

panying diagrams. Both could have been improved by use of a larger scale and improved print quality.

Overall the book is well planned and written in a clear concise style. If criticism is to be made it is that the subject matter could benefit by greater emphasis on applications and the crystallographic structural relationships. The book is well produced with clear print and generally good diagrams which again do not do justice to the text, in that they would benefit by higher quality reproduction.

At £35, it is unlikely to be extensively purchased by individuals, but it should find its way into every well-stocked materials science library.

R. S. Stevens

Glass-Ceramic Materials, By Z. Strnad. Elsevier Science, Amsterdam 1986, 268 pp. Price: US\$86.75; Dfl. 195.00, ISBN 0 444 99524 2.

This timely, volume by Dr Strnad represents a distinguished successor to the book 'Glass Ceramics' by the late Professor P. W. McMillan. These materials are of increasing technological importance, yet they are not widely recognised, and few attempts have been made to bring together their science and technology in a readily-assimilable form.

Strnad approaches the subject by first examining the phenomena accompanying the conversion of a glass to a glass-ceramic. He gives a concise thermodynamic description of the processes of phase-separation, nucleation and crystallisation, including details of how the kinetics of these processes may also be studied. In a subsequent chapter, the use of various physical techniques for examining the development of microstructure are outlined.

This is followed by a very useful summary of the crystallisation behaviour of a number of common glass systems—particularly ternary aluminosilicates—emphasising the differences in crystal-phase formation depending on precise composition, thermal history and nucleating agent. For each system, examples are presented of specific compositions, including commercial compositions, to show the variation in physical properties such as thermal expansion, deformation temperature, bending strength, etc.

One of the considerable advantages of glass-ceramic materials is that they are formed in the glassy state and therefore the wide variation of fabrication techniques which exist for glasses can be employed to produce relatively complex shapes which present considerable problems to a traditional powder ceramic route. Dr Strnad devotes a chapter to the procedures involved in the production of a glass-ceramic article from melting, through

forming, with a useful tabulation of the working conditions required by the different forming techniques, and then onto the types of heat treatment suitable for conversion of glass to ceramic and how these relate to the nucleation and crystallisation characteristics of the composition. Other fabrication routes, such as powder sintering and sol-gel, are also described. Further aspects of fabrication are discussed, such as ion-exchange strengthening, coloration and production of microstructures with particular attributes such as orientation, physical machining capability and photolithographically-induced chemical machining capability.

In addition to the ease of their fabrication, the importance of glass-ceramics is that, by careful choice of composition and heat treatment, the physical properties of the product can be tailored to fit specific requirements. Dr Strnad illustrates the range of physical properties achievable by reference to real systems with their applications in mind, and the ground rules by which the properties are controlled are described.

The final chapter is devoted to a very useful compilation of data on commercially available glass-ceramic materials. This also serves to give the newcomer to glass-ceramics an insight to the vast areas of application of these materials. Dr Strnad's book is not only an invaluable summary of glass-ceramic science for those already working in this area but is also a very readable discourse on a subject which will fascinate any person interested in materials science.

D. Holland