Amazon reviews of *Concepts of Materials Science*

Professor Peter Haynes, Head of Department of Materials, Imperial College London

Materials underpin all of the technologies upon which our modern lives are built, including energy conversion, transportation, information & communications and healthcare. They will also be key to solving the challenges associated with an environmentally sustainable future.

However materials science is not taught as a separate subject in the Sixth Form, so it can be hard for students considering applying to university to study science or engineering to understand what it is about. Teachers without experience of the subject may also find it hard to advise them.

This book demonstrates that materials science is just as intellectually challenging as physics, chemistry or engineering. It complements some excellent popular books on materials that have emerged in recent years by providing an overview of the subject in terms of ten central concepts. These are described at a level that is accessible to the interested Sixth Former and makes minimal use of mathematical formulae. I strongly recommend this book as essential reading for anyone considering applying to study materials at university.

Professor David J Srolovitz, Dean of Engineering, University of Hong Kong

Materials science is the embodiment of and a manifestation of mathematics, physics, chemistry,... It is the application of these ideas in the corpus of all physical technology. Materials are the enabler (and the ultimate limiter) of devices - jet engines, microelectronic devices, sensors, automobiles, batteries - and living matter.

Sutton, Materials Science's leading pedagogue, has distilled the essence of materials science to its most basic, beautiful ideas and presents it in a manner accessible to every science or engineering student. At the same time, this small book will surprise and enlighten even the professional materials scientist. The complexity of real materials (and the deep mathematics) is pushed aside in favor of clear, conceptual, foundational ideas.

In my view, this book does NOT replace the typical Introduction to Materials Science text, but rather should be read alongside it. It is the depth, that balances the breadth of a classical introductory text.

This is a MUST READ for every young scientist, as well as their teachers!

After spending an entire career and writing many hundreds of scientific articles in this field, I am astonished how much I learned in this beautiful, little book.

Professor Frans Spaepen, Harvard University

Materials science has its roots in physics, chemistry, mathematics and, most recently, biology. As materials engineering, it guides the development of materials with desirable properties and the discovery of new ones. To provide a broad and insightful overview of this rich and varied field, and to do so in just over one hundred highly readable pages, requires a special talent. Adrian Sutton, who learned from the best and has many distinguished achievements in the field, is one of those talented few.

The author strikes a judicious balance between descriptive and quantitative exposition. Many of the insights and phenomena are simply stated or explained qualitatively. A well chosen number, on the other hand, is explained with simple mathematics or with figures. This makes the book accessible for a wide range of readers, who all will learn something from it: basic facts for the newcomer; Sutton's elegant take on a classic phenomenon for an old colleague.

The book will therefore be useful at many levels of education. It may steer high school students who have taken advanced physics and chemistry classes toward a college major they probably have never heard of. Likewise, it may excite physics and chemistry majors in college about contributing to this highly interdisciplinary field in graduate school. It will be useful supplementary reading in a college science course for non-scientists. And, of course, for the professionals, it will be a treat to savor the broad sweep of Sutton's vision of their field.

Professor Mike Ashby FRS, University of Cambridge

Materials Science is a bridging discipline, one linking the purer sciences to the more applied. It has its basis in physics and chemistry, and its predictive capacity is increasingly extended by mathematical modelling. Most materials scientists are motivated not just by the fundamental understanding these bring, but also by the way they can be deployed in practical ways in engineering and design to improve lives, expand the economy and approach the big issues of the day.

This book is a remarkable attempt to provide the background needed to engage with Material Science in the 21st century. It is not a text book – there are no exercises or problems – but rather a monograph based around the authors wide grasp of the concepts of Materials Science and the way they inform today's thinking. It starts, as many introductions to solid-state physics do, with the principles of crystallography, thermodynamics, phase equilibria and kinetics. It builds on these to introduce readers to quantum behaviour and the way nano-manipulation of structural scale can control material properties, and the collective response when these are combined. It introduces self-organised structures and how nature uses self-organisation to create biological matter. And it gives a fascinating glimpse of emerging developments: meta-materials, negative refraction, smart materials and much more. The book is concise and well-illustrated, challenging but readable, with recommended further reading on each topic. An interesting and stimulating contribution to the field.

Professor Steve Fitzgerald, University of Leeds

This is not a technical textbook, nor a popular account of materials science -- excellent examples of these abound; indeed, the author has written several of them. What this book does instead is explain, with great clarity and insight, the fundamental concepts and intellectual driving forces behind what is, after all, a relatively young scientific discipline. It will be of most use and interest to those embarking on study or research in materials science. Whilst it ought to be comprehensible to undergrad students, it is not a replacement for course textbooks. Rather it should be read alongside to provide context and increase understanding, much as I would recommend the Feynman lectures for students of physics. In particular, it should be required reading for those starting a materials-focussed PhD after an undergrad degree in physics, chemistry, engineering, or another related field. The author could not be more highly regarded in the field, and he brings his usual lucid and engaging style to this essential book.

Professor Steve Sheard, University of Oxford

Much more than an introduction to materials science, this is an overview of the key fundamentals presented in a simple clear narrative, combined with the breakthrough ideas that have enabled new technologies. It is written with great insight, explained in straightforward language and with a minimal use of equations. There are plenty of illustrations and accounts of scientific discoveries that make this book an enjoyable read that will inspire many to explore further.

How to use this book? Clearly, this is not a standard textbook but would be useful supplementary reading for undergraduates looking for the bigger picture on selected topics. I would recommend this book to pre-university students wanting to learn about materials science and to post-graduates in neighbouring disciplines. Throughout this book there are complex concepts elegantly and simply explained with a unique perspective, I can honestly say my understanding has been enhanced.

Professor Frank Ernst, Case Western Reserve University

This is a very much needed book to introduce current and future scientists and engineers to the underlying concepts of materials science, showing readers some of the big ideas that permeate the subject. In remarkably comprehensive form and a fresh, logical approach, the book provides a backbone on which readers can build further and deeper studies on specific topics without losing sight of the underlying physical concepts that link together the vast number of topics that materials science includes today.

Professor Takeshi Egami, University of Tennessee and Oak Ridge National Laboratory

Materials science is a relatively new field of study, born as a part of the response to the Sputnik shock in 1957. Unlike many traditional fields which were formed organically,

materials science was strategically designed, as an interdisciplinary field among physics, chemistry, metallurgy and ceramic engineering. It was a major intellectual adventure, to break down the barriers between disciplines and to create a new discipline. It is not surprising, therefore, that it took a while before the principal ideas are integrated into canonical concepts and become documented. Sutton's effort is one of them, aimed at young students entering the field, or thinking about entering it.

The book concisely summarizes ten concepts that form the basis of this field. The subjects chosen are diverse, timely and forward-looking. I suspect that the book will be revised every fourscores or so, possibly by new generations. For instance, the 11th subject on biology added as a possible future direction may soon become one of the principal subjects. I always emphasize to students the importance of differentiating principles from details. Students tend to be bogged down into details and see trees rather than forest. This book tries successfully to guide students to big ideas and key concepts, without stepping into details. This made this book immensely readable and attractive. I recommend this book to all young friends aspiring to venture into this new and exciting field.

Professor David Pope, University of Pennsylvania

When I teach certain topics in materials science, I often feel that I am spending too much time "down in the mathematical weeds", going over details that really do not deserve emphasis, before I finally arrive at the unifying concept. Suttons' discussions of the "key concepts" of Materials Science never gets into those weeds, and that is why I find it so refreshing – and useful as a teaching tool. Consider his discussion of the Helmholtz and the Gibbs free energy - why they are minimized at equilibrium, and why they are so useful for determining the maximum amount of work that can be extracted from a system. He treats these two concepts clearly and completely in no more than two pages of text, and in the process he reminds us that we can be equally efficient and clear in the classroom.

In addition to the simplicity and clarity of his exposition, he also reminds us about the contributions made by important experimentalists, for example, the results of Simmons and Balluffi on vacancies in metals. Again, when learning about vacancies, it is so meaningful for students to see those experimental results and immediately understand that the volume of the sample actually increases with increasing temperature, and, as a result, a certain fraction of the lattice sites in the crystal must be vacant. I personally remember having a "gee whiz" moment when I saw this result many years ago. Sutton reminds us to make make frequent use of such results in the classroom.

Having taught Materials science for so many years, I am gratified to see the clarity of Sutton's treatment, but I am also a bit jealous of his expository abilities. However he showed this same talent even when I knew him long ago when he was a graduate student. It's wonderful to see that he has continued to develop it.

Professor Mojmír Šob, Masaryk University, Czech Republic

Exploring basic concepts of materials science may be more challenging than one might expect. This is illustrated by the recent remarkable book of Adrian Sutton who, on only about 130 pages, identifies and perfectly characterizes key concepts central to materials science, starting with thermal stability of materials and mechanical properties up to quantum behaviour and materials by design even to biological matter considered as a material. With a minimum of mathematics, but without compromising rigor, the author brings all the necessary basic physics that constitutes fundamentals of all what is essential in materials science. The key concepts are illuminated both at elementary and advanced level and the book features nuanced connections between various parts of materials science.

Adrian Sutton's direct and informal writing style and his emphasis on physical understanding via elementary thinking make this marvelous book very attractive and pleasure to read. I recommend it most enthusiastically to any person interested in modern science of materials, even if with just pre-university education, however, also, university students, including graduates and even established scientists working in the field will find refreshing and enlightening views on the basic concepts. Whether the readers are just interested in materials science or working actively in the field, they will be rewarded. Adrian Sutton's book will be an excellent companion!

Dr Sergei Dudarev, Visiting Professor at University of Oxford and Imperial College London

A highly readable, comprehensive in-depth summary of modern concepts of materials science. A book that would be particularly useful to a scientist or engineer solving applied problems. This book would stimulate innovative ideals and alternative approaches, offering a fundamental insight into the logical structure of the science of materials. This enjoyable book not only introduces, in the form of a brief but clearly delivered and entertaining narrative, a selection of concepts and notions that dominated and largely defined the modern knowledge and applications of materials.

The chapters on phase diagrams, fluctuations, and defects are particularly good in explaining the fundamental origin of mechanical behaviour of materials, highlighting the key facts and explaining them in an accessible and at the same time rigorous manner. It is a great short introductory treatise, which can readily serve as one’s first book on the subject.

Professor Xanthippi Markenscoff, University of California, San Diego

The science of materials is a vast subject, overlapping physics, chemistry, biology, mathematics and engineering, which is my field. In this short book Professor Adrian Sutton has identified ten concepts that knit the subject together. His selection of ten concepts and the exceptional clarity of the text enables university students and advanced degree students to gain a unique insight into the subject in just 132 pages. It is a book on many levels and it will interest everyone from freshmen to university professors. As the mechanical engineer

uses the new materials in the design of applications, understanding of the fundamental physics that lie behind is essential: the book navigates through the more classical topics such as Einstein's 1905 diffusivity-mobility relation following a drunk student on the dance floor, and the probabilities of hydrogen atoms tunneling through the potential barrier in quantum diffusion, to quantum dots, and metamaterials, with attention to the mechanical effects that the mechanical engineer relates to. Even if you wonder what is the self-cleaning glass, you have the answer clear! This book is priceless!

Dr Masanori Kohyama, National Institute of Advanced Industrial Science and Technology, Japan

This book is suitable to researchers to begin research or engineering work in materials science and engineering in universities, laboratories, or companies, who have background of other research fields. For such people, it is quite important to get his own MAP in the world of materials. Varieties of materials and their properties may discourage newcomers to get such a MAP. For such people, this concise book of Sutton-sensei is quite effective, where various kinds of materials are dealt with and described by his unified view on the underlying principles of materials properties. This is based on his rich experiences of basic researches of materials science as is well known.

Dr Johannes Lischner, Imperial College London

I highly recommend Adrian Sutton’s new book to anyone who wants to understand the essence of Materials Science, the science of the material world around us. It is a short book that lacks neither in depth nor breadth: fundamental concepts of thermodynamics, electronic structure, etc are explained clearly along with many examples of current research topics.
I very much enjoyed reading the book and learned quite a number of new things.

Dr Beñat Gurrutxaga-Lerma, University of Birmingham

Materials Science is so interdisciplinary that some people deem it to be a field without definition: a loosely connected collection of materials, methods, techniques, and applications. Thus, unlike in other natural sciences, general science books concerning Materials Science tend to devote their pages to listing examples of different "cool" materials, their very exciting properties, or how they will change the world. This is somewhat mystifying, as it does little to explain how one actually does materials science – saying that carbon nanotubes are much stronger than steel does little to convey the whys and wherefores of what that means, or how one gets there.

"Concepts of materials science" by Adrian Sutton is nothing like that, and that in my opinion makes it both unique and an excellent introduction to Materials Science: rather than a general science book about Materials, Adrian Sutton's book is a general introduction to the Science of materials. Sutton assumes the reader has no scientific background, and uses a

simple and very accessible language to guide the reader through a fascinating overview of how thermodynamics, quantum mechanics, classical mechanics and complexity theory come together to form the basis of materials science. Sutton explains in a very clear and easy to follow manner all the key concepts here, and their significance, and how these can be (and indeed are) used to study materials from the meter all the way down to the atom. It is this emphasis on concepts and their science which makes the book truly excellent.

As a very approachable introduction to the field, this book offers an exceptional overview of all the key concepts and scientific ideas that any reader wishing to learn about Materials will want to hear about. It is so comprehensive it can almost be used as a study guide from which to delve deeper into the field. The book will be a perfect introduction to Materials Science for anyone wishing to understand the fundamental concepts of materials science, including high school students, teachers, and undergraduates students.