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Intermetallics. Structures, Properties, and Statistics. By Walter Steurer and Julia Dshemuchadse. Oxford University Press, 2016, Hardcover, Pp. 592. Price GBP 85.00. ISBN 9780198714552

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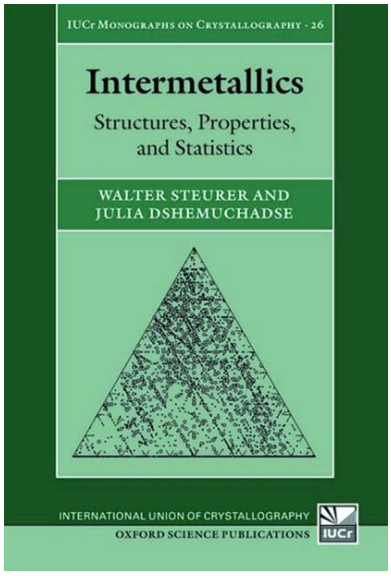

Intermetallics are solid-state compounds exhibiting metallic bonding, defined stoichiometry and ordered crystal structure. It is now a century since it was recognized in an early book (Giua & Lollini Giua, 1918), written by Michele Giua, Professor of Industrial Chemistry at Turin University together with his wife Clara Lollini Giua, that numerous compounds could form. Many more were discovered in the following decades. A few gained increasing industrial interest, *e.g.* aluminides, but it was only in 1993 that a dedicated journal, *Intermetallics*, was founded by the late Robert Cahn. Now, here comes the book *Intermetallics* with subtitle *Structures, Properties and Statistics* by Walter Steurer and Julia Dshemuchadse which sets a new paradigm in the topic by analyzing the structure and classifying the tens of thousands intermetallics known to date.

The book is divided in two parts: Concepts and Statistics are the content of Part I and Structure and Properties of Part II. The text is full of information filling more than 500 pages. It has an extensive literature section as well an index of chemical formulae. A useful list of abbreviations and a glossary are provided. The linguistic approach is rigorous in terminology and in making reference to theories, methods and rules.

Chapter 1 gives the basic terminology concerning symmetry, lattices, atomic environment types. It is clear and well organized. I would suggest it to students of materials science courses to learn definitions properly.

The second chapter summarizes the factors governing structure and stability of intermetallics with emphasis mainly on quantum chemistry. The quantum chemistry methods employed in the literature are mentioned with a short description of up to one page. For the reader not experienced in this topic, this section is of limited usefulness considering also the absence of illustrations. It is understood a more lengthy treatment would have diverted the text from its main objectives. The authors, however, direct the reader to the relevant literature for all methods. Being perhaps biased by my thermodynamic background, I felt the stability issue could have been tackled also by mentioning the methods employed to evaluate the Gibbs free energy of intermetallics, especially because the calculation of this quantity is an expanding topic for those performing phase diagram calculations including the calculation of the enthalpy of formation from first principles.

The description of tilings in Chapter 3 is detailed, though concise, with good examples and images. This represents the basis for building up the structure of complex intermetallics through an accurate description of polyhedra and packings. The next step is the treatment of *n*-dimensional spaces to represent the structure of both complex periodic and aperiodic compounds in Chapter 4.

The following Chapter 5, is the most innovative one dealing with a statistical analysis of the occurrence of intermetallics in binary (the largest number), ternary and higher order systems. This is a striking amount of work carried out with absolute competence and corroborated with several examples of structure types.

The structure of compounds is classified according to the Pettifor chemical scale, which is used extensively. Apparently, the Pettifor scale is successful in indicating the zones of the plot of the Mendeleev number of constituents where structures can be found. This can be considered as an indication for predicting new compounds, although not explicitly stated in the text. I have a problem with the readability of such plots which are necessarily

numerous and, therefore, reduced in size. I wonder whether they could be provided in an electronic version together with the book.

The second part of the book deals with the structure and properties of intermetallics.

The first chapter of this part (Chapter 6) describes the structure of all allotropes of metallic elements in the Periodic Table including the effect of pressure on each of them. It is extremely detailed in the discussion of data which may be very appealing to the reader interested in this general topic.

Chapter 7 on the structure of intermetallic compounds is a book in within a book, covering more than 200 pages. The *leitmotif* in the first paragraphs on phase types (Heusler, Frank–Kasper, Laves, Zintl, *etc*.) is the geometrical description of atomic packing. The paragraphs following contain detailed descriptions of the structure types of binary and some ternary compounds. It is impossible to mention all details provided on structures of interest. The chapter is the place for professional crystallographers to look for classifications which could approach the 'big picture' (in the authors' words) of the formation and stability of intermetallic compounds. It ends with a minor paragraph on a new class of materials called high-entropy alloys, actually multicomponent solid solutions. No doubt these are intermetallic systems, however, they do not comply with the introductory statements of the book which deals with compounds. It is understood the topic is introduced because it is presently 'hot' for both fundamental studies and property discovery. However, the brief chapter only provides a general definition of these materials, not a thorough review of the literature which would deserve much more space.

The following Chapter 8 is strictly related to the previous one in terms of statistics of the number of structures and methodology for presenting the structure of compounds. It describes complex intermetallics which are defined as those compounds containing at least 100 atoms in their unit cell. The reason for the occurrence of such complex compounds is discussed in structural and energetic terms.

Chapter 9 reviews the structures of the stable quasicrystals, both decagonal and icosahedral, known so far. The concept of atomic cluster overlap is extensively used to represent the structure of quasicrystals and of their approximants as well as the growth of such phases and their stability. The first quasicrystals discovered were metastable compounds produced by rapid solidification. Thermodynamically stable ones were found a few years later. This shows the relevance of metastability of intermetallic compounds which has not been treated in this book (rightly so, because it would have required a large digression) apart from discussing the non-existence of high-order approximants in Chapter 9.

The final Chapter 10 reviews the structural features of some intermetallics of importance for functional properties (ferromagnetic, magnetocaloric, thermoelectric, *etc*.). It is useful to the reader that each property is briefly defined at the beginning of the respective paragraph. For the sake of completeness some compounds containing silicon and boron are also included in this chapter.

Overall, this book is an extremely valuable collection of information on the structure of intermetallic compounds. It will represent an essential landmark for many years to be used for specialized teaching and for consultation by professionals in the field.

Reference

Giua, M. & Guia-Lollini, C. (1918). *Chemical combination among metals*, translated from *Combinazioni chimiche fra metalli* by Gilbert Wooding Robinson. London: Churchill, xiv+341 pp.