REAL SOLIDS AND RADIATION

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PREFACE

NEARLY everything we do in our lives depends in one way or another on the properties of solids, so it is not surprising that a large part of the research and development activity in modern science is devoted to the study of the solid state. The physics of solids has one of its most obvious practical products in electronic devices, the chemistry of solids in plastics, dyestuffs and fibres, and the science of metallurgy is apparent through the wide range of structural materials which are now available to the engineer. The motivation for this book arose originally through our own involvement in radiation effects in solids, which is a topic invoking a wide range of modern scientific concepts without being an accepted mainstream subject which features much in formal science courses at school or university. We therefore aimed to write an account of this field which would be intelligible to the non-specialist. However, after starting a text based on this idea, and discussing it with Brian Woolnough, it seemed to us all that some benefit would derive by broadening the subject matter. Radiation effects in a solid revolve almost exclusively around the production of defects in its atomic structure, which manifest themselves through changes in various physical properties of the material. But there are many other features in the behaviour of solids which are controlled by structural defects which are present for reasons which have nothing to do with radiation at all. In many cases the presence of defects explains why the properties of many solids with which we are very familiar, such as pottery and steels, differ from the ideal solids which are discussed in most text-books. We therefore have tried to write a book for the Wykeham series which describes how the properties of 'real' solids may be understood in terms of the atomic and electronic structure of ideal solids modified by the presence of a wide range of types of structural defect. We have kept the interaction of solids with radiation as a recurring theme, partly because this is one of the more important ways in which defects are formed and has stimulated a great deal of study of defect properties, and partly because the interaction of solids with one simple form of radiation, light, is the means by which we gain much of our practical experience of the nature of real solids. The sort of general questions we aim to answer in this book are exemplified by such as "Why are some solids

electrical conductors and some insulators?“, “Why are some solids transparent and others opaque?“, and “Why are some solids brittle and others ductile?”

The first two chapters of the book form an introduction to the structure and properties of perfect solids, developing the ideas about electrons and atoms which are required to understand the nature of the solid state. Chapters 3 and 4 introduce the types of defect which may be present in a real solid and their influence on some of the physical properties of materials. Chapters 5 and 6 describe the interaction of solids with radiation, leading to a discussion of the production of defects by irradiation in Chapter 7. Finally Chapters 8 and 9 are devoted to some of the practical consequences of radiation effects, both where they have unwanted effects and where they are used to perform some potentially useful tasks.

Some of the material covered in this book overlaps the content of other books in the Wykeham series, and in some cases we have deliberately referred to other books rather than spell out an argument in detail. The reader should find the following texts to be especially useful companions to our volume: ***Elementary Quantum Mechanics*** by N. F. Mott, ***Elementary Science of Metals*** by J. W. Martin, ***Crystals and X-rays*** by H. S. Lipson, ***Biological Effects*** of ***Radiation*** by J. E. Coggle, ***Solid State Electronic Devices*** by D. V. Morgan and M. J. Hawes and ***Strong Materials*** by J. W. Martin.

It is a pleasure to acknowledge the help we have received from our schoolmaster-collaborator, Brian Woolnough, and from the series editor Mr. G. R. Noakes. Both have contributed in many ways towards making the text more readable. Finally we should like to thank many of our colleagues at Harwell who have contributed to our understanding of the subject matter of this book, and our families who have put up with many hours of silence and detached contemplation during its writing.

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