Book Reviews

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Phase separation in glass. Edited by *O. V. Mazurin* and *E. A. Porai-Koshits*. Pp. xi + 369. Amsterdam and New York: North-Holland, 1984. Price US $80.75, Dfl 210.00.

In a nutshell, this is a beautiful book, and is a timely and relevant contribution. It is most highly recommended.

The title *Phase separation in glass* tells the reader of the theme, but does not indicate the extent of the excellent discussions and the coherence of the whole presentation. The book contains a rigorous, but always very readable, development of the theory, intertwined with descriptions of the phenomena in glasses. It is this approach that enables the book to succeed so well. The authors have divided the theory into digestable pieces and interspersed it with examples in such a way that a wonderfully logical account ensues. Here the theory runs along, but never away into incomprehension, and there experimental observations are discussed, but never into compilation, and everywhere the whole thing makes such good sense. One is never theoretically overwhelmed, the experimental behavior is always made comprehensible, deviations are clear, and the modifications of theory (additional developments) follow in a rational way. To have 'done' the theory in Part *A*, as an alternative structure to the book, and put behavior into Part *B* would have produced an exhausting (and boring) Part *A*, and an incomprehensible (and irritating) Part *B*.

On having read the book, and upon reflection, it is clear that the whole field of phase decomposition has been covered, and its relation to thermodynamics and kinetics elegantly set forth, a most satisfying feeling. The development of the theory is general and self contained and although glass-in-glass phase separation has been used to illustrate the phase decomposition without the problems of crystalline anisotropy, and is specific in a sense, there is much here of interest to a general readership, both graduate students and mature scientists. This book should be enjoyed by all interested (or who wish to become literate) in a central theme of materials science, namely the scientific basis of phase separation and its temporal development. Additionally, glass scientists will find this a beautiful book covering almost all aspects of inhomogeneous glasses. The editors and the contributors have produced an outstandingly coherent description, with no barriers between chapters and to the interflow of information.

The book is laid out in a very logical and pleasing manner.

The first chapter of the book starts appropriately at the beginning of it all with a *Historical review*. The second chapter is entitled *Theory of immiscibility*. Here in 50 pages a formal free-energy approach is taken to discuss phase diagrams with insight, develop and describe various theories of binary and ternary solutions (regular solutions, ionic models and quasi-molecular approaches) followed by a section on the kinetics of phase separation which covers nucleation rates and diffusion both in and outside the spinodal region. This last section beautifully discusses the whole range of possibilities from sharp to diffuse second-phase boundaries to spinodal decomposition in a coherent way. This overview and stage-setting chapter is well worth reading: it is so clean, so clear, and it doesn't get lost.

The next chapter is concerned with the techniques of determining the structure of two-phase glasses, with discussion on optical and electron microscopy and scattering methods (the section on SAXS is outstanding).

Chapter IV presents a very readable account and review of immiscibility in oxide glass-forming systems. Some interesting points are raised, particularly the immiscibility questions in borosilicate and borate glasses, which are indeed timely. Additional experimentation will go on here. Ternary and multicomponent glasses are also addressed.

Reading right along into Chapter V on *Tie-lines*, this reviewer first really realized fully why this book is so enjoyable: consistently, the reader is led through a very thorough and careful review of all you need to know (in this case about tie-lines and their determination) and only then presented with the actual behavior of various systems, logically ordered. This leads of course to ease of reading and ease of comprehension. What is remarkable, and probably why this book comes off so well, is the timing. Some one hundred or so pages before, discussing the nature of immiscibility, the subject of tie-lines could have been introduced. To have done so would have detracted much from the discussions there, the immediate impact and relevance of the subject at this point would have been lost, and the discussion would have been so much the poorer.

So prepared comes Chapter VI, on *The structure of phase-separated glasses*, a major central aspect of the subject. It is surprisingly 'spartan' in the limited number of photomicrographs actually shown. The essence of the different topography is captured and to have overdone it would be the greater evil. A comparison of electron microscope observations with SAXS investigations on the same glasses shows surprisingly good consistency in the example studies, and may be used as a benchmark study of the credibility of SAXS in determining such parameters as 'the degree of phase separation'. A section on supercritical fluctuations concludes the chapter.

Kinetics, of course kinetics. Again, in a way that is so natural and relaxed that it goes almost unnoticed, the relevant equations of the earlier chapter are displayed and the relation to experimental method established. So it's easy to pass into the temporal development of the Fourier components of the composition fluctuations, and the dominant wavelength and the cross-over point so significant to spinodal decomposition. The actual observed shifts with time, and the developments to understand these since Cahn's classic paper are well described. It's easy to go on into the nucleation and growth regime, where the comparison between the scattering curves under these conditions with those in the spinodal region are most enlightening. The chapter concludes with good and interesting sections on coarsening, homogenization, interdiffusion and viscosity.

The next chapter is on the *Properties of phase-separated glasses*. The chapter begins with a discussion about the properties of the co-existing phases, and how far they may differ from those of bulk glasses of the same composition, followed by interfacial effects as an introduction into particular topics. Rheological properties and electrical properties and their sensitivity on morphology, diffusion, chemical durability, glass transition temperature, density, thermal expansion, strength, and topical properties are equally well discussed.

The final chapter, on the *Practical use of metastable liquid–liquid immiscibility* is quite fascinating in outlining what has been done in various fields, and hints at the volume of work below the iceberg tip still to be done. A major section on porous glasses and their wide variety of uses concludes this chapter and work.

Technically, the book is carefully crafted, with only a few typographical errors.

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