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On Al_2M-type phases in splat cooled aluminium alloys

As part of a systematic investigation on the structure of rapidly solidified aluminium alloys, we have studied the structure and the decomposition behaviour of a rapidly solidified aluminium–2 at% platinum alloy. The present communication reports the observation of a non-equilibrium phase Al_2Pt in the as splat foils. Fig. 1a shows a typical microstructure and Fig. 1b gives the corresponding diffraction pattern. The diffraction pattern can be indexed in terms of a cubic cell with lattice parameter $a = 5.67 \pm 0.03$ Å. On heating, within the error of the electron diffraction, an increase in the lattice parameter was observed. One of the features of the diffraction pattern is the absence of the 200 reflection. Among the equilibrium phases in the aluminium–platinum system, the only phase which has close similarity to the above structure is Al_2Pt. This phase has the CaF_2 type of structure and its lattice parameter is reported to be 5.922 Å [1]. However, the structure exhibits a weak 200 reflection.

In a similar experiment with Al–8 wt% Fe, Stowell and co-workers [2] observed a cubic phase with lattice parameter 5.85 Å during the precipitation of iron from the single phase region of the splat foil. They assigned a diamond cubic structure to this phase, which accounts for the absence of the 200 reflection. However, the calculated atomic volume of the structure is 25.03 $Å^3$ which is very different from the atomic volumes of aluminium (16.60 $Å^3$) or iron (12.12 $Å^3$). By assigning the CaF_2 structure to Al_2Fe (metastable), the atomic volume (16.68 $Å^3$) turns out to be close to the atomic

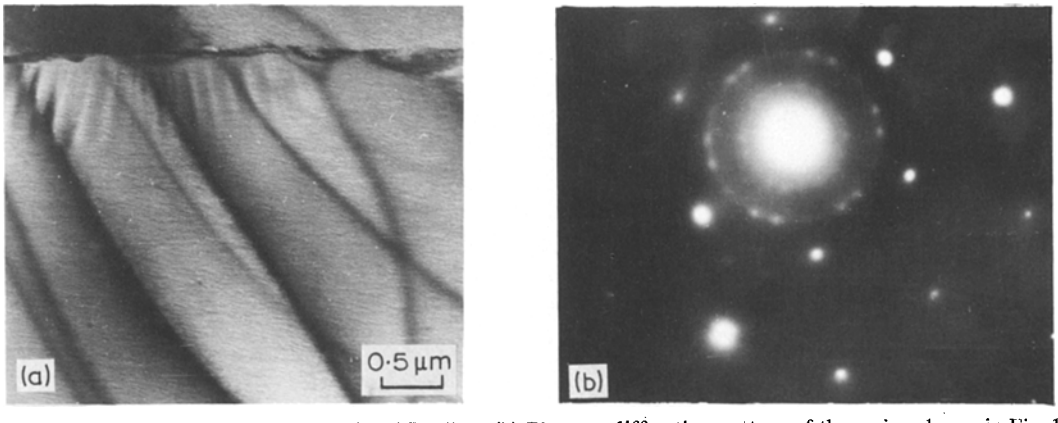

Figure 1 (a) As-quenched structure in Al–2 at% Pt alloy. (b) Electron diffraction pattern of the region shown in Fig. 1a.

volume of aluminium. The same is true for our phase as well (15.19 Å^3 for CaF_2-type and 22.97 Å^3 for diamond cubic type).

Further proof that we are dealing with isostructural metastable phases in both Al–Fe and Al–Pt systems can be obtained from diffraction patterns (Fig. 1b). If we consider the intense spots, then it will be observed that this pattern is the same as that reported by Stowell and co-workers in Fig. 8c of their paper [2]. The schematic illustration of their pattern also holds good for our pattern and we can, therefore, conclude that the same orientation relationship exists in both cases, namely

(1 1 1) precipitate ‖ (0 0 1) matrix

[$\bar{1}$ 1 0] precipitate ‖ [0 1 0] matrix

In order to understand the missing 2 0 0 reflection, we have carried out structure factor calculations for electron diffraction for the first three reflections. The results are shown in Table I. In both cases (Al_2Fe and Al_2Pt) we have considered the atom positions as in CaF_2 [3]. It can be seen that the intensity of the 2 0 0 reflection is much less in comparison to other reflections. Since the 2 0 0 reflection occurs very near to the strong 1 1 1 reflection, it is likely that it may not be seen in the electron diffraction patterns.

TABLE I Calculated structure factors of Al_2Pt and Al_2Fe metastable phases for electron diffraction.

hkl	$\lvert F\rvert^2$	
	Al_2Pt	Al_2Fe
1 1 1	1425	340
2 0 0	145	30
2 2 0	1770	760

Note added in proof

An isostructural metastable Al_2Pd phase has since been observed in a rapidly solidified Al–6 at% Pd alloy (G.V.S. Sastry and C. Suryanarayana, private communication).

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A novel method for the establishment of solvus surfaces as demonstrated with nickel-base alloys

The unidirectional solidification of alloys in the form of dendritic monocrystals, followed by quenching of the remaining liquid at a given moment, offers a very broad spectrum of possible microstructural studies as a function of temperature and time. In polyphase alloys the process allows the determination of the temperature at which a given phase appears and of the temperature range over which it grows. It also makes it possible, knowing the constant rate at which the dendritic monocrystal is pulled, to study growth or coarsening kinetics of the various phases.

In cast nickel-base alloys γ' precipitates in the solid at the solvus temperatures, which depends on the local concentration of those elements that are included in this phase. Based on this precipitation a novel method is described herein for the establishment of solvus surfaces and is applied to the ternary Ni–Al–Ta system.

Dendritic monocrystals of Ni–7.5 wt% Al–2.0 wt% Ta, Ni–8.0 wt% Al–2.0 wt% Ta and Ni–8.5 wt% Al–2.0 wt% Ta were unidirectionally solidifed under argon in an induction furnace