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Fundamentals of Superconducting Nanoelectronics

Anatolie Sidorenko

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《纳米科学与技术》丛书序

在新兴前沿领域的快速发展过程中，及时整理、归纳、出版前沿科学的系统性专著，一直是发达国家在国家层面上推动科学与技术发展的重要手段，是一个国家保持科学技术的领先权和引领作用的重要策略之一。

科学技术的发展和应用，离不开知识的传播：我们从事科学研究，得到了"数据"（论文），这只是"信息"。将相关的大量信息进行整理、分析，使之形成体系并付诸实践，才变成"知识"。信息和知识如果不能交流，就没有用处，所以需要"传播"（出版），这样才能被更多的人"应用"，被更有效地应用，被更准确地应用，知识才能产生更大的社会效益，国家才能在越来越高的水平上发展。所以，数据→信息→知识→传播→应用→效益→发展，这是科学技术推动社会发展的基本流程。其中，知识的传播，无疑具有桥梁的作用。

整个 20 世纪，我国在及时地编辑、归纳、出版各个领域的科学技术前沿的系列专著方面，已经大大地落后于科技发达国家，其中的原因有许多，我认为更主要的是缘于科学文化的习惯不同：中国科学家不习惯去花时间整理和梳理自己所从事的研究领域的知识，将其变成具有系统性的知识结构。所以，很多学科领域的第一本原创性"教科书"，大都来自欧美国家。当然，真正优秀的著作不仅需要花费时间和精力，更重要的是要有自己的学术思想以及对这个学科领域充分把握和高度概括的学术能力。

纳米科技已经成为 21 世纪前沿科学技术的代表领域之一，其对经济和社会发展所产生的潜在影响，已经成为全球关注的焦点。国际纯粹与应用化学联合会（IUPAC）会刊在 2006 年 12 月评论："现在的发达国家如果不发展纳米科技，今后必将沦为第三世界发展中国家。"因此，世界各国，尤其是科技强国，都将发展纳米科技作为国家战略。

兴起于 20 世纪后期的纳米科技，给我国提供了与科技发达国家同步发展的良好机遇。目前，各国政府都在加大力度出版纳米科技领域的教材、专著以及科普读物。在我国，纳米科技领域尚没有一套能够系统、科学地展现纳米科学技术各个方面前沿进展的系统性专著。因此，国家纳米科学中心与科学出版社共同发起并组织出版《纳米科学与技术》，力求体现本领域出版读物的科学性、准确性和系统性，全面科学地阐述纳米科学技术前沿、基础和应用。本套丛书的出版以高质量、科学性、准确性、系统性、实用性为目标，将涵盖纳米科学技术的所有领域，全面介绍国内外纳米科学技术发展的前沿知识；并长期组织专家撰写、编辑出版下去，为我国

表面分子组装》，是对相关工作的归纳总结。

多年来，本人的研究组开展固体表面分子组装研究，不但发展表面组装方法，还一直试图找到分子结构-固体种类-组装结构间的关系，也不放过发现组装结构中重要现象的机会并阐明原因，意欲探索表面分子组装规律，利用分子组装实现表面功能化。书中在介绍固体表面的结构特点和 STM 技术等表面分子组装基础知识之后，顺序介绍了简单烷烃/烷烃衍生物分子的组装结构、复杂配合物分子的组装、主客体组装以及功能化组装等，随后介绍结构转化研究、手性结构研究、电化学环境下的组装和相变化，最后是可能的表面功能化，内容安排尽量承上启下、先易后难且逻辑相关。

借此机会，我要感谢我研究组的研究生们，他们倾心科学，随我多年耕耘于固体表面分子组装研究领域，努力工作，夜以继日，他们终学有所成，也留下了丰富的科研结果。陈婷、严会娟、殷雅侠、陈庆、张旭、崔博、管翠中、郑轻娜等还参与了书稿内容整理、文献核对等工作。感谢科学出版社杨震、张淑晓和刘冉诸位编辑的悉心指导，感谢国家出版基金对本书的出版资助。感谢国家自然科学基金委员会、科技部和中国科学院，多年来，我的研究工作一直得到他们的支持，本书中的研究内容大多是在他们的资助下获得的科研成果。

还要感谢我的妻子姜红，她不厌其烦地整理我写下的零散片段，帮助打字输入我的手写书稿，保存相关资料，愿本书的出版给她带去一份快乐！

分子组装研究历史已久，内容丰富，且时有挑战课题出现，也有轰动性和里程碑性成果问世。限于水平和时间，书中不妥之处在所难免，恳请各位前辈和同行不吝赐教。出版本书意在抛砖引玉，以诱导、鼓励更多的科技工作者，尤其是青年科技工作者加入该研究行列，发展新技术，探索规律，攻坚克难；同时，发现新问题和解决新问题，推动分子组装研究不断发展。

萬立駿

Preface

The idea to write this book appeared after a series of workshops devoted to superconductivity of low-dimensional objects, which we organized last decade. In 2004 director of Walther-Meißner-Institut Professor Rudolf Gross and I organized an NATO Advanced Research Workshop "Nanoscale Devices, Fundamentals and Applications" and published the book with the same title, collecting the best of reports, presented on that workshop. As we realized a bit later, the book was in demand by colleagues, who deal with applications of superconductivity. For example, the group of researchers is engaged in development and fabrication of a very sensitive superconducting sensor for infrared radiation, superconducting thin-film bolometer, would like to achieve the highest possible sensitivity. They develop different technological processes for improvement of the quality of the superconducting film, trying to obtain thin films with the narrowest width of superconducting transition. In case, when a member of such group has knowledge in superconducting fluctuations (which are rather noticeable for low-dimensional objects) that there exists a limitation of the smallest possible width of the superconducting transition, ΔT_c, given by the Ginsburg criteria, $\Delta T_c = Gi T_c$, then such group of researchers can save a lot of time and instead of many experimental attempts to improve the quality of the films, just select the most suitable material with the smallest value of the parameter Gi. This is a simple example how the knowledge of the intrinsic phenomena in superconductivity at nanoscale can help the experimentalists to save their resources and time to achieve the desirable result.

Recently, some very interesting effects were first predicted theoretically and then detected experimentally in layered and low-dimensional superconductors – triplet superconductivity, crossed Andreev reflection, and pi-shift. How one can use them for novel devices? What kind of nanostructures should be prepared for detection and application of those effects? In order to highlight some of the rosen questions, well-known experts were invited to write chapters for this book.

We believe that the book can attract attention of researchers, engineers, Ph.D. students and others, who would like to gain knowledge about some intrinsic effects of Superconductivity at nanoscale.

Kishinev, June 2011 *Anatolie Sidorenko*

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