Comments on "Spinodal Decomposition in Al/Zn Alloys"

X-ray small-angle scattering experiments have provided strong evidence for spinodal decomposition in an aluminium-22 at. % zinc alloy [1-3]. However, recently Douglass [4] has used the criterion of the existence of "side-bands" in X-ray diffractometer traces as evidence for spinodal decomposition in several quenched and aged aluminium-zinc alloys containing 15 to 38 at. % zinc. In this work only the high-angle side band was consistently observed; nevertheless the result was interpreted in terms of asymmetric side bands indiating spinodal decomposition.

Recently, as part of an investigation of superplasticity in aluminium-zinc alloys, we have studied the decomposition processes in an alloy containing 29 at. % zinc, and have obtained similar diffractometer traces to those of Douglass. It is the purpose of this communication to point out that such evidence is consistent with the presence of the metastable rhombohedral R phase, and is not conclusive proof of spinodal decomposition.

In the present work an alloy containing 29 at. % zinc was prepared from 99.999 % aluminium and 99.995 % zinc. Two types of specimen were studied, namely rolled and recrystallised sheet and a compacted powder disc. Both specimens were solution-treated at 440°C for 30 min, quenched into iced water at 0°C and stored in liquid nitrogen for one day before mounting in a Philips diffractometer. The results for the sheet specimen are shown in fig. 1. The uneven nature of the (200) aluminium matrix peak is due to the coarse grain size of the sheet material, since a smooth peak was observed for the compacted powder mounted on a spinning holder. There is a broad peak at $\theta = 22.82°$ on the high angle side of the (200) aluminium matrix reflection for both the as-quenched condition and after ageing for 2000 min at room temperature. This is in close agreement with an observed θ value of 22.73° and a calculated value of 22.70° for the $(01\bar{1}2)$ R phase reflection in a quenched 29 at. % zinc alloy [5]. No zinc reflections were detectable in the as-quenched condition but faint reflections were observed after ageing for 200 minutes at 20°C. After ageing for 2000 min at 20°C, well defined zinc peaks were observed (fig. 1b).

Specimens suitable for transmission electron microscopy were produced by electropolishing at − 60°C sheet material taken directly from the liquid nitrogen. Thin foils were viewed in the electron microscope at a time corresponding to the X-ray trace in fig. 1a, and no matrix satellite spots were observed in electron diffraction patterns. The above results are in agreement with the work of Krishna Rao *et al* [5] who have shown that the R phase is present after water-quenching a 29 at. % zinc alloy from 400°C.

Douglass has shown a very similar diffracto-

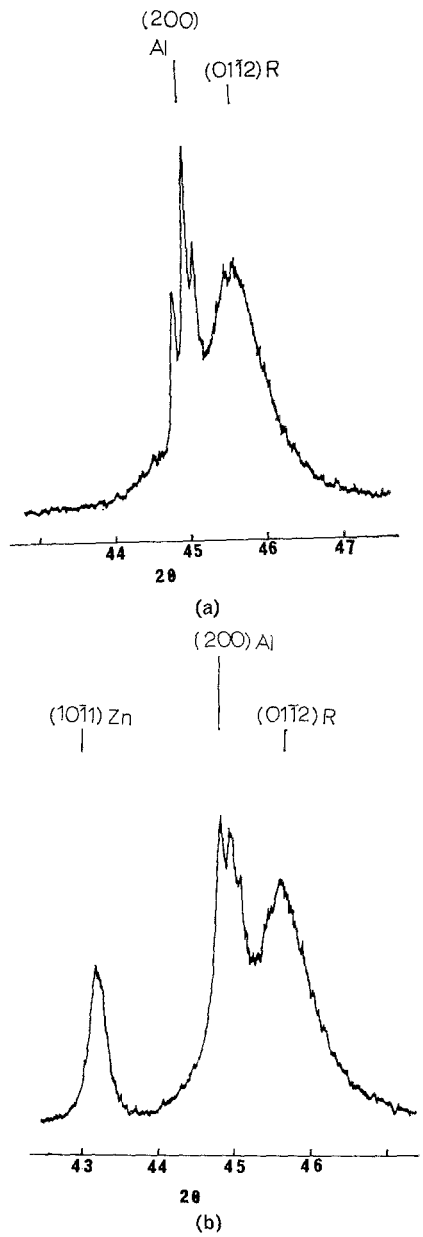

Figure 1 (a) As-quenched sheet specimen, diffractometer trace. (b) Sheet specimen quenched and aged 2000 min at 20°C; diffractometer trace.

meter trace to that in fig. 1 in his fig. 8, for material of the same composition and quenching treatment as that used in the present work. Although he has interpreted his results in terms of an asymmetric side band produced by spinodal decomposition, we can index his "side-band" as an $(01\bar{1}2)$ reflection of the R phase, $\theta = 22.8°$. The R phase peak shown in fig. 1 is more intense than that in fig. 8 of Douglass' paper. This has been demonstrated to be a texture effect as rotation of the specimen about the surface normal reduced the intensity of the peak. Small differences between the observed θ values may be due to differences in rhombohedral distortion of the R phase as a result of differences in quench-rate. Furthermore the observed width of the R phase peak is probably caused by slight variations in the amount of rhombohedral distortion and the small size of the precipitate. Douglass observed asymmetric side bands in specimens of different compositions aged at room temperature and 100°C. Our interpretation of Douglass' results in terms of a metastable phase is consistent with previous work [6-9] which has shown that R phase or fcc α' is produced over a composition range comparable to that investigated by Douglass. Consequently we do not consider that the X-ray data presented by Douglass are satisfactory evidence for spinodal decomposition in his alloys.

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References

1. K. B. RUNDMAN and J. E. HILLIARD, *Acta Metallurgica* **15** (1957) 1025.
2. J. E. HILLIARD and K. B. RUNDMAN, *Scripta Met.* **1** (1967) 37.
3. J. E. HILLIARD, "Phase Transformations" (Amer. Soc. Metals, Ohio, 1970) p. 542.
4. D. L. DOUGLASS, *J. Mater. Sci.* **4** (1969) 138.
5. K. KRISHNA RAO, H. HERMAN, and E. PARTHE, *Mater. Sci. Eng.* **1** (1966) 162.
6. G. J. C. CARPENTER and R. D. GARWOOD, *Met. Sci. J.* **1** (1967) 202.
7. N. A. KHATANOVA and M. I. ZAKHAROVA, *Phys. Met. Metall.* **28** (1968) 955.
8. M. SIMERSKA and V. SYNECEK, *Acta Metallurgica* **15** (1967) 223.
9. K. KRISHNA RAO and H. HERMAN, *J. Inst. Metals* **94** (1966) 420.

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Short Notice

Contemporary Crystallography

Martin J. Buerger

Pp xi + 364 (McGraw-Hill Book Company 1970) 120s

This well-known author gives an introduction to the geometry of crystals and its determination by X-ray diffraction. After a clever presentation of the basic concepts of symmetry, diffraction and the reciprocal lattice (80 pp), the second part of the book (105 pp) deals with the routine determinations of symmetry, lattice type, and cell dimensions. The Weissenberg method and the precession method are also dealt with at some length.

The last five chapters (151 pp) are an exceptionally well-written survey of the investigation of the arrangement of atoms in the cell. A prominent example of Buerger's art of explaining is his introduction to the Patterson function from different points of view.

The book is suitable for beginners in crystallography because the author goes step by step through the deduction assisted by many instructive pictures. It needs an experienced teacher to lead the reader so carefully without lengthening the text. Graduate research workers from many fields, eg chemistry, physics, metallurgy, mineralogy, biology, and materials science will get a quick and enjoyable access to the concepts of the determination of crystal structures.

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H.A.