Electrons And Phonons: The Theory Of Transport Phenomena In Solids (Oxford Classic Texts In The Physical Sciences)

Synopsis

This study of the theory of electrical and thermal conduction in metals, semiconductors, and insulators is written at a level appropriate to graduate students and research workers and assumes some knowledge of wave mechanics in its reader. The basic ideas of crystal lattice dynamics, electron zone structure, and transport theory are developed from first principles, and formulae for the macroscopic coefficients are deduced by self-contained mathematical arguments. Interpretation in terms of electronic structure, chemical purity, crystal structure, and crystal perfection is emphasized as a tool for further investigation but detailed discussion of individual means or alloys is avoided.

Book Information

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Customer Reviews

"Zimnan’s [sic] work was in print nearly 20 years, and out of print another 20 before becoming an official classic. For graduate students and researchers who have some knowledge of wave mechanics, he looks at theoretical aspects of electrical and thermal conduction in metals, semiconductors, and insulators. He develops the basic ideas of crystal lattice dynamics, electron zone structure, and transport theory from first principles."--SciTech Book News". . .[This] book is of historic significance since it represents a mile stone in the development of the theory of transport phenomena in solids. . .[This] book is a pleasure to read, owing to its remarkable eloquence and clarity of presentation."--MATH

J.M. Ziman is Emeritus Professor at University of Bristol.

I mainly studied the chapters related to phonons and electron-phonon interactions. The book starts off with one of the best explanations of the Bloch theorem I've ever seen, as applied to phonons. The chapter on phonon-phonon interaction is a great bridge between a basic textbook on solid state like Kittel, and research papers. The rigorous treatment of 3-phonon processes presented in this chapter is perhaps more useful than the author implies, because when it was written in 1958, density functional theory had not yet been invented, and it was virtually impossible then to get a good theory of anharmonic coefficients. In my opinion, electron-phonon interactions were not as well explained. The author uses several superficially similar models without adequately explaining the differences. Also, he uses seemingly disparate concepts (uniformity of Fermi level in $5.6, "Deformation Potential", and scattering theory in $5.7, "Bardeen's self-consistent calculation") to obtain the matrix element for e-ph scattering, and seemingly magically obtains similar-looking results. For studying the Frohlich interaction, I'd instead recommend Feynman's "Statistical Mechanics: A set of lectures" since it gives a more comprehensive treatment, while assuming similar mathematical preparation. The Boltzmann transport theory (Ch.$7) was very well explained, and I especially recommend the discussion on the formal properties of the collision operator, because it yields the only plausible way of obtaining an upper bound on the resistivity. Ch. $8, "Lattice conduction" is an applied chapter and contains some surprises about the interplay of various scattering mechanisms in determining the phonon thermal conductivity. Ch. $11, "Size and surface effects" is good introductory reading for understanding heat transport in situations where the mean free path is comparable to the specimen size (especially in light of recent findings that phonons in silicon with MFPs of >= 1 micron contribute a significant fraction of the total heat flux).

The papers of the book are deteriorated due to age, the book is over priced.

Excellent summary of this subject. ziman is a well-regarded expert on this subject.He was a professor at Oxford for many years.

Transport and Conversion: A Parallel Treatment of Electrons, Molecules, Phonons, and Photons (MIT-Pappalardo Series in Mechanical Engineering) The Friction and Lubrication of Solids (Oxford Classic Texts in the Physical Sciences) The Mathematical Theory of Black Holes (Oxford Classic Texts in the Physical Sciences) The theory of electrons and its applications to the phenomena of light and radiant heat (TOC) The Theory of Electrons, and Its Applications to the Phenomena of Light and Radiant Heat Kinetic Theory and Transport Phenomena (Oxford Master Series in Physics) Advanced Transport Phenomena: Fluid Mechanics and Convective Transport Processes (Cambridge Series in Chemical Engineering) Band Theory and Electronic Properties of Solids (Oxford Master Series in Physics) Laser Interaction and Related Plasma Phenomena (Laser Interaction & Related Plasma Phenomena) The Crystal Lattice: Phonons, Solitons, Dislocations, Superlattices Books of Breathing and Related Texts -Late Egyptian Religious Texts in the British Museum Vol.1 (Catalogue of the Books of the Dead and Other Religious Texts in the British Museum) Kinetic theory of gases, the: an anthology of classic papers with historical commentary (History of Modern Physical Sciences, 1) Transport Phenomena in Multiphase Flows (Fluid Mechanics and Its Applications) Introduction to Transport Phenomena: Momentum, Heat and Mass Advanced Transport Phenomena: Analysis, Modeling, and Computations Transport Phenomena and Materials Processing Theory of Electron Transport in Semiconductors: A Pathway from Elementary Physics to Nonequilibrium Green Functions (Springer Series in Solid-State Sciences) Transport Phenomena in Biological Systems (2nd Edition)