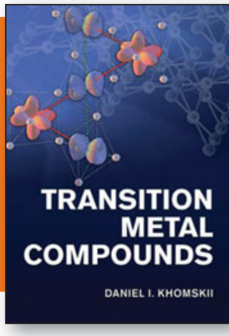


Transition Metal Compounds

Daniel I. Khomskii

Cambridge University Press, 2014
496 pages, $125.00
ISBN 978-1-107-0217-7

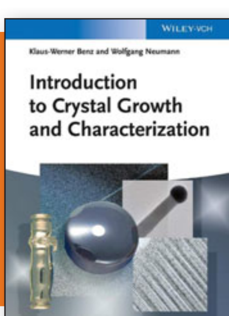
This book gives an overview of transition-metal compounds and the physics of highly correlated systems. The application areas discussed include magnetoelectricity, multiferroicity, high-T_c superconductivity, and spintronics. These systems are classified around a few concepts, including the interelectron Coulomb repulsion between metal sites (U), the site-to-site electron hopping matrix element between metal sites (t), and the number of electrons per site (n).

Chapter 1 describes the simplest system, Mott insulators, where all the sites are occupied ($n = 1$), and there is strong electron correlation ($U/t >> 1$). Chapters 2–8 present modifications of the simple model that give more realistic descriptions of these materials. Chapter 2 summarizes the behavior of isolated transition-metal ions, including atomic physics and the behavior of d orbitals and Hund's rules and spin–orbit interaction. Chapter 3 focuses on the behavior of transition-metal ions in crystals, discussing crystal field splitting, the Jahn–Teller effect, the behavior of high-spin versus low-spin states, spin–orbit coupling effects, and the principles of crystal structure formation. Chapter 4 highlights the role of the oxygen ligand in electron hopping between metal atoms, where oxygen has a small effect on the hopping rate in Mott–Hubbard insulators and a large effect in charge-transfer insulators. Chapter 5 discusses a wide variety of magnetic structures and their effect on the character, sign, and strength of the exchange interaction. These concepts are applied to magnetic anisotropy, magnetostriction, and weak ferromagnetism. Spinels, face-centered-cubic lattices, and frustrated magnets are given as magnetic ordering examples. Chapter 6 describes the cooperative Jahn–Teller effect, where structural phase transitions lead to splitting of the degenerate crystal orbitals. Chapter 7 describes ordering phenomena associated with charge degrees of freedom. There is an extensive discussion of charge ordering occurring with systems having non-integer numbers of electrons per site. Chapter 8 builds on the concepts developed in chapter 7 and discusses magnetoelectrical coupling in multiferroic materials.

Chapter 9 extends the previous chapters to systems having non-integer electron occupancy per site ($n < 1$), but with strong electron correlation ($U/t >> 1$). In this chapter, the author delves into high-T_c superconductors. In chapter 10, the author discusses the general case of variable U/t, focusing on metal–insulator transitions in Mott insulators. Chapter 11 applies these ideas to rare-earth and actinide systems containing partially filled f orbitals.

Each chapter is self-contained and has a helpful summary at the end. There are three appendices giving the history of the key concepts, an explanation of the method of second quantization, and a discussion of Landau theory. The references list critical books and review articles. The equations and illustrations enable an understanding of how these materials work and provide clarity. Khomskii successfully leads the reader through the field of transition-metal compounds by focusing on physical insight without detailed mathematical derivations. He has a deep understanding of the field and communicates his knowledge very well. This book can be used as a textbook for students with a background in solid-state physics or inorganic chemistry, although exercises are not included. It can also serve as a reference book for entry into the transition-metal compound field.

***Reviewer: Thomas M. Cooper** of the Air Force Research Laboratory, USA.*



Introduction to Crystal Growth and Characterization

Klaus-Werner Benz and Wolfgang Neumann

Wiley-VCH, 2014
438 pages, $120.00
ISBN 978-3-527-31840-7

Single crystals are important to many industrial and commercial applications, including electronics, solar cells, light-emitting devices, lasers, optics, and jewelry, just to cite a few examples. The ability to produce high-quality crystals is also essential for exploring material properties and for developing new applications.

This book is a new classic in the canon of important books on crystal growth and characterization. Its unique purview is to cover the basics of both crystallography and crystal growth, tandem topics that are interrelated. It is both quantitative, with many equations, and descriptive: it is profusely illustrated with insightful figures that make important ideas and theories clear. A few examples are scattered throughout the book demonstrating how the equations are used. It does not contain problems, as would be helpful for a textbook. Its treatment is very modern: it draws on the many discoveries and detailed understanding made possible