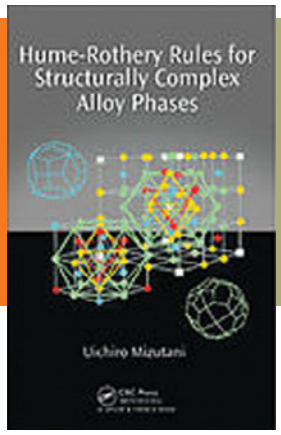

Hume-Rothery rules for structurally complex alloy phases

Uichiro Mizutani

CRC Press, 2011
342 pages, $89.95 (pay per view)
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Hume-Rothery's work in the 1920s and 1930s turned the art of metallurgy into science and contributed to the emergence of solid-state physics. Hume-Rothery or H-R rules express the conditions for alloy formation in terms of the difference in atomic diameters of the constituent elements, electronegativity difference, and electron concentration (electron/atom) ratio of the alloy. Hume-Rothery (H-R) rules for formation of alloys continue to be important. For example, quasicrystals, whose crystallographic structures did not follow the classical definition of crystals, respect these rules and some of them were discovered using H-R rules as guidelines. In this book by Uichiro Mizutani, the main concern is the electron concentration rule and the book provides deep insights into this topic using first-principles band calculations.

The book is well organized. The first three chapters review the early theories. Several key concepts are discussed in chapters 4 to 6, such as mechanisms for the formation of pseudogap at the Fermi level, using linear muffin-tin orbital-atomic-sphere approximation (LMTO-ASA), and the full-potential linearized augmented plane wave (FLAPW). This part of the book assumes a background in quantum mechanics. The calculations are made on alloys containing 52 atoms per unit cell, whereas the term "structurally complex alloys" used in the title of the book would include giant unit cells with thousands of atoms with well-defined clusters. Chapters 7 to 10 apply the concepts developed to metallic alloys.

The author introduces "the effective Fermi sphere" and H-R plots based on first-principles calculations. Mizutani derives an effective valency for transition metals (TMs) and points out they take positive values which depend on the atomic environment. Frequently, negative values suggested by Raynor for TM are used in calculations for Al-TM alloys and positive values suggested by H-R for the same TM in the case of Cu–TM alloys. Mizutani shows that the use of valence electron concentration instead of valency assigned in the periodic table results in a better correlation with many properties. For example, Cu has a value of 11 and 1, respectively, for these parameters.

In summary, this book will serve as a good reference work for graduate students in metallurgy and physics and researchers in metallurgical laboratories and industries. It is Hume-Rothery revisited in the light of first-principles calculations. It is therefore appropriate to point out one feature of the concluding chapter11. Hume-Rothery's famous book in 1948, *Electrons, Atoms, Metals and Alloys*, is entirely in the form of a conversation between a young scientist and an old metallurgist. Mizutani adopts the same format for the last chapter of this book. The dialogue continues.

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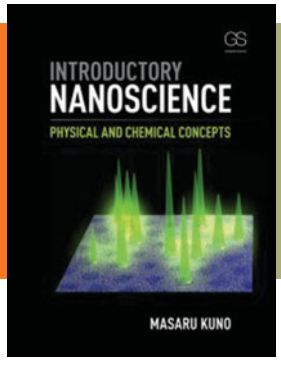

Introductory nanoscience: Physical and chemical concepts

Masaru Kuno

Garland Science: Taylor & Francis Group, 2011
420 pages, $115
ISBN 978-0-8153-4424-7

Introductory Nanoscience is a textbook for upper-level undergraduate and beginning graduate students, particularly those with a background in chemistry. The book discusses the structure of various nanomaterials, addresses the optical and electronic properties, and describes some important synthesis and characterization methods. In order to highlight underlying fundamental concepts, the text provides a substantial discussion of relevant results from quantum mechanics and band theory.

The text is not a comprehensive introduction to nanoscience. For instance, while there is a significant discussion of solution-phase nanoparticle growth, the section on molecular beam epitaxy is short, and a number of other synthesis methods are left for the "Thought Problems" or references sections. Similarly, only a few representative measurement techniques are described in the body of the text.