

Book news

1. Book reviews

● *Physicochemical properties of molten slags and glasses*, by E.T. Turkdogan. London, Metals Society, 1983. 516 pp. £35.

Reviewer: A.F.S. Schoukens

This book gives an extensive review of the available data on the physical and thermodynamic properties of molten slags and glasses, and is primarily aimed at the university lecturer, the graduate student, and the scientist or engineer involved in pyrometallurgical research or applications. It is a rather specialized book, and the reader is assumed to be familiar with elementary chemical thermodynamics.

Physical properties that play an important role in the melting of slags and in slag-metal reactions are treated in Chapters 1 and 2. These rheological and transport properties include density, viscosity, electrical and thermal conductivity, and mass diffusivity. Thermodynamic properties such as the activities of oxides and reaction equilibria in gas-slag-metal systems are dealt with in Chapters 3 to 6. In Chapter 7, the reaction-rate phenomena of slag reactions are discussed, and experimental data from kinetic investigations are presented. While Chapters 1 to 7 are mostly concerned with the physicochemical properties of relatively simple slag systems, the last two chapters (Chapters 8 and 9) deal with industrial slags and fluxes in pyrometallurgical reactions. These slags include slags formed in iron- and steel-making, as well as slags in the extraction of copper, tin, lead, and zinc. The physicochemical properties of flux-slag mixtures are discussed in relation to their application in metal extraction, metal refining, welding, and casting.

A valuable addition to the book as a research tool is the list of more than 1000 references to publications giving additional information on slag chemistry and thermodynamics.

● *Microstructural characterisation of metals and alloys*, by P.E.J. Flewitt and R.K. Wild. London, Institute of Metals, 1984. £14.

Reviewer: M.P. Shaw

This monograph is one of the most recent publications produced under the auspices of the newly formed Institute of Metals.

The book is aimed primarily at students of metallurgy and materials science, and provides a guide to the techniques and procedures used in the characterization of the microstructure of metals and alloys. The stated intention is to consider techniques that have now reached a stage at which they are widely available as a tool for use by research scientists, although they are not necessarily considered to be suitable for routine application. This includes the theory behind them, the relative benefits they bring, and their application. As a consequence, certain basic techniques are assumed and less attention is given to optical microscopy, although the authors stress that this is a powerful and often essential technique in most

microstructural evaluations.

This relatively slim volume manages to cover a surprisingly broad range of techniques in a way that gives most of the information necessary to ensure a reasonably thorough acquaintance with the physical principles involved and the type of situation in which specific techniques can be applied fruitfully. The range of techniques covered includes scanning electron microscopy, transmission electron microscopy, analytical electron microscopy, X-ray and electron diffraction, a number of spectroscopic and spectrometric techniques, and atom probe microscopy. A rather brief chapter at the end of the book gives some examples of applications.

In view of the type of reader aimed at and the breadth of coverage, there is an unavoidable lack of detail throughout the text, detail that would certainly be required if any of the methods discussed were to be seriously applied in materials research. However, this does not substantially detract from a volume that admirably fills the gap between under-graduate education and applied research. In addition, a comprehensive bibliography provides a useful source of information for those interested in serious use of the various techniques described.

A somewhat disappointing aspect of the book is its standard of production, particularly when so many interesting and informative photographs have been used to augment the text. In view of the source and price of the book, one might expect a higher standard of presentation (although substantial price reductions are available to members and student members of the Institute of Metals).

In summary, the monograph represents a very creditable effort (with few serious competitors) to cover a range of techniques of ever-increasing importance in physical metallurgy. The authors are to be congratulated on a well-thought out text, which should become popular with the student of physical metallurgy and materials science in the early stages of a research career. The main function of the book will be to act as a reliable feeder to more substantial works that cover the material in greater detail, but that would be considerably less digestible to an interested student.

● *Metallurgical applications of magnetohydrodynamics*, edited by H.K. Moffatt and M.R.E. Proctor. London, Metals Society, 1984. 346 pp. U.K. £35, U.S. \$70.

Reviewer: N.A. Barcza

This publication contains the proceedings of a symposium of the International Union of Theoretical and Applied Mechanics that was held at Trinity College, Cambridge, from 6th to 10th September, 1982. Thirty-three papers are presented covering a wide range of applications of magnetohydrodynamics in the metallurgical field. The topics dealt with include the behaviour of liquid metals in melting, smelting, reduction, refining, separation, casting, solidification, and welding.

The papers are generally of a fairly theoretical nature, and most are concerned with rather specific applications. The processes and equipment featuring in the papers include the aluminium reduction cell, induction melting and stirring furnaces, continuous casters for steel, levitation

melting, arc furnaces for steel melting, electroslag refining, and plasma melting and smelting.

Papers worthy of special mention are those dealing with the magnetohydrodynamic effects in aluminium reduction cells, in which the position of the conductors around the cell are optimized by use of a numerical model of the current flow, the magnetic field, and the fluid flows; and with the influence of system geometry on the electromagnetic stirring forces in crucible induction-melting furnaces, in which the use of the Finite Element formulation is very suitable for the solution of the force distribution in the crucible. Plots of force distributions based on a computer model are illustrated in the latter paper.

Another paper worthy of mention is that of experimental measuring techniques in continuous casting. The use of the Variabloc, Permabloc, and Cutibloc measurement systems for the control of the bath level in the mould is described. The non-destructive determination of billet skin thickness is also dealt with.

A more general paper entitled 'On heat and fluid flow phenomena in electric melting and smelting operations' covers mathematical representations of a variety of metallurgical processes. Both liquids and gases are dealt with, the latter for arcs and plasma systems. Magnetohydrodynamics in arc furnaces is examined in a paper that deals specifically with the two regions, the arc and the liquid steel itself. Arc furnaces have no externally applied magnetic fields, but magnetohydrodynamic effects are present because of the high currents. The arc comprises a very strong jet similar to that from a nozzle. The current flow in the steel bath also causes a strong mass flow, giving rise to bath circulation effects.

The subject of magnetohydrodynamics has tended to be neglected as an important aspect of the behaviour of liquid metals. This collection of papers shows that, in recent years with the advent of new technology in the metallurgical industry, a basic understanding of this subject can explain many important phenomena in the handling or processing of liquid metals. Measurements are usually limited under difficult environmental conditions, and the use of models can be of assistance in the improvement of the technology. Several of the papers in this volume are topical state-of-the-art publications and are well worth reading.

● *Extractive metallurgy symposium. Proceedings of a meeting on 12-14 November, 1984, organised by the Melbourne Branch. Parkville (Victoria), Australasian Institute of Mining and Metallurgy, 1985.*

Reviewer: B.K. Loveday

A total of 17 papers on hydrometallurgy, 26 papers on pyrometallurgy, and 7 others were presented at the meeting. Several are aimed at the derivation of models of processes. Topics that could be of interest to South African readers include the following:

- (1) laboratory leaching of an oxidized gold ore with thiourea (1 paper),
- (2) an integrated flotation plant (for nickel) and a carbon-in-pulp plant (for gold) by Kambalda Nickel (1 paper),
- (3) oxidation of gold-bearing pyrite under alkaline conditions (1 paper),

- (4) chloride hydrometallurgy routes for the treatment of sulphide concentrates, the stability of the various complexes being shown as a function of Eh and chloride concentration (1 paper),
- (5) the fundamentals of steel making (a few papers), and
- (6) the teaching of extraction metallurgy (5 papers).

● *Conference on gold mining, metallurgy and geology. Proceedings of a meeting on 9-11 October, 1984, organised by the Perth and Kalgoorlie Branch. Parkville (Victoria), Australasian Institute of Mining and Metallurgy, 1985.*

Reviewer: B.K. Loveday

A total of 16 papers on metallurgy, 9 on mining, 5 on geology, and 6 others are included in this volume. The geological papers describe local deposits, with explanations. One paper speculates on the formation of a gold deposit through precipitation from thiosulphate solution by contact with carbonate and manganese dioxide. Laboratory tests support the hypothesis.

A number of papers describe the re-opening of old mines and the problems encountered underground. The selective open-cut mining of quartz veins and long-hole open stoping in the Mount Charlotte Mine are particularly interesting.

The metallurgical papers cover a wide spectrum. Gravity concentration using spirals, cones, and a new device called a Knelson concentrator is discussed. There are over 200 of these concentrators in operation, and they can be described as centrifugal fluidized beds. Various carbon elution systems are compared in terms of effectiveness and cost, and fundamental aspects of gold adsorption onto activated carbon and ion-exchange resins are discussed. Plant installations are described, including a cost comparison of heap leaching and carbon-in-pulp. Finally, a comparison is made of cyanide, thiourea, and chlorine as lixiviants for gold.

Factors influencing the gold market and the gold-mining industry in Australia are also described.

This volume is a 'must' for anyone involved in research and development on gold, particularly on the metallurgical side.

● *Corporate policies for the 1980's in the steel industry, by Patrick Genevaz in collaboration with B.A. Bloom. La Chambre des Cartes, 26 rue de Piepus, 75012 Paris (France). U.S.\$700, additional copies \$140.*

Reviewer: D.C. Maree

The title of this study may be misleading in that it seems to refer to the steel industry as a whole, whereas only the corporate policies of four steel groups in the U.S.A. and eleven in Europe are discussed. The following countries are dealt with: Belgium and Luxemburg, France, West Germany, Italy, the United Kingdom, and the United States of America.

The study gives the background to developments in the steel industry mainly since 1973 in each country with regard to matters such as production and protectionism, and also deals with developments in the case of individual producers.

For individual companies, aspects and policies relevant to the following are discussed: products, mergers, vertical and horizontal integration, competitors, development strategy, nationalization, and denationalization.

The publication has been well prepared, and is up-to-date. It can be used fruitfully as a reference work for all those actively involved with the steel industry.

- *Mineral processing technology*, by B.A. Wills. Oxford, Pergamon Press, 1984 (3rd edition). 629 pp. Hard cover £31.50, soft cover £9.75.

Reviewer: B.K. Loveday

Dr Wills has revised and expanded his book, which was first published in 1979. Most of the contents of the second edition (1981) have been retained, but the insertion of more detail and photographs has increased the number of pages by 50 per cent.

The chapter on flotation has been improved significantly by the inclusion of more chemistry and detail on modern flotation equipment. The use of computers for the manipulation of plant data, control, and optimization is also discussed. Appendices describing the occurrence and uses of metals and minerals are very useful.

This book covers all the unit operations in mineral technology in sufficient detail for students and operators, and is likely to become a standard text.

- *Management information—managing for improvement, volume 2: symposium proceedings and additional papers*, edited by M. Hammond. Doncaster (England), The Institution of Mining Engineers, 1984. 86 pp. £60 for vols. 1 and 2 (124 pp.).

Reviewer: M.J.R. Meyer

This publication contains 3 papers and the proceedings of a symposium organized by the Institution of Mining Engineers that was held at Harrogate from 8th to 10th December, 1982. The other 13 papers that were presented are included in volume 1.

The theme of the symposium signals a significant departure from those of previous years, which reflected progress in the development and application of mechanization in mining systems. The swing is from the discussion of advances in mining engineering technology to management's use of information technology.

The discussions comprehensively cover such topics as improvement in operation, investigation and forecasting, and mine resource utilization; information technology and management; and the influence of management information systems in the future of mining engineers. The many topics covered mean that an account cannot be given of them all, but the following points are worthy of note.

The session on 'Improving Mine Resource Utilization' covered improvements in the acquisition of information and its subsequent storage and analysis by computers through the improved reliability of the equipment, both by better design and the prediction of imminent failures, and by improved maintenance techniques and organization. It also discussed the use of computer technology in the optimization of the performance of a total system.

The session on 'Information Technology and Manage-

ment' noted that information technology, although far from complete, has increased productivity. Where information technology had been applied in the past, it had to deal with routine, formalized, and rule-bound tasks, whereas more text-related applications are now being tackled. It was mentioned that more effective systems, based on digital storage and intelligent recording devices, are available, and will overcome most of the drawbacks associated with current devices.

The paper on the 'Influence of Management Information Systems in the Future Formation of Mining Engineers' takes an integrated and multi-disciplinary approach to future formation processes for mining engineers. The influence of management information systems on technical and managerial roles is discussed, emphasizing the importance of the co-ordination and integration of specialisms, and underlining the need for flexible formation. Composite formation structures are advocated, including courses common to all engineers involved in mining, incorporating options for specialists. The impact of management information systems on management development methods is reviewed, and it is mentioned that management development must be a continuous process throughout a career and must take cognizance of modern methods of learning, including self-managed methods.

The paper 'Planning 90's Style in 1982' discusses the application of computers to planning, and describes a number of computer systems designed as aids in the planning process, most of which incorporate some form of computer graphics. It points the way towards a possible future integrated computer system for planning, and stresses systems that can be used routinely by managers, with little or no assistance from computer professionals.

The way in which the material is presented (i.e. open discussions of papers published elsewhere) makes it extremely difficult for a reader to follow the points of discussion without access to volume 1 as well. Some very good points were raised, but they can be found only with great effort in the discussion sections.

2. Recent publications

- *Tin and its uses* no. 144, 1985.

This issue by the International Tin Research Institute (Fraser Road, Greenford, Middlesex, UB6 7AQ, England) contains articles on tinplate as a packaging material, interconnections using solder sleeve devices, a modern pewter craftsman, and catalysts based on tin oxide.

- *Canadian minerals yearbook 1983-84*. Department of Energy, Mines and Resources Canada, Mineral Report 33. Ottawa, Canadian Government Publishing Centre, 1985. \$35.40.

This issue of the *Canadian Minerals Yearbook* is a report of developments in the industry during 1983-84. The chapters deal with specific commodities, a general review, a regional review, a list of selected mineral commodities, and a statistical summary.

- *82 Years 1984*, edited by I.O. Jones and R.M. Louthean. Kalgoorlie (Australia), Western Australian School of Mines, 1985. 100 pp.

This, the 1984 annual report of the School of Mines in Kalgoorlie, contains the following feature articles and student papers in addition to a report on events during the academic year.

Feature articles

- A study of gold extraction by chlorination and carbon-in-pulp process, by A. Gupta and G. Martin
- Vacuum lift systems for the transport of broken rock in shafts, by M. Dorricott and I.O. Jones
- Application of EDM techniques to the routine survey of underground mines, by J.E. Maisey, R.D. Lysnar and G.J. Sloan
- SEM Systems for mineral industry applications, by J.P. Vaughan and B.W. Robinson

Student papers

- The origin and geology of the Yeelirrie uranium deposit, by D.H. Reeves
- Developments in metallurgical practices in Sweden, by W. Gosling
- Report on the Fifth Triennial Students Conference of the Australasian Institute of Mining and Metallurgy, by G. Wardell-Johnson

● *Johnson Matthey Chemicals 1984-85*, issued by Matthey Catalogue Sales (Orchard Road, Royston, Hertfordshire SG8 5HE, England). 416 pp.

This catalogue includes the following new items that were added as a result of customers' suggestions: high-purity materials, rare-earth products, precious-metals compounds, platinum laboratory apparatus, and laboratory equipment.

● *South Africa's mineral industry 1984*. Johannesburg, Minerals Bureau, 1985. 190 pp.

This publication is an improvement over the Bureau's review for 1983 in that the cover design is more attractive, the number of commodity chapters is 32 (instead of 20), the statistical coverage has been expanded, a forecast is given of mineral exports for 1985, and recommended lists of publications for further reading are included. The parts are entitled as follows: General Review, Review of Selected Commodities, Statistical Tables, and General Information.

● *Coal 1985. Operating and developing coal mines in the Republic of South Africa*. Johannesburg, Minerals Bureau, Directory 2/85. 1985. 72 pp.

This directory, which is an update of previous editions, lists details of collieries within the confines of the country as supplied by officials of the coal companies concerned. The information is grouped under the names of the controlling companies and includes mine locations, seams worked, coal types, mining and preparation methods, sales tonnages, transport of the products, and chief markets.

● *Gold 1985. Operating gold mines and gold recovery plants in the Republic of South Africa*. Johannesburg, Minerals Bureau, Directory 3/85. 98 pp.

This directory, which is an update of the 1983 directory, provides information on the history, current levels of production, and ore resources of all the gold mines and installations in the country.

3. New journal

Pergamon Press, New York, have announced the publication of a new quarterly known as the *International Journal of Plasticity*.

The scope of the journal encompasses original research on all aspects of plastic deformation of isotropic and anisotropic solids, including the thermodynamics of plasticity and fracture, continuum theory, and macroscopic as well as microscopic phenomena. The topics of interest include plastic behaviour of single crystals and polycrystalline metals, ceramics, rocks and soils, composites and polymers, plasticity aspects of failure, and fracture mechanics. Significant experimental, numerical, or theoretical contributions are welcome for publication. The Editor-in-Chief is Professor Akhtar S. Khan, of the School of Aerospace, Mechanical & Nuclear Engineering, University of Oklahoma, and the co-editors are Professor James F. Bell of the Department of Mechanical Engineering & Mechanics, The Johns Hopkins University, and Professor Nicolae Cristescu, of the Department of Mechanics, University of Bucharest.

The annual subscription is US\$100.

4. Mintek reports

The following reports are available free of charge from the Council for Mineral Technology, Private Bag X3015, Randburg, 2125 South Africa.

● Report M93D

Hydrochloric acid leaching and low-temperature roasting of tin-tungsten concentrates from Van Roois Vley. (First issued April 1983.)

The Metals Division of Shell S.A. (Pty) Limited carried out exploratory work on a fairly large deposit in the north-western Cape referred to as the Van Roois Vley deposit, and Mintek produced high-grade concentrates of the tin-tungsten minerals from this area.

These concentrates were treated for the separation of tin and tungsten and for the production of synthetic scheelite of a purity acceptable to industry for further processing in the manufacture of rock-drill bits.

The process steps were as follows: direct leaching in 10 M hydrochloric acid at 95°C for 3 to 4 hours, dissolution in caustic soda of the tungstic acid formed, and precipitation of the tungsten as synthetic scheelite by the addition of calcium chloride.

This process yielded 99.5 per cent recovery of tungsten into a synthetic scheelite with a tungsten content of at least 61 per cent compared with the end-user's specification of 60 per cent as a minimum. The cassiterite residue had a tin content of 60 per cent or better.

Concentrates from different zones of the deposit did not all respond well to the process. A patented process (no. S.A. 78/6478) using a low-temperature roast with sodium carbonate as the reactant was tested. This process was partially optimized and yielded over 99 per cent extraction of tungsten from the most refractory concentrates produced from various zones of the deposit. However, precipitation of the tungsten from the carbonate mother liquor presented some problems.

The recovery of tungsten from carbonate liquor requires detailed investigation.

● **Report M99D**

The upgrading of coarse kyanite crystals. (First issued May 1983.)

Large crystals of kyanite, which are pseudomorphs after andalusite, were tumbled with water in a rubber-lined mill for the removal of their iron-rich surface coatings. After tumbling for only 5 minutes, the iron content was reduced to 0,35 per cent ferric oxide. However, the crystals still had a coating of impurities, and impurities also remained within the chialtolite crosses inside the crystals.

It is recommended that refractory bricks should be manufactured so that it can be ascertained whether the impurities still present in the kyanite are detrimental to their manufacture.

● **Report M105D**

The development and installation of a microcomputer-based data logger, and the analysis and evaluation of data. (First issued July 1983.)

The production of ferrochromium at Consolidated Metallurgical Industries Limited, Lydenburg, involves pelletization, preheating, prereduction in a rotary kiln, and smelting in a submerged-arc furnace. The furnace-control strategies employed there differed from those of conventional practice.

A stand-alone data logger was constructed and installed to provide a better understanding of the process and to give rise to new or modified furnace-control strategies. The electrical variables of the on-line furnace were monitored over six months and analysed in conjunction with the metallurgical data. Certain problem areas were identified, and additional control techniques are suggested.

● **Report M109D**

The remelting of silicon fines. (First issued July 1983.)

Silicon fines arise when silicon metal is crushed to the size required by the customer. Such fines are not readily disposable and fetch a low price compared with the larger-sized metal.

The remelting of these fines in an open-arc mode in a furnace with a maximum voltage of 120 V was unsuccessful. However, success was achieved when the fines were melted under an acid slag in a submerged-arc mode. Good recoveries were obtained, and there was a considerable reduction in the amounts of calcium and aluminium in the metal.

Preliminary tests were conducted in plasma furnaces of the transferred-arc and diffuse-plasma types. Indications were that refining was achieved, i.e. the calcium and aluminium levels in the product were lower, when fines were melted without a slag cover.

Tests of longer duration using a diffuse-plasma furnace confirmed these results: for one material that was remelted during the campaign, the calcium content of the product was reduced from 0,24 per cent to an average of 0,052 per cent, and the aluminium content from 0,47 per cent to an average of 0,26 per cent.

Large-scale tests with a 1,4 MVA transferred-arc furnace showed that the energy transfer from the plasma to the metal fines was very efficient. No assessment of the degree of refining was made during this campaign.

In an extended campaign using a 100 kVA transferred-

arc plasma furnace, it was demonstrated that metal containing as little as 0,19 per cent aluminium and less than 0,01 per cent calcium could be produced from metal that originally contained 0,45 per cent aluminium and 0,17 per cent calcium.

● **Report M180**

An assessment of available corrosion inhibitors for the reticulation systems of South African gold mines.

Corrosion control by the use of chemical inhibitors is cost-effective in many reticulation systems. This report is intended to inform the mining industry of the methods of corrosion inhibition that are available, and to recommend cost-effective types of inhibitors for particular applications.

The report describes an in-depth study of the loss in mass undergone by mild steel in artificial minewaters representative of those commonly found in South African gold mines. A series of static tests was followed by stirred tests on selected inhibitors, together with surface analyses by Auger electron spectroscopy where these would prove useful in the interpretation of the mechanisms of protection of various inhibitors. Electrochemical studies showed the effective control offered by a phosphonate-phosphate mixture in a realistic hydrodynamic system.

The interference of cooling waters on the action of passivation inhibitors was examined. The performance of phosphonate mixtures is highlighted and the mechanism of protection explained. The mechanisms of protection of all the inhibitors tested are described, as well as the use of natural protection in a water. A number of photographs are included to illustrate the surface condition of steel after the application of certain inhibitors. Future work of a more specific nature is suggested.

● **Report M201**

Quantitative assessments of abrasive and impactive wear from ball-size distributions in rotary mills.

New distribution functions are derived that describe the steady-state size distributions of grinding balls in mills under conditions of combined abrasive and impactive wear. Previously derived and reported size-distribution functions that are applicable under conditions of purely abrasive or purely impactive wear are shown to be special cases of the more general formulae derived in the present work.

The new distribution functions are applied to all the data on ball-size distributions found in the literature, and it is shown that quantitative assessments can be made of the abrasive and impactive components in the total rate of ball wear. The correlation between the calculated values and the known conditions that prevailed in the mills is good.

This clearly indicates that such assessments can be used in the optimization of the metallurgical and chemical characteristics of grinding balls for any given application. Conversely, this information can provide guidelines for the modification and adjustment of factors of mill operation and liner design to give the most desirable combination of impactive and abrasive conditions in a given mill.

The formulae and techniques of analysis developed could also be useful in other applications where particles are consumed at rates proportional to their dimensions.