

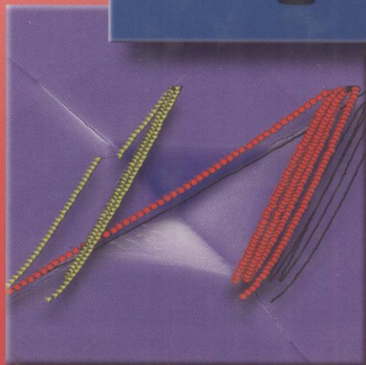
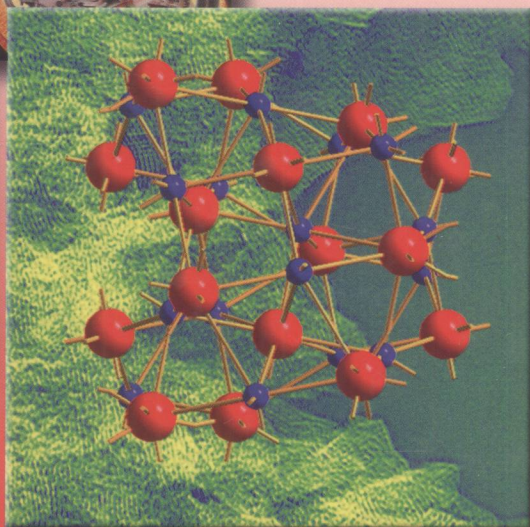
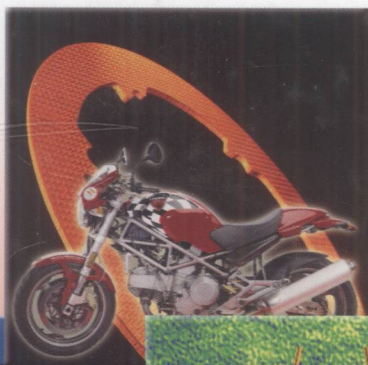
Edited by Ralf Riedel and I-Wei Chen

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Ceramics Science and Technology

Volume 1

Structures



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Ceramics Science and Technology

Volume 1: Structures

Edited by
Ralf Riedel and I-Wei Chen



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**Ceramics Science
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Ralf Riedel and I-Wei Chen*

Further Reading

W. Krenkel (Ed.)

Ceramic Matrix Composites

Fiber Reinforced Ceramics and their Applications

2008

ISBN: 978-3-527-31361-3

M. Scheffler, P. Colombo (Eds.)

Cellular Ceramics

Structure, Manufacturing, Properties and Applications

2005

ISBN: 978-3-527-31320-4

Preface

Besides metals and polymers, advanced ceramics are one of the most promising classes of materials for the key technologies of the 21st century. Recent developments in the field of ceramics include a selection of synthesis, processing and sintering techniques applied for the production of novel structural and functional ceramics and ceramic composites. Significant progress has been made in the past two decades with respect to the production of novel multifunctional ceramics with a tailor made micro- and/or nanoscale structure reflecting the increasing technological importance of advanced ceramic materials.

The 4-volume series of *Ceramics Science & Technology* covers various aspects of modern trends in advanced ceramics reflecting the status quo of the latest achievements in ceramics science and development. The contributions highlight the increasing technological significance of advanced ceramic materials and present concepts for their production and application. Volume 1 deals with structural properties of ceramics by considering a broad spectrum of length scale, starting from the atomic level by discussing amorphous and crystalline solid state structural features, and continuing with the microstructural level by commenting on microstructural design, mesoscopic and nano structures, glass ceramics, cellular structures, thin films and multiphase (composite) structures. Volume 2 will focus on (i) the distinct ceramic materials classes, namely oxides, carbides and nitrides and (ii) physical and mechanical properties of advanced ceramics. The series will be continued by Volume 3 with chapters related to modern synthesis and processing techniques used for the production of engineering ceramics and will be completed by Volume 4 which will be devoted to application.

Quo vadis ceramics? The 4-volume series also intends to provide comprehensive information relevant to the future direction of advanced or engineering ceramics. The present book series evidences technologically important trends related to the further development of this fascinating class of materials. Latest examples of technological achievements already commercialized include piezoelectric ceramics based on PZT ($\text{Pb}(\text{Zr},\text{Ti})\text{O}_3$) used e.g. for common rail diesel engines, Si_3N_4 -based ball bearings and glow plugs for diesel engines, carbon fiber reinforced silicon carbide (C/SiC) brake, luminescent ceramics based on sialon derivatives for LED applications, GaN-based ceramics for optoelectronics, and many others.

Furthermore, a variety of application fields are emerging in which novel ceramics are required and are expected to be established and commercialized in the near future. This technologically driven process requires a long-term alignment and a strong basis in continued fundamental research in ceramics science and technology. The 4-volume series would like to contribute to this development by providing the latest knowledge in ceramics science suitable for students specializing in ceramics as well as for university and industrial research.

We wish to thank all contributing authors for their great enthusiasm in compiling excellent manuscripts in their respective area of expertise. We also acknowledge the support of Karen Böhling who proofread each manuscript with due accuracy and patience. Last not least we thank the Wiley-VCH editors, Martin Ottmar and Rainer Münz, for their continuous encouragement to work on the book project.

Darmstadt and Philadelphia
December 2007

Ralf Riedel
I-Wei Chen

Dedication

Volume 1 of the Ceramic Science & Technology series is dedicated to Prof. Sir Richard Brook

It gives me great pleasure to dedicate *Ceramics Science and Technology Vol I* to Prof. Sir Richard Brook on the occasion of his 70th birthday.



Prof. Sir Richard Brook (source: Leverhulme Trust)

With respect to his remarkable lifework, this handbook covers many aspects of modern trends in advanced ceramics, a research interest passionately pursued by Prof. Brook.

Born in Leeds/UK on 12th March 1938, he has enjoyed a profound education in materials science and a long and distinguished research career in the field of engineering ceramics. After graduating in Ceramics at Leeds University in 1962, he continued his studies at the Massachusetts Institute of Technology in Boston, where he completed a thesis on “Nickel-ferrite thin films” and was conferred a ScD degree in 1966. Afterwards, as an Assistant Professor of Materials Science at the University of Southern California, he conducted research activities focusing on defect chemistry of oxides, the electrical properties of insulators and the kinetics of microstructure development in ceramics. In 1970 he returned to the UK to embark on more in-depth studies into the general processing of ceramics at the Atomic Energy Authority in Harwell. In his capacity as Head of the Department of Ceramics at Leeds University from 1974 he emerged as a leading figure in technological advances related to the fabrication of oxide and non-oxide ceramics. In recognition of his dedicated services to science, he received the award of Officer of the Order of the British Empire in 1988. In the same year he moved to Stuttgart after accepting an offer to become a Director of the Max-Planck-Institute for Metals Research, where he was conferred an Honorary Professorship at the University of Stuttgart. During the time he spent at the Max-Planck-Institute he gained further inspiration from distinguished scientists from all over the world. In 1991 he then went back to the UK initially joining Oxford University as Cookson Chair of Materials Science and subsequently taking on the role of Chief Executive of the Engineering and Physical Sciences Research Council. In 2001 he took up the Directorship of the Leverhulme Trust with the role of making awards for the support of research and education. His career then culminated in his receiving a knighthood in the same year for services to Science and Engineering. Particularly noteworthy is the great importance he attaches to the fact that his work in ceramics has its roots in the ancient tradition of pottery. This awareness has had an enduring influence on his ambition to systematically understand the sintering mechanisms as well as microstructure property relation associated with the processing of ceramics as a fundamental basis to develop novel structural and functional ceramics for both domestic and high-tech applications. In addition to his position at Leverhulme Trust he has enthusiastically worked as the main Editor for the *Journal of the European Ceramic Society* for many years. Under his editorship, the Journal emerged as one of the most important scientific ceramic journals.

I am glad that I had the chance to work with Prof. Sir Richard Brook and to share thoughts and scientific discussions with him during his time at the Powder Metallurgical Laboratory (PML) of the Max-Planck-Institute for Metals Research. In particular, our joint organization of the scientific workshop entitled “Powder-Free-Processing of Ceramics” held in 1990 at Schloß Ringberg in Germany was a fundamental step in the further development of the polymer-derived ceramics field I have been involved in.

On behalf of the co-editor, Prof. I-Wei Chen, I extend my best wishes and warmest greetings to Prof. Sir Richard Brook on his 70th birthday. As a prolific teacher and researcher, author of countless scientific papers, recipient of numerous prestigious awards and member of internationally acclaimed research societies and editorial boards, Prof. Sir Richard Brook has won great admiration from the materials science community while playing an influential and truly innovative role in technological advances in ceramics science and technology.

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