Preface

Engineers in many areas, such as materials science and engineering, and electrical and electronic engineering, have felt frustration due to the lack of suitable texts on electronic and ionic conductivity. This led us to write just such a book. Most of the textbooks on the market cover the chemistry or the physics of electronic or ionic behaviour, usually titled "Solid State Physics or Chemistry", and put great emphasis on the theoretical aspects of the solid state. On the other hand, current materials science and engineering texts do not cover the area of electronic and ionic materials in enough detail, leaving the student to wonder how important these materials really are. As the area of materials science expands, so do the topics that need to be taught in the field. It is, therefore, very important that students feel that the topic under study is relevant, and not just a rehash of other topics in chemistry or physics. The application of electronic and ionic materials has definitely taken a driving seat in today's world. This is shown by, for example, the need for particular materials in the electronics industry, the energy industry, and many other applications which are too numerous to be mentioned here. This subject, therefore, now plays an increasingly important part in the curricula of most undergraduate engineering studies, including materials science and engineering and electrical and electronic engineering.

This book is particularly aimed at undergraduate level as the text assumes a very limited knowledge of chemistry or physics (up to, perhaps, first-year level). It aims to convey a basic understanding of a wide range of electronic and ionic materials important to today's world, and it emphasises the properties and applications of such materials. A question commonly asked is: "How much mathematics will I have to know?" Some mathematics

is, of course, necessary in any science and engineering degrees. However, we have tried to keep the mathematics needed to describe particular processes to a minimum. We have also used mathematics as a descriptive tool and have considered all necessary formulae from first principles. This will enable the student to understand the originating points.

Chapter 1 gives a brief overview of materials science and engineering. Chapters 2 to 4 introduce some basic theories covering the principles of electrical conductivity, electron energy levels, band structure and work function. The remainder of the book is divided into properties of particular materials and their applications. Chapter 5 discusses semiconductor property, materials and device applications. Chapters 6 to 9 discuss magnetic, dielectric, optical and thermal properties and materials, while Chapter 10 covers the relatively new area of superconductivity and superconductors. Chapter 11 is devoted to the new topic (from an applications rather than a theoretical viewpoint) of ionic conductivity, while Chapter 12 discusses mixed conductivity. Chapter 13 discusses the techniques available for measuring ionic and mixed ionic/electronic conductivity. The book concludes with a case study describing the solid oxide fuel cell, and brings together much of the material covered in the previous chapters. Throughout the book, we have attempted to maximise the number of examples where the particular property is used in today's world. We have also concluded most chapters with a case study covering at least one example of that particular property in more detail.

In conclusion, we trust that the book will be entirely suitable for materials science and engineering, and electrical and electronic engineering students at an undergraduate level. It is anticipated that first-year postgraduates, who are new to the topic, may also find the subject matter of interest to them.

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