

prior to publication, the references generally stop at 1968. This means that topics such as Weare's treatment of the energy gap in amorphous materials, Levine's bond-charge theory of non-linearities, the transient analysis of parametric amplification and short pulses, and the present experimental situation in the investigation of parametric processes are at best treated sketchily, if at all. However, the book is already 1026 pages long, and, as is hoped by the author, its qualities outweigh its defects and it is to be recommended.

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Infrared and Raman spectra of crystals. By G. TURRELL.

Pp. xii + 384, 101 Figs., 73 Tables. London: Academic Press, 1972. Price £8.50, \$26.50.

The study of infrared and Raman spectra of crystals has rightly attracted considerable attention in recent years from both chemists and physicists. Professor Turrell's book is an admirable account of the theory behind these spectra and their detailed interpretation for a variety of systems. In the first five chapters he gives a very clear and intelligible account of the normal modes of vibration of both molecules and crystals, and of their interaction with light. The description of the relevant group theory is particularly well presented. In the final three chapters he applies the formalism to the determination of interatomic forces in pure crystals, polymers and crystals containing defects.

The book should be particularly useful to students commencing optical work on normal modes of vibration, because the text is unusually clear and gives adequate detail for the student to follow.

Unfortunately the book cannot be recommended as providing a broadly based survey of the infrared and Raman spectra of crystals. There are many topics for which infrared and Raman spectra have and do provide vital results but which are not included. Polaritons are mentioned without any comment that they may be observed with Raman scattering techniques; interatomic forces in the perovskite lattice are discussed in detail without any reference to temperature dependent normal modes and phase transitions; no reference is made to work on electronic or magnetic excitations in crystals. The student's insight into Raman and infrared techniques would also have been greatly improved if the book had included a chapter on experimental techniques. In short the book would have been more appropriately titled, 'The theory of the infrared and Raman spectra of molecular crystals'.

The book, which will be of great use to many students, left this reviewer pondering how foolish we are to separate physicists and chemists from one another when we both have need of each other's insights. It is well produced, with clear diagrams and a good index.

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Chemical bonds in solids. Vol. 1. General problems and electron structure of crystals. Chemical bonds in solids. Vol. 2. Crystal structure, lattice properties and chemical bonds. Edited by N. N. SIROTA, Pp. xii + 163 (Vol. 1), xii + 133 (Vol. 2). New York: Consultants Bureau 1972. Price \$43.00 each.

These two volumes are the first of four volumes under the collective title *Chemical Bonds in Solids*, which are revised and reorganized translations of the two Russian books *Chemical Bonds in Crystals* and *Chemical Bonds in Semiconductors*. The original books were the published proceedings of a conference on 'Chemical Bonds' held in Minsk between 28th May and 3rd June 1967, plus a few specially incorporated extra papers. The English versions are direct translations from the Russian, except in the case of non-Russian authors where the original manuscripts were consulted.

Vol. 1 is divided into two parts, the first of which contains 16 papers mainly on semiconductors, including three on gallium arsenide, and transition-metal compounds. Most are concerned with the physical consequences of the type of chemical bonding between atoms. The second part contains 11 papers dealing with electron distributions in crystals, involving resonance spectra, reflexion spectra, some theoretical calculations and a neutron diffraction study of magnetic structures.

Similarly Vol. 2 is divided into three parts, the 12 papers of the first part being of most interest to crystallographers, containing papers on inorganic crystal structures together with papers on magnetic susceptibility, carrier mobility, band structure and radiation damage in various solid systems. The 10 papers of the second part are concerned with the lattice dynamics of crystals, involving neutron and X-ray diffraction techniques with theoretical calculations. Finally there are three papers on defects, elastic and thermal properties of crystals.

Since all the papers date from 1967 it is inevitable that they are at least five years out of date and no longer in the mainstream of research. The interest to crystallographers is very limited, the majority of the papers being of interest to solid state physicists and inorganic chemists working on solids. In view of this it can be concluded that both volumes will find a place in the reference libraries of research institutions working on these specialist research topics.

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Technik-Wörterbuch. Kristallografie. Englisch-Deutsch-Französisch-Russisch. 1. Auflage 1972. By K.-O. BACKHAUS, Pp. 132. Berlin: VEB Verlag, 1972. Price 20 DM.

This work is a technical dictionary covering 2042 words and phrases in the field of crystallography in the languages English, German, French and Russian.

The first section gives translations from English to the other three languages and to each English word or phrase

there is allocated a reference number. The other three sections, one for each of the languages German, French and Russian, lists these words and phrases alphabetically and also gives the reference number so that the equivalents can be found in the 'English' section.

The coverage of the field is comprehensive and the book is recommended as part of the reference library available to the crystallographer.

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Oxide magnetic materials (2nd Ed.). By K. J. STANDLEY. Pp.viii+254. Oxford Univ. Press, 1972. Price £5.50.

This book on oxide materials has both strengths and weaknesses. Its strengths lie in the subjects with which the author has had most experience. Chapter 9, for example, is an excellent exposition of the propagation of electromagnetic waves in a magnetized medium. Conditions for ferromagnetic and ferrimagnetic resonance are developed. Most of the discussion is on polycrystalline materials, but tables of results on single-crystal specimens of ferrosinels and rare earth garnet materials are given. Chapters 5 and 6 deal with magnetic and electrical properties mainly of ferrosinels and garnets. Chapter 8 deals with low-frequency applications and while not much recent work is described, it contains useful information for the non-expert. Of special interest is the explanation of the desirability of square-hysteresis-loop ferrites for magnetic core switches which have been so important in the development of big computers. Chapter 10 is on high-frequency ferrite devices and includes a description of the microwave gyrator and how it is used in the isolator and in circulators. These devices make use of the Faraday (non-reciprocal) rotation of electromagnetic radiation by the ferrimagnetic material.

Several of the chapters may be of more direct interest to the crystallographer. The first chapter gives a classification of magnetic materials according to five main groups. Two, weak ferromagnetism and metamagnetism, are omitted. The latter is relatively unimportant but I believe that the former is important and deserves to be listed separately inasmuch as it is really distinctly different from antiferromagnetism, especially on a magnetic symmetry basis. In his discussion of some weak ferromagnets in Chapter 11, the author does not mention anything about magnetic symmetry, and while he correctly cites a discussion of weak ferromagnetism by Moriya in 1963, he does not cite the 1957 work of Dzialoshinski, the first to establish clearly the existence of weak ferromagnetism and its relation to magnetic symmetry.

The author describes (p. 3) antiferromagnetism as 'balanced ferrimagnetism'. With this definition, $\{Y_2Ca\} [Fe_2] (Fe_2Si)O_{12}$ would be an antiferromagnet. This *should* be called a 'compensated ferrimagnet'. The reason is that the tetrahedral and octahedral sublattices are still each ferromagnetic; only the *interactions* between the crystallographically non-equivalent sublattices are antiferromagnetic. The antiferromagnetic space groups must require that each sublattice itself be antiferromagnetic; or conversely, no magnetic space group can *require* that two sets of nonequivalent sites have exactly *oppositely* directed spins.

Chapter 2 gives a brief survey of preparative techniques and is fairly well referenced. I would not choose the Verneuil process as 'a relatively quick method of preparing new oxide compositions as single crystals'. The first use of the flux technique was not in 1950; tiny emeralds were grown from a lithium molybdate flux in 1888. The method by which we prepared a substantial number of polycrystalline garnet specimens of laboratory size over the last decade and, in fact, the first specimen of yttrium iron garnet which gave the theoretically predicted 0 K magnetization, is not mentioned.

Chapter 3 discusses the important magnetic oxide crystal structures. The only way (p. 25) that 'apparently simple ferrite formed from, say, nickel and iron oxides may turn out to be mixed... resulting possibly in the mixed ferrite $Ni_{1-x}^{2+}Fe_x^{2+}Fe_2^{3+}O_4^{2-}$ ' is by making a mistake in the initial proportions of nickel and iron oxides used. There are later and better lattice constants for almost all the garnets listed in Table 3.5 (p. 35). Geller and Gilleo did not imply a 'rattling' of ions in the YIG structure nor that 'forces maintaining it (the garnet structure) are relatively weak...'. Garnets are rather hard; the carbon atoms in diamond are inefficiently packed and diamond is very hard. It is well known, contrary to the author's statement on p. 36, that all garnet ions are not trivalent and even in many of such cases, the garnets have high resistivities. In reference to the orthoferrites the author states 'The subunits are not quite cubic since the cubic relationship $a=b=c/\sqrt{2}$ is not obeyed.' Of course, even if it were, this does not mean that the crystal is necessarily cubic. Chapter 11 also contains some crystallographic myths, the perpetuation of which does not seem to be hampered by scientific results. One of these is the 'slight' distortion which is far from being slight; another is the cubic phases which are far from being cubic as in the case of the $LaMnO_3-LaCrO_3$ system, in which no composition is cubic. $LaCrO_3$ itself does not become cubic below 1873 °K.

Chapter 4 is titled 'Magnetization in Ferrimagnetic Materials'. The Néel theory of ferrimagnetism is given in some detail. The Yafet-Kittel theory is discussed and a diagram of a possible ferrimagnetic spin configuration is given. However, the model proposed by me which accounts well for the behavior of substituted yttrium and gadolinium iron garnets is not discussed explicitly. The Yafet-Kittel theory, which originally treated nickel-zinc ferrites, predicts that at a certain substitution of the diamagnetic ion, a transition from a ferrimagnetic to an antiferromagnetic ground state occurs. This prediction is based on molecular field coefficients of the original ferrosinels, in this case, nickel ferrite. As has been discussed elsewhere, this does not appear to be a completely tenable theory for substituted ferrimagnets even though it has merit. My model includes the different ground states, but allows random canting associated with the random substitution to occur in both ground states. It was pointed out in our early *Bell System Tech. J.* paper that this model would apply to the ferrites as well as to the garnets.

The author actually discusses the gradual weakening of $A-B$ interactions (it should be the weakening of the *average* $A-B$ interaction) and the canting but does not efficiently attribute this idea to anyone. On p. 72, it appears that he attributes it to Néel's 1950 paper. Néel's 1950 paper discusses the unsaturation of one of the sublattices upon large substitution of Zn^{2+} for Ni^{2+} but it does not mention or imply moment canting.