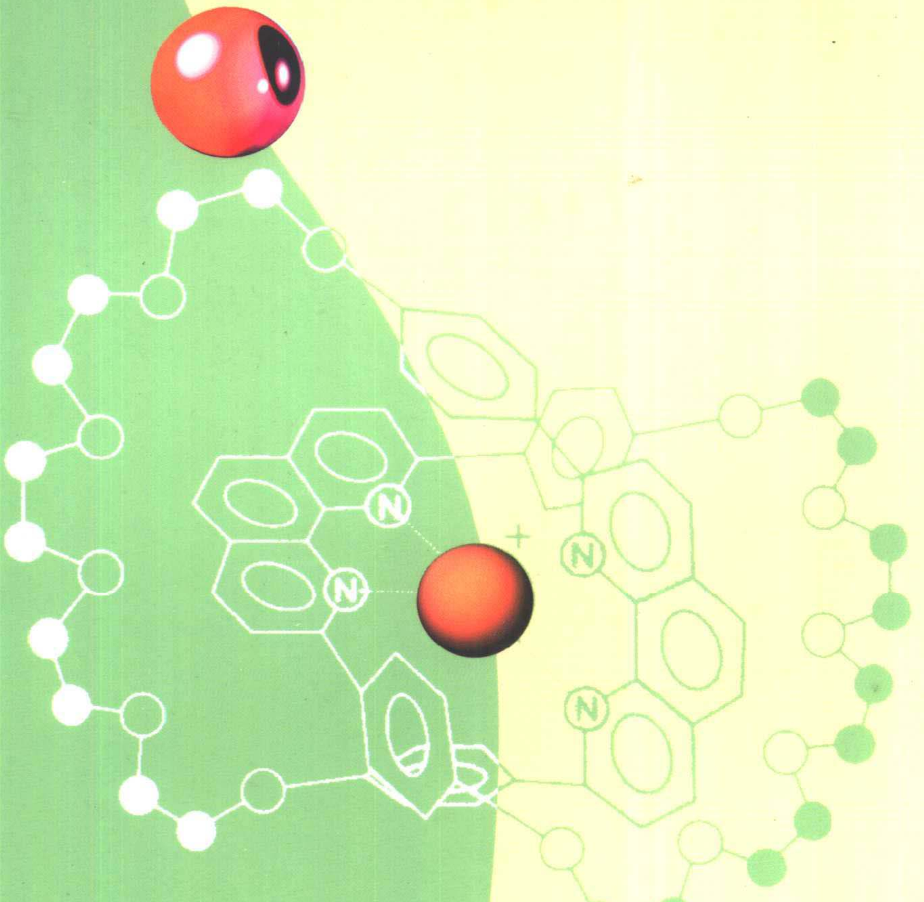
北京大学专业英语丛书

化学专业基础英语 II

设计分子世界：前沿化学

〔美〕Philip Ball 著

魏高原 王剑波 甘良兵 注释



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——设计分子世界：前沿化学

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Designing the Molecular World

Chemistry at the Frontier

Philip Ball

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内容简介

作为一部专业英语阅读教材，本书选自美国普林斯顿大学出版社的英文原版科普畅销书《设计分子世界——化学前沿》，全书由英文（含彩图）与中文注释两部分组成。英文部分共10章，包含于以“变化中的传统”、“新产品·新功能”和“作为过程的化学”为题的三大部分之中。中文注释为本书第四部分，它以章为单位，每章都包括“内容提要”、“词汇”及“句子和段落”几项。列入注释的词汇一般为不常见的生僻单词和词组以及专业术语，对于较复杂的句子和对专业知识有较高要求的某些段落，则给予详细注释或给出译文。该读本图文并茂、深入浅出地向读者介绍了当今化学领域里的许多新成果，包括对富勒烯和第一种塑料导体——聚乙炔的发现经过的生动描述，以及对诸如分形、混沌等内容深奥的新概念所作的浅显易懂的解释。

编者之所以将本书作为化学专业基础英语（II）特别推荐给读者，是期待他们能接受这一继续学习的挑战——在读懂此书，遨游了多彩的化学世界前沿领域的同时，全面提高专业英语水准。

本书可作为大专院校化学、生物学、材料科学等专业的高级专业英语教材或主要参考书，也可作为研究生、教师、科研人员及一般读者的参考读物。

前　言
(Preface)

《化学专业基础英语》(II)是化学专业基础英语(I)的后续教材。作为一部原汁原味的英语阅读资料，该书选用了美国普林斯顿大学出版社的原版书《设计分子世界——化学前沿》(作者Philip Ball)。各章配有内容提要、词汇表和难句解释和翻译，使学习者进一步提高化学专业英语水平，并了解当今化学领域的新成果、新思想。

《化学专业基础英语》(I)是根据教育部批准的《大学英语教学大纲》关于专业英语教学的要求和编者本人多年化学专业英语教学实践而编写的一部教材。该教材已在北京大学化学学院试用过七个学期，受到学生普遍欢迎。该教材的目的是培养学习者在化学专业英语方面的较强的读、写、译的能力，并适当训练听、说的能力，不是单纯培养阅读能力。教材分三个部分：基础化学讲座、重要专业术语、化学文献选讲。附录部分包括总词汇表，习题答案，会话材料，翻译材料，常见化学单位、常数等的英文表达方式，常见科技英语语法结构等。

整套教材可作为大学化学专业英语教材，也可作为化学类基础课的英文教材。可安排在三年级，各用一个学期(18周，周学时2)教完。教学重点应是培养较强的化学专业英语的读、写、译的能力。在使用该教材的过程中，教师可针对学习者的情况，采用灵活的教学方式，参照教育部《大学英语教学大纲》关于专业英语教学各项指标要求。在有条件的院校，可用全英语授课，给学习者全面的化学专业英语训练。

安美华
北京大学英语系
2001年3月25日

注释者的话
（Words from the Editors）

英国著名科学周刊《自然》(NATURE)副主编菲利普·鲍尔(Philip Ball)博士所著的科普读物《设计分子世界——前沿化学》(*Designing the Molecular World: Chemistry at the Frontier*)一问世，便在世界各地读者中产生了很大反响。该书之所以广受欢迎，我们认为主要是因为作者向读者展示了当今化学领域里的许多最新成果，包括对全碳化合物的第三种形式——富勒烯的激动人心的发现经过的生动描述，以及对诸如分形、浑沌等深奥的新概念所作的浅显易懂的解释。毫无疑问，作者职业上的有利条件，在使本书内容的选取得以如此尽善尽美上，起到了很好的作用。

全书共10章，并附有引人入胜的序言：“操纵元素”。第1～4章、第5～7章和第8～10章分别属于以“变化中的传统”、“新产品·新功能”和“作为过程的化学”为题的三大部分。

本书的中文注释以章为单位，包括三部分的内容：“内容提要”、“词汇”及“句子和段落”。列入注解的词汇一般为不常见的生僻单词和词组，特别是专业术语，一般不管难易均给出中文释义。对于个别或因句子结构较复杂或因包含习惯用法而不易理解透的句子，以及对专业知识有较高要求的某些段落，也有选择地作了注解或给出译文。

参加本书注释工作的有王剑波、甘良兵和魏高原三位教授，他们均有讲授北京大学化学系本科“化学专业英语”课的经验。魏高原负责第一、三、六和九章以及序言、目录和彩色插图说明文字的中文注释，王剑波和甘良兵则分别注释了第二、五、七、八章及第四、十章，全书由魏高原定稿。鉴于本书的内容新颖、浅显，并且英语词汇的专业覆盖面相对较宽，故特别推荐此书作为高等院校化学化工及生物类本科高年级学生及研究生的英语课外读物，或作为有条件的院校开设“化学专业英语”课高级班的教材。如将此书(已列入“北京大学专业英语丛书”)与同由北京大学出版社出版的《化学专业基础英语》(I)(已列入“北京大学专业英语丛书”)联用，则效果更佳。

本书在确定选题、购买版权、编写和出版过程中得到北京大学出版社的大力支持，特别是责任编辑赵学范老师提出过许多宝贵的建议并自始至终从各方面给予很大的帮助，在此一并致以诚挚的谢意。

1999年8月8日
于燕园

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If this book achieves its goals, it will be because of the indispensible help that I have received. In particular, I would like to acknowledge valuable suggestions, advice and assistance from Harry Kroto, Ahmed Zewail, Charles Knobler, Mark Davis, Toyoichi Tanaka, Julius Rebek, Stefan Muller, Fleming Crim, Stephen Scott, Norman Herron, and Ilya Prigogine. My colleagues at *Nature*, particularly Laura Garwin, have provided a great deal of the stimulus that prompted me to attempt something so foolhardy in the first place, and those at Princeton University Press, in particular Emily Wilkinson and Malcolm Litchfield, persuaded me that it was worth persevering with. I am very grateful to Sue Fox and Steve Sullivan for assistance with the illustrations. Somewhere in the distant past, I owe considerable debts to Colin McCarthy, Kit Heasman and Peter Walker. And Julia has been wonderfully patient in the face of many late nights and early mornings.

Philip Ball
London, September 1993

Credits

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Figure 9.1 from S. Motojima & H. Iwanaga, *Journal of Chemical Vapour Deposition* **1**, 87 (1992). Figure 9.12 from J. Schütze, O. Steinbock & S. C. Müller, *Nature* **356**, 45 (1992). Figure 9.15 from E. O. Budrene & H. C. Berg, *Nature* **349**, 630 (1991). Figure 9.18 from H. Meinhardt & M. Klingler, *Journal of Theoretical Biology* **126**, 63 (1978). Figure 10.2 redrawn from C. Lorius, J. Jouzel, D. Raynaud, J. Hansen & H. Le Treut, *Nature* **347**, 139 (1990). Figure 10.12 from C. Sagan, W R. Thompson, R Carlson, D. Gumett & C. Hord, *Nature* **365**, 715 (1993).

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Designing the Molecular World

原书空白

Introduction

Engineering the Elements

> *He who understands nothing but chemistry doesn't even understand chemistry.*
>
> Georg Christoph Lichtenberg

> How to Avoid Science
>
> A good way in a science lesson is to wait until some old fashioned poison like sulphurick acid etc. turns up. As per ushual science master, who not forward-looking, sa: No boy is to touch the contents of the tube.
>
> Make up tube which look the same and place alongside acid. Master begins lesson drone drone drone. Sudenly you spring to feet with grate cry: 'Sir Sir I can't stand it any longer!'
>
> Drink coloured water and collapse to be carried out as if dead. n.b. if you make a mistake with this one you are still carried out as if dead and you *are*.
>
> Geoffrey Willans and Ronald Searle
> *Down With Skool!*

Even that most aberrant of schoolboys Nigel Molesworth would have to admit that there are times when it pays to have a little knowledge of chemistry. It remains, however, one of the least glamorous of sciences. Physicists, by comparison, are to be found pondering the deepest mysteries of the Universe: Where did everything come from? What will happen to it all? What is matter? What is time? Physics represents science at its most abstract, and also on its grandest scale, as gigantic telescopes search the heavens for the echoes of creation and particle accelerators miles in diameter smash subatomic particles into each other in order to glean clues about what the world is made of. The questions tackled by biologists, meanwhile, are the matters of life and death – it is for them to take up arms against the thousand natural diseases that flesh is heir to, or to strive towards understanding how we evolved from sea-bound blobs of jelly. Geologists brave the awesome fury of volcanoes and earthquakes; oceanographers plumb the hidden depths of the world. What do chemists do? Well, they make paint, among other things.

One might expect to find nothing more of interest in the practice of making paint than in watching it dry. But there is, as I hope to convince you later, a subtlety and cleverness to the art. If that still seems a prospect wanting in enticement, let me mention that we will also see what paint has in common with living cells and soap bubbles, with muscle tissues and plastics. The tiny corner of chemistry in which paint is contrived holds unguessed surprises, and supplies as good an illustration as any other of the way in which an understanding of the chemical nature of substances helps us to control the shape and form of our world. For the truth is that, while many of the other sciences are associated with mysteries of an awe-inspiring scale, chemistry is the science of everyday experience, of how plants grow and how snowflakes form and how a flame burns.

Yet chemistry has acquired the image of a mundane pursuit; and it must be said that some blame resides with chemists themselves, many of whom seem resigned to accept a perception of their research as worthy but dull. It is true that chemists are hampered from the outset by low expectations. (According to the fossilized wit of Oxford, the chemist (invariably male) is a dour clod with long hair and dirty hands – a formidable beer-swigger perhaps, but a social gorilla.) Yet chemists themselves often insist on a humility that borders on insecurity. They will say at conferences, "I don't claim to understand these results – I leave that to the physicists. All I did was make the materials."

I have no crusade in mind, however. Rather, what this book aims to do is to present a selection of some of the things that a chemist today may find her- or himself engaged in studying. If by doing so it succeeds in demonstrating simply that the new chemistry is no longer a matter of test tubes and bad smells (although both may be encountered along the way), that is fine enough. For this demonstration we will need to take a cursory glance not only at some of the basic principles of chemistry but also at a pot-pourri of ideas from disciplines as diverse as genetics, climatology, electronics and the study of chaos. Yet this is most certainly not a textbook: it will not cover chemistry comprehensively, nor will it provide a rigorous scientific description of the phenomena that will be discussed. Simply, I hope to show that in order to discover a sense of wonder about the world, it is not always necessary to look to the stars or to the theory of evolution; one can look instead at the washing-up liquid, the leaves on a tree or the catalytic convertors in our cars.

In 1950 the distinguished American chemist Linus Pauling said "Chemistry is a young science." It is true that chemistry of a sort was practised in Ancient China, in

Babylonia and beyond, but you could see his point. At that time only a few decades had passed since we had come to understand the constitution of the atom, chemistry's building block; and Dmitri Mendeleev's Periodic Table of chemical elements was just 81 years old, with several of the gaps only recently filled. But almost half a century later, does chemistry still retain any of its youthful vigor?

Much of chemistry today is becoming motivated and guided by principles dramatically different from those that informed Pauling's comment. The new chemistry pays scant regard to the disciplines into which the topic has been traditionally divided. At college, chemistry still is often taught in three distinct chunks: physical, organic and inorganic. But few are the chemists today who claim firm allegiance to a single one of these branches; rather, novel concepts and classifications are emerging through which researchers define their work. I shall give here an incomplete list of some of these; we will find these ideas cropping up many times in the subsequent chapters, often lending a common thread to studies that otherwise appear disparate. If you can, bear them in mind in what follows.

Materials: There may be many who lament the dawn of the plastic age. It has, however, demonstrated in unambiguous terms that we are no longer forced to manage as best we can with the materials that the natural world provides – we can design new ones that better suit our purposes. Plastics now have a seemingly limitless variety of properties: they show tensile strengths comparable to steel, they can dissolve in water or be eaten by microbes, conduct electricity, change color or contract and flex like muscles. Plastics generally consist of carbon-based chain-like "polymer" molecules; polymers based on silicon and oxygen, meanwhile, serve as the precursors to new kinds of ceramic materials, "artificial rocks" that promise new limits to hardness and strength

The explosion of interest in materials science in recent years has gained tremendously from the realization that an understanding of the structure of materials at the molecular level can lead to the design of properties useful at the engineering level. We can now control the growth of materials atom by atom, opening up new possibilities in semiconductor microelectronics for example, or allowing the possibility of mimicking the impressive design of natural substances like bone and shell. And as our ability to control the microscopic structure of materials improves, chemistry continues occasionally to produce materials with unforeseen surprises in store, such as the carbon cages known as fullerenes or the metal alloys called quasicrystals.

Electronics: Did I say plastics that conduct electricity? Yes, not only do they exist but they are already being used in electronic devices. A broad range of synthetic chemical compounds are now known that possess metal-like electrical conductivities, and some even show the remarkable property of superconductivity – conductivity without resistance. Magnets too can now be made without a metal in sight, based on carbon- and nitrogen-containing molecules more like those found in the organic world. An entire electronics industry is beginning to look feasible that has no need for metals or