Structure and Bonding in Condensed Matter
Carol S. Nichols
(Cambridge University Press, New York, 1995)
ISBN 0-521-46283-5; paper, ISBN 0-521-46822-1

This clearly and carefully written book for materials science students should be extremely helpful in preparing students for advanced theoretical work on structure and bonding or in applying the information given to real materials. Brief introductions connect chapters with preceding ones; even on abstract topics the author connects with the reader and retains interest. The book has the flavor of materials science but invokes and joins materials physics and materials chemistry.

The main thrust of the book is on group theory, which is introduced and applied to identify crystal structures and to underlie quantum mechanical calculations, especially electron energy bands. The table of contents lists the following chapters: Introduction; Group Theory: Background and Basics; Matrix Representations and Characters of Finite Groups; Review of the Mathematics of Quantum Mechanics; The Schrödinger Equation; The Hydrogen Atom; Diatomic Molecules; Translational Invariance and Reciprocal Space; Characterization of Electrons in a Solid; Generalization in Two and Three Dimensions; Crystal Structures; More on Bands; Some Case Studies in Two and Three Dimensions; Free-Electron and Nearly-Free-Electron Systems; Transition Metals; and More Sophisticated Electronic Structure Calculations. Most of these titles are typical of the several available textbooks on electrons in solids, but the underlying group theory makes these chapters special.

The group-theory thrust is continued in the appendices—Stereographic Projections of Some Point Groups, and Character Tables—in addition to sections on quantum mechanics—Atomic Units; Hermitian Operators; The Dirac Delta Function; Moments of Distribution Functions; and the Sommerfeld Expansion.

Energy band calculations of crystalline silicon and copper are presented from the literature and interpreted well. In addition, Carol S. Nichols includes descriptions of energy bands of several materials of contemporary research interest not usually covered in standard solid-state physics courses: amorphous silicon, chemisorbed hydrogen on single crystal silicon, Buckyballs, transition metals, and ruthenium oxide. Many of the problems included extend these ideas to other current materials. This approach makes *Structure and Bonding in Condensed Matter* a refreshing modern work.

Although it is an excellent and coherent book, the text has a few drawbacks. The book references little of the relevant work on "bands and bonds" written earlier by several solid-state physicists. Important contributions in the 1970s by Phillips and Van Vechten on mixed ionic/covalent bonding, which really superseded the pioneering work of Pauling, is also not included. Although several band structures are shown and interpreted, only a couple of the many alternative techniques of calculating energy bands are discussed—even in the chapter entitled "More Sophisticated Electronic Structure Calculations."

Several of the simple energy versus k-vector diagrams show flat bands with sharply rounded corners rather than parabolas. Students not acquainted with such curves and who learn that electron group velocity is proportional to the slope of E versus k might be puzzled, asking why the electron velocity goes to zero far from the Brillouin zone boundary

In summary, *Structure and Bonding in Condensed Matter* is a fine first book by Nichols. Its length is finite and it has a specific focus: group theory and its relation to crystal structures and energy band calculations. Perhaps a second edition or another book from Nichols would extend the purview of this one in a profitable way.

Reviewer: *Wendell S. Williams is Professor Emeritus of Physics and of Materials Science & Engineering at the University of Illinois at Urbana-Champaign and former department chair of Materials Science & Engineering at Case Western Reserve University, Cleveland, Ohio. Williams's research interests include properties of transition metal carbides, nitrides, and borides; electromechanical transduction in biological tissues; and materials science in archaeology and art.*