



Atomic and Electronic Structure of Solids, *E. Kaxiras*, Cambridge University Press, 2003, pp: xx+676. ISBN 0521523397 (pbk) / 0521810108 (hc); Price: US\$60/\$110

This is a wonderful book. The work is addressed to first-year graduate students in physics, chemistry, materials science and engineering. In a manner entirely appropriate to the intended audience, the author assumes a certain familiarity with electrodynamics, quantum mechanics, thermodynamics, statistical mechanics, elasticity and mathematical methods. However, Kaxiras also provides very detailed appendices on all these topics. This is an excellent feature of the work, since as one's memory of the relevant equations is being refreshed, one is also familiarized with the notation used in the text. In fact, Kaxiras has been most careful in his use of notation throughout, and where this is nonstandard he explicitly tells one so (for example, to avoid confusion because the symbol E is conventionally used for both electric field and Young's modulus).

The book is divided into three parts: Part I, "Crystalline solids" (Chapters 1 to 8); Part II, "Defects, non-crystalline solids and finite structures" (Chapters 9 to 13); and Part III, the lengthy set of appendices commented on above.

Part I begins with atomic structure and bonding and then considers (Chapter 2) the single-particle approximation in various theoretical frameworks, including an excellent introduction to Density Functional Theory. The third chapter ("Electrons in crystal potential") deals with periodicity, Bloch states, Brillouin zones and group theory. In Chapter 4 we are introduced to the band structure of crystals, with a nice discussion of 1- and 2-dimensional examples of the tight-binding approximation (TBA) using s and p orbitals, followed by a discussion of the ways in which the TBA can be generalized. Band structure is further illustrated by considering graphite (as a 2D solid), and then 3D semiconductors, insulators and metals. Having learned about band theory, we are immediately introduced to its applications in Chapter 5. Chapter 6 is on lattice vibrations, and considers all the usual material, including discussions of the specific heat of solids. Chapter 7 is an introduction to the magnetic properties of solids, including the BCS theory of superconductivity.

It is in Part II, "Defects, non-crystalline solids and finite structures," that the book starts to cover material that I have not seen elsewhere presented at a similar level. As the author comments in the introduction, in deciding what to include he has drawn mostly from his own research experience, and the material is necessarily selective. This section begins with a discussion of defects, organised according to the scheme of: point defects (Chapter 9), including doping in semiconductors and the p-n junction; then line defects (Chapter 10), considering dislocations and bulk properties such as ductility, stress, strain and fracture.

In Chapter 11, we are introduced to another class of defects – surfaces and interfaces. This is the only chapter that begins with an exposition of experiment, specifically the scanning tunnelling microscope (STM), and the Tersoff-Hamann expression for tunnelling current. Also covered is the phenomenon of surface reconstruction, with Si(001), GaAs(110) and Si(111) surfaces as examples. Surprisingly, no STM images of the surface reconstructions are given, although a cartoon version of the Si(111)- 7×7 reconstruction is shown.

Chapter 12 covers non-crystalline solids, beginning with quasicrystals, and continuing with amorphous solids and polymers. The final chapter (13) considers structures that are not quite solids, such as clusters, carbon nanotubes and biological molecules (DNA, RNA and proteins).

For each chapter there is suggested further reading (with a sentence or two introducing each suggested work) and a fairly extensive set of problems (about 10 per chapter). The solutions manual alluded to on the dust jacket is not yet available; however, the author is willing to send copies of his (mostly) handwritten solution sets to lecturers who want them.

The production values of this work are high. The work is well illustrated with grey-scale images (almost all illustrations are by the author himself, so they are correct) and on average there is probably one illustration for every two or three pages.

This book deserves to be widely adopted as a graduate text. Kaxiras recommends that 40 hours of lectures are adequate to cover the first section, while the second section can be used as a basis for special assignments or projects for a one-semester course.

The exposition is extremely clear throughout. The appendices are mini-textbooks in themselves and, given the clarity of thought evident throughout this book, we can only hope that in due course Kaxiras will expand each of them to full textbooks.

Iain R. McNab,
University of Toronto,
Toronto, Ontario, Canada