

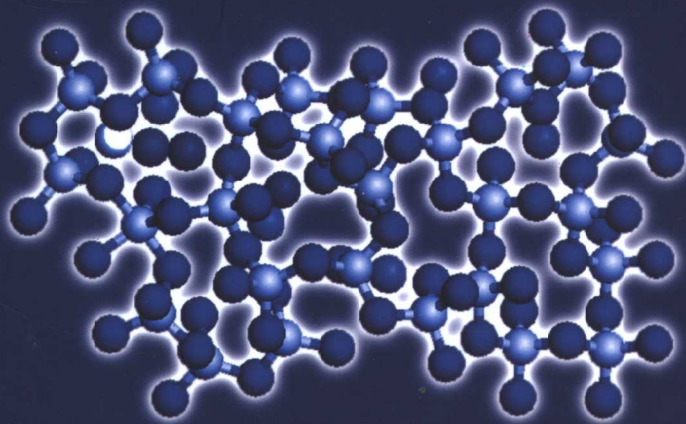


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New Functional Glass Materials
新型功能玻璃材料

卢安贤 (著)



中南大学出版社
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前 言

人们对传统玻璃的形成规律和结构进行了较为广泛的研究，获得了丰富的玻璃形成和结构方面的科学知识，这些理论以查哈里阿森的无规则网络学说为基础，对于指导传统玻璃的开发、认识传统玻璃组成—结构—性能三者之间的关系是合适的。然而，有许多玻璃的组成与传统玻璃是完全不同的，有的不含玻璃网络形成体或仅含极少量玻璃网络形成体，在这种情况下套用无规则网络学说是并不恰当的，重金属氧化物玻璃就是一个典型例子。因此，重金属氧化物玻璃形成规律和结构方面的研究成果，是传统玻璃形成规律和结构理论的重要补充，对于新型玻璃材料，特别是对功能玻璃材料（如非线性光学材料、闪烁材料、透红外光学材料、低光学损耗材料、金属玻璃等）的开发有着重要的指导意义。所谓功能玻璃是指通过改变基础玻璃的化学成分或采取适当的工艺和加工方法，将一定的物理性质、化学性质、生物性质等赋予玻璃体而获得的功能玻璃材料，如光功能玻璃、电功能玻璃、磁功能玻璃、机械功能玻璃、生物功能玻璃、化学功能玻璃、热功能玻璃等。这些功能材料正随着现代科学技术的发展和社会文明程度的提高，被愈来愈广泛地应用在工业、农业、国防、现代科技等方面，发挥着越来越重要的作用。

本书以作者承担的国家自然科学基金项目及多年来在玻璃科学研究与新材料开发方面所取得的科研成果为基础，系统、全面地总结了国内外在玻璃科学研究及功能玻璃材料开发方面的最新成果，介绍了各类功能玻璃材料的概念、功能效应、研究与开发现状、应用领域、存在的问题及其发展方向。全书共分成六章，包括：①传统玻璃概述（玻璃的概念及通性、玻璃的形成、玻璃的结构理论、玻璃结构的近程有序论、常见传统玻璃和微晶玻璃

等);② 重金属氧化物玻璃(重金属氧化物玻璃的特点及应用前景、重金属氧化物玻璃的形成区、重金属氧化物玻璃的形成规律与结构、形成非晶态物质的新方法、重金属氧化物玻璃的应用等);③ 光功能玻璃(玻璃的基本光学现象、光学纤维、激光玻璃、闪烁玻璃、非线性光学玻璃、梯度折射率玻璃、光致变色玻璃、反常色散玻璃、滤光玻璃等);④ 电磁功能玻璃(载流子运动与玻璃的电磁性能、等离子体显示屏玻璃、静电键合玻璃及微晶玻璃、电致变色玻璃、电真空玻璃、快离子导体玻璃、绝缘基板玻璃及微晶玻璃、法拉第旋转玻璃、电磁屏蔽玻璃和铁磁性微晶玻璃等);⑤ 热和机械功能玻璃(晶格振动与热学性能、吸热与热反射原理、吸热玻璃、热反射玻璃、低热膨胀和零膨胀系数微晶玻璃、高热膨胀系数微晶玻璃、玻璃的力学行为、氮氧玻璃、可机械加工微晶玻璃等);⑥ 生化和其他功能玻璃(生物材料概述、替换用生物玻璃、治疗用生物玻璃、玻璃的表面结构特征、载体用多孔玻璃、自洁净玻璃、金属玻璃和有机玻璃等)。

作者在编写本书的过程中得到了多方面的帮助,参考了大量文献,从中获益匪浅,并得到国家自然科学基金、国家自然科学基金出版专项基金、国防军工配套项目基金及湖南省科技攻关项目基金的资助。在此,谨向所有提供参考文献的作者和资助单位表示衷心的感谢。同时,也对在本书编写过程中提供过大量帮助的博士和硕士研究生们表示谢意,他们是陶辉锦、刘树江、张小富、常鹰、谭常优、贾明、林娜、肖卓豪、杨舟、向其军、周娟、周键、冯艳、柯尊斌、黄光锋、鲁飞、王宇等。

玻璃非晶态科学及玻璃新材料的发展很快,内容也很丰富,但限于时间和作者的水平,书中不妥之处在所难免,竭诚希望使用本书的同志批评指正。

作者

2005年1月28日

Preface

The forming regularity and the structure for traditional glasses have been widely investigated and explored, which results in the accumulation of abounding knowledge-related forming and structure of glasses. The random network structure theory originated by Zachariasen is the base of this knowledge and is also helpful to guide the development of traditional glasses and to understand the relationship among composition, structure and property of these glasses. However, compared with conventional glasses many new type of glasses do not contain glass network former or only contain a little network former oxide. In such a case, it is not suitable to use Zachariasen's theory for explaining the forming and structure of these glasses such as heavy metal oxide glass. For this reason, the results in heavy metal oxide glass research is an important supplement for the conventional glass forming regularity and structure theories and have important guiding effects for developing new type glass materials, especially for new functional glass materials such as non linear optical materials, scintillating glass, transmitting infrared light glass, low optical loss materials and metallic glass etc. So-called Function glass is a new type of material obtained by changing the composition of basic glass or by adopting suitable processing technology. Function glass includes optical, electronic, magnetic, mechanical, biological, chemical and thermal function glass etc. With progress of science and technology and raise of social civilization degree, these glasses are increasingly used and play a more and more important role in our industry, agriculture, national defense,

modern science and technology fields.

Based on the results in glass scientific research fields such as the National Natural Science Foundation project—forming and structure of heavy metal oxide glass, new materials projects for national defense and various other research projects, the new achievements and the present progress on the investigation for glass science and on the development for new kinds of glass materials are across-the-board summarized in this book. The concepts, functional effects, present status of investigation and development, application fields, problems and developing directions of various function glasses are introduced. This book is composed of 6 chapters and the main contents cover that: 1) summary of the traditional glass, including concept and general character of glass, forming of glass, structure theory of glass, short-range orderly theory, conventional glass materials, glass-ceramics etc; 2) heavy-metal oxide glass, including Concept, character and application perspective of heavy-metal oxide glass, forming and structure of heavy-metal oxide glass, new means to form amorphous materials etc. ; 3) optical function glass, including basic optical phenomenon appearing in glass, optical fiber, laser glass, scintillating glass, non linear optical glass, gradient refraction index glass, photochromic glass, abnormal dispersion glass and filtering light glass etc. ; 4) electronic and magnetic function glass, including movement of charging particles and electronic and magnetic property of glass, static bonding glass-ceramics, electrochromic glass, glass used in plasma display panel, electric vacuum glass, sealing glass suitable for magnetic reed switch, fast ion conducting glass, glass and glass-ceramics used as isolation substrate, Faraday rotation glass, electromagnetic shielding glass etc. ; 5) thermal and mechanical function glass, including lattice vibration and thermology properties, absorbing heat glass, reflecting heat glass, low

or high thermal expansion coefficient glass-ceramics, zero expansion coefficient glass-ceramics, oxynitride glass, machinable glass-ceramics etc. ; 6) biological, chemical and other function glass, including a brief introduction of biological glass materials, biological glass used as replacer, biological glass and glass-ceramics used in treatment, porous glass used as substrate, self-cleaning glass, metallic glass, organic glass etc.

During writing this book, the author gets much help, cites a lot of materials from the references and obtains the supports from the National Natural Science Foundation (No59672008), the Publish Foundation of National Natural Science Foundation (No50424218), the foundation of national defense and war industry projects and the foundation of research projects for attacking a key problem in science and technology of Hunan province. Herein, the author expresses heartfelt thanks to the authors of all references cited in this book and to all supporting divisions. Simultaneously, the author also thanks the postgraduates who provided much help. They are Tao Huijin, Liu Shujiang, Zhang Xiaofu, Chang Ying, Tan Changyou, Jia Ming, Lin Na, Xiao Zhuohao, Yang Zhou, Xiang Qijun, Zhou Juan, Zhou Jian, Feng Yan, Ke Zunbin, Huang Guangfeng, Lu Fei and Wang Yu etc.

The progress of glass non-crystal science and new glass materials is very fast and the contents are also plentiful. But due to limited time and limited knowledge horizon, it is possible and unavoidable for some mistakes and disadvantages existing in this book. The author wholeheartedly desires the users to put forward criticism and to point out these mistakes in this book so that they can be corrected.

The author

Jan. 28, 2005

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