Advanced Aluminum Alloys Containing Scandium: Structure and Properties

L.S. Toropova, D.G. Eskin, M.L. Kharakterova, and T.V. Dobatkina (Gordon & Breach Science Publishers, Newark, NJ, 1999)
175 pages, $75.00
ISBN 90-5699-089-6

Although scandium (Sc) was discovered by L.F. Nilsson in 1879, the first industrial patent on an aluminum-scandium alloy was taken by Willey only in 1971 (U.S. Patent No. 3,619,181). Even in 1998 the "Teal Sheets" published by the Aluminum Association "International Alloy Designations and Chemical Composition Limits for Wrought Aluminum Alloys" did not contain a single industrial alloy on the basis of the Al-Sc system, or even with small additions of scandium. For this reason the reviewed monograph is unique because it provides an interested reader or an alloy developer with a considerable amount of experimental information on multicomponent aluminum alloys containing scandium. It incorporates a significant coverage on microstructure and its evolution under the conditions of different thermo-mechanical treatments as well as physical and mechanical properties of a number of Al-Sc-X alloys.

The book consists of an introduction, five chapters, conclusion, and a list of references (which reflects mostly the work done in Russia during the last 10–15 years). Chapter 1 contains information on peculiarities of physico-chemical interaction between aluminum and some transition metals (including Sc). Phase diagrams of the Al-Sc, Al-Sc-TM, and some other ternary and quaternary diagrams are described in Chapter 2. These studies reflect mostly the experimental work done by the authors, but the self-consistent evaluation of phase equilibria and thermodynamic properties was not performed (see, e.g., *CALPHAD*, by N. Saunders and A.P. Miodownik, Pergamon, Oxford, 1998; see *MRS Bulletin*, September 1999 for a review). Chapter 3 contains valuable information on decomposition of supersaturated solid solutions and precipitation hardening in Al-Sc alloys. The supersaturation can be brought about either by rapid solidification or solution heat treatment and quenching. The main strengthening effect was achieved through solid state precipitation of the supersaturated alloys to result in fine coherent $L1_2$ Al_3Sc particles. Chapter 4 provides information on recrystallization of Al-Sc alloys; it is noted that such alloys are highly stable with respect to recrystallization. Finally, Chapter 5 gives a detailed description of mechanisms of hardening of Al-Sc alloys and describes a remarkable grain-refining effect of small additions of Sc on different aluminum alloys, especially in combination with Zr.

This monograph will be a valuable resource for specialists in physical and mechanical metallurgy of aluminum alloys, and to graduate students specializing in metallurgy and materials science.

Reviewer: *Michael Glazov is with the Alcoa Technical Center in Western Pennsylvania. His present assignments include computer simulation of microstructure evolution, understanding of light scattering from rough metallic surfaces, and applications of extended x-ray absorption fine structure (EXAFS)-spectroscopy. He has ~60 publications, organized two MRS Symposia and received the 1994 MRS Graduate Student Gold Award and the 1995 MRS Graduate Student Silver Award. He received a PhD degree in materials science from the University of Pennsylvania in 1995 and a PhD degree in physical chemistry from the Russian Academy of Sciences in 1987. Dr. Glazov expresses his sincere gratitude to Dr. John Liu, of the Alcoa Laboratories, for a useful discussion when writing this review.*

The Inorganic Chemistry of Materials

Paul J. van der Put
(Plenum Press, New York, 1998)
391 pages, $95.00
ISBN 0-306-45731-8

This book sets out to offer practicing technologists sufficient information for decisions to be made regarding the synthesis of materials with the intention of avoiding detailed scientific theories by just concentrating on the essential facts. This is a very worthwhile aim but, unfortunately, I do not feel that the author has achieved this goal. My main interest is materials, so I am unable to comment competently on much of the detailed chemistry that is included in the book, except to say that it appears to take a lot for granted and, without a thorough grounding in the fundamentals, it is difficult to gain a great understanding. I suppose the things that concern me most are that in the areas about which I feel that I am fairly knowledgeable, there are serious omissions and errors. For example, many of the phase diagrams do not label the vertical axis and in many of the diagrams, the phase fields are either not identified or are incorrect. This could be very confusing to the uninitiated. Similarly, free energy curves are simply stated with very little explanation and to present free energy curves in relation to a phase diagram without identifying the phases on either diagram is meaningless.

Furthermore, some of the definitions do not follow those usually used in materials science. For example, "Toughness in a material is somewhat related to the crystal structure"; the usual definition of toughness is the ability of a material to resist crack propagation. However, my greatest concern is the author's poor knowledge of thermodynamics. For example, all the Ellingham diagrams have ΔG, free energy change, as the ordinate rather than ΔG^0, standard free energy change, which makes an enormous difference as, in order for ΔG to be meaningful, all the activities and partial pressures of the products and reactants need to be stated.

The entropy of mixing is stated to be zero at 0 K, yet the line above gives an expression for the change in entropy at 0 K which does not go to zero. Unfortunately, I could go on with other examples. Obviously, materials and thermodynamics may not be the author's primary interest but this does not excuse the numerous major errors of fact. I hope that the rest of the book is more factually correct but my experience, as already outlined, does not allow me to recommend the book with confidence.

Reviewer: *Derek Fray is Professor of Materials Chemistry in the Department of Materials Science and Metallurgy, University of Cambridge. His main interests are solid electrolytes and molten salts and the application of these materials to solving industrial problems.*

The following recently published books, relevant to materials science, have come to *MRS Bulletin's* attention. Some of the books listed here may be reviewed in future issues of *MRS Bulletin*.

Books

Cambridge Guide to Minerals, Rocks, and Fossils, A.C. Bishop, A.R. Woolley, and W.R. Hamilton. Cambridge University Press, Cambridge, United Kingdom, 2000. 336 pp., $14.95, ISBN 0-521-77881-6.

Chemical Mechanical Polishing in Silicon Processing, Shin Hwa Li and Robert O. Miller. Academic Press, San Diego, 2000. 307 pp., $160.00, ISBN 0-12-752172-0.

Cryochemical Technology of Advanced Materials, Yu. D. Tretyakov, N.N. Oleynikov, and O.A. Shlyakhtin. Chapman & Hall, New York, 1997. 323 pp., $185.00, ISBN 0-412-63980-7.

The Diamond Makers, Robert M. Hazen. Cambridge University Press, Cambridge, United Kingdom, 1999. 244 pp., $15.95, ISBN 0-521-65474-2.

Electrodynamics of Materials: Forces, Stresses, and Energies in Solids and Fluids, Scipione Bobbio. Academic Press, San Diego, 2000. 364 pp., $79.95, ISBN 0-12-108260-1.

Electroluminescence I, Gerd Mueller, vol. ed. Academic Press, San Diego, 2000. 331 pp.,

$160.00, ISBN 0-12-752173-9; **Vol. II**, 257 pp., $160.00, ISBN 0-12-752174-7.

Fluid Dynamics at Interfaces, Wei Shyy and Ranga Narayanan, eds. Cambridge University Press, Cambridge, United Kingdom, 1999. 461 pp., $100.00, ISBN 0-521-64266-3.

Fractography: Observing, Measuring and Interpreting Fracture Structure Topography, Derek Hull. Cambridge University Press, Cambridge, United Kingdom, 1999. 366 pp., $44.95, ISBN 0-521-64684-7.

Fundamentals of Adhesion and Interfaces, Lawrence P. DeMejo, Donald S. Rimai, and Louis H. Sharpe. Gordon & Breach Science Publishers, Newark NJ, 1999. 333 pp., $85.00, ISBN 90-5699-682-7.

Gallium Nitride (GaN) I, Jacques I. Pankove and Theodore D. Moustakas. Academic Press, San Diego, 1998. 517 pp., ISBN 0-12-544056-1; **Vol. II**, 1999. 489 pp., $129.95, ISBN 0-12-544057-X; $129.95.

Geometrical Frustration, Jean-Francois Sadoc and Remy Mosseri. Cambridge University Press, Cambridge, United Kingdom, 1999. 307 pp., $100.00, ISBN 0-521-44198-6.

Handbook of Giant Magnetostrictive Materials, Goran Engdahl, ed. Academic Press, San Diego, 2000. 386 pp., $160.00, ISBN 0-12-238640-X.

Handbook of Superconductivity, Charles P. Poole, Jr., ed. Academic Press, New York, 2000. 693 pp., $95.00, ISBN 0-12-561460-8.

Intersubband Transitions in Quantum Wells: Physics and Device Applications I, H.C. Liu and Federico Capasso, vol. eds. Academic Press, San Diego, 2000. 309 pp., $160.00, ISBN 0-12-752171-2; **Vol. II**, 244 pp., $160.00, ISBN 0-12-752175-5.

Ionized Physical Vapor Deposition, Jeffrey A. Hopwood, ed. Academic Press, New York, 2000. 253 pp., $145.00, ISBN 0-12-533027-8.

The Magic of Ceramics, David W. Richerson. The American Ceramic Society, Westerville OH, 2000. 290 pp., $45.00, ISBN 1-57498-050-5.

Mathematical and Physical Modeling of Materials Processing Operations, Olusegun J. Ilegbusi, Manabu Iguchi, and Walter Wahnsiedler. CRC, Boca Raton, 2000. 494 pp., $89.95, ISBN 1-584880-17-1.

Optical Crystallography, F. Donald Bloss. Mineralogical Society of America, Washington, DC, 1999. 239 pp., $32.00, ISBN 0-939950-49-9.

Optical Materials, Joseph H. Simmons and Kelly S. Potter. Academic Press, San Diego, 2000. 391 pp., $79.95, ISBN 0-12-644740-5. □

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