Yufeng Zheng earned his PhD in materials science from the Harbin Institute of Technology, China, in 1998. From 1998 to 2004, he was assistant professor (1998–2000), associate professor (2000–2003), and full professor (2003–2004) at the Harbin Institute of Technology, China, and since 2004, he has been a full professor at Peking University in Beijing, China.

Dr. Zheng has authored or co-authored more than 300 scientific peer-reviewed articles, has been cited more than 5800 times, and has an H-index of 37. He served as a member of the editorial board of the *Journal of Biomedical Materials Research-Part B: Applied Biomaterials* (Wiley), *Journal of Biomaterials and Tissue Engineering* (American Scientific Publishers), *Materials Letters* (Elsevier), *Intermetallics* (Elsevier), *Journal of Materials Science & Technology* (Elsevier), *Frontiers of Materials Science* (Springer), *Acta Metallurgica Sinica (English Letters)* (Springer), and *Journal of Orthopaedic Translation* (Elsevier). His areas of special interest include the development of various new biomedical metallic materials (beta-Ti alloys with low elastic modulus, biodegradable Mg alloys and Fe alloys, bulk metallic glass, bulk nanocrystalline materials, etc.). Dr. Zheng has received several awards, including New Century Excellent Talents in University awarded by the Ministry of Education of China (2007) and Distinguished Young Scholars awarded by the Natural Science Foundation of China (2012).

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