Advances in Physical Metallurgy, edited by S. Banerjee and R. V. Ramanujan, Gordon and Breach Publishers, 1996

The last book with the same title was published by the Institute about six years ago in celebration of Sir Alan Cottrell's 70th birthday. It consisted mostly of invited review papers written with feeling. The latest version is the result of an international conference which was held in India during 1994. It also contains some fascinating papers, most of which are original contributions.

There is one author who has published in both of these proceedings. Robert Cahn's opening article in the Indian conference deals with trends in the subject. But it also contains many wonderful stories with, I think, subliminal messages. Like the case where an understanding of the elastic field of a dislocation could affect national security. His conclusion is a good one, that we need in our subject to study both isolated phenomena in detail and to accept complex problems as a whole. I have avoided a direct quote since that would have required an explanation of a term which is new to the language.

There is a large number of papers dealing with configurationally frozen metastable structures, some of which might contain enough excess energy to cause melting if released inappropriately. Work is reported for a case where heat released during the crystallisation of a metallic glass is such that the reaction snowballs giving temperature fronts which advance at several tens of meters per second.

Another probably metastable structure is the quasicrystal. Such a crystal cannot be represented by one unit cell; its description requires two or more cells tiled together to produce strange symmetries. I was not able to see a use for these quasicrystals; the papers deal mostly with characterisation and structure. On the other hand, the intensity of intellectual attack on these materials has to be admired.

The techniques used for producing highly metastable structures can also be adapted to circumstances where it is not the metastability that is important but the homogeneity. This is because rapid cooling reduces the scale of the microstructure. Bearing alloys contain phases with quite disparate melting temperatures; a description of the processing of such alloys using melt spinning is included.

Atomic order and disorder are as ever, thriving with many papers, both fundamental and applied. There is a remarkable study on changes in the misfit (and crystal symmetry) between γ and γ' in nickel base superalloys as a function of creep strain. A plausible mechanism for these changes is proposed in terms of the distribution of dislocations as a function of strain. Another paper shows how irradiation at low temperatures can readily destroy order; this is in contrast to higher temperatures where the order may be preserved but the precipitates tend to dissolve by ballistic mixing.

The section entitled "Microstructural Evolution" contains a mixed bag of papers. But one on the deliberate manufacture of porous alloys is fascinating. The method involves a high–pressure reaction in which liquid metal containing dissolved hydrogen decomposes into a eutectic mixture of solid metal and gaseous hydrogen. The bubbles can occupy up to 75% of the final volume! Perhaps it is time to look again at the manufacture of sound deadening porous steel. Another isotope of hydrogen features later in the proceedings. Tritium is stored in a metal as a tritide; it is not entirely stable in this form but decays into helium, until about a quarter of the octahedral interstices in the metal are filled with helium. Why a quarter?

It could be argued that ceramics cannot be classified into metallurgy. But this is where creativity comes in. I recall someone saying that high T_C superconductors are metallic. But how does "*Metallurgy* of ceramic cutting tools" qualify? I guess that even the ceramics ultimately contain metals like aluminium!

The proceedings finish with a section on steels and martensitic transformations. In an interesting paper on texture prediction, it is argued that transformation textures cannot be properly calculated using known γ/α orientation relationships because the microstructure that evolves from deformed austenite is not random. This is a different interpretation from an earlier one by the same author, that the final texture may not depend on the observed orientation relation but on the interaction with the nucleation process which involves the Bain strain.

I have enjoyed this book and I think it is well worth having.