

The Microstructure of an Aged TiAlW Alloy

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TiAl alloys have been regarded as one of the strongest candidate materials for light and high temperature structural materials. In the Ti-Al binary phase diagram, the β phase only appears at high temperature. By adding β phase stabilizing elements such as Cr, W, Nb, Mo, ect., the primary β phase field can be extended to lower temperature. β phase can develop and provide attractive combinations of properties[1]. Gas atomized Ti-48.4at% Al-1.9at% W powder, manufactured by Crucible Compaction Metals Inc., with maximum powder size of 500 μm was vacuum encapsulated in stainless steel and consolidated by hot isostatic pressing at 1250°C and 200MPa for 2 hours. The stepped cool treatment was applied. TEM observations were performed in a JEOL-2010 high-resolution transmission electron microscope.

After aging at 950°C for 5 hours, the β precipitates appear as shown in Fig. 1a. The average length for long axis of β phase is about 20nm. When aged at 950°C for 96 hours, the β precipitates became larger apparently as shown in Fig. 1b. The average length for long axis of β phase is about 90nm. The inset in Fig. 1b is the corresponding selected area electron diffraction pattern (SAED). The OR between β and γ can be written as: $[\bar{1}01]_{\gamma}/[111]_{\beta}$, $(111)_{\gamma}/(\bar{1}10)_{\beta}$. In fact the above OR is the well known K-S relationship between f.c.c. and b.c.c. structure except that the γ -TiAl phase is ordered.

When viewed along $[111]_{\gamma}/[\bar{1}10]_{\beta}$, a typical TEM morphology of the β precipitates is shown in Fig. 2a. There are six different needle variants, indicated by A, B, C, D, E and F. Fig. 2b is the corresponding SAED. We can identify six β variants diffractions. From these diffractions, one can certainly obtain that β phase is b.c.c structure instead of B2 structure in the literature [1,2]. In order to understand the six different growth directions of β phase, the OR between β and γ phase and the atom arrangement on close packed planes of two phases are considered. As shown in Fig. 3, on $(111)_{\gamma}$ plane there are three $60^{\circ} \langle 110 \rangle_{\gamma}$ direction; on $(\bar{1}10)_{\beta}$ plane there are two $70.52^{\circ} \langle 111 \rangle_{\beta}$ direction. In accordance with the OR between γ -TiAl and β phase, the two $\langle 111 \rangle_{\beta}$ direction will parallel to any one among three $\langle 110 \rangle_{\gamma}$ direction, then we can have six group superposition of close-packed plane of γ -TiAl and β phase. This indicates six different variants on $(111)_{\gamma}/(\bar{1}10)_{\beta}$ [3].

References

- [1] B. J. Inkson et al., *Acta Metall. Mater.*, 41 (1993) 2876
- [2] G. Ignacio et al., *Intermetallics*, 9 (2001) 373
- [3] Thanks to D. Y. Seo for providing of the materials used in this study.

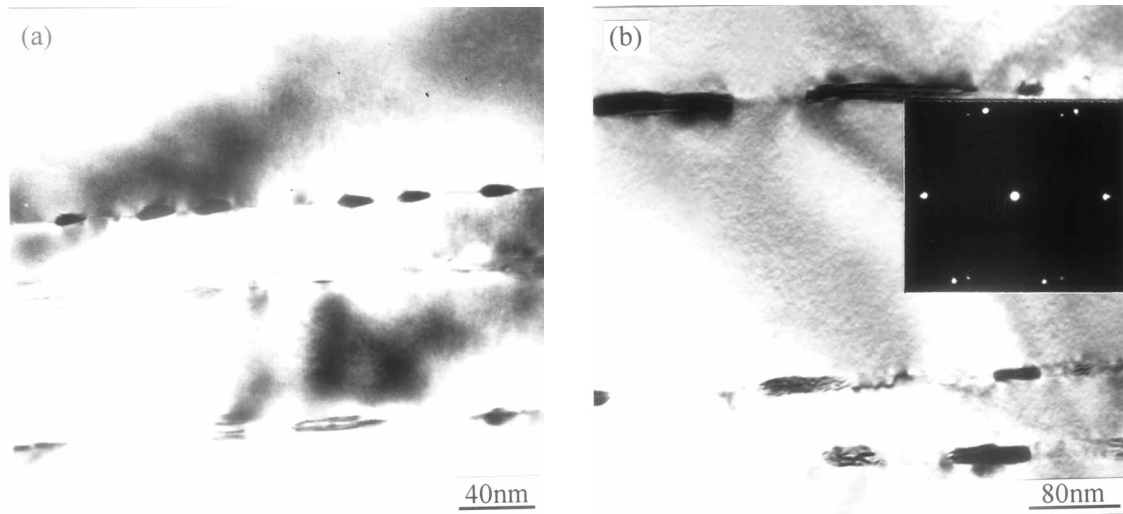


FIG. 1 The morphology of β precipitates, viewed along $[\bar{1}01]_{\gamma}/[111]_{\beta}$ (a) aged at 950 °C for 5 hours, (b) aged at 950 °C for 96 hours.

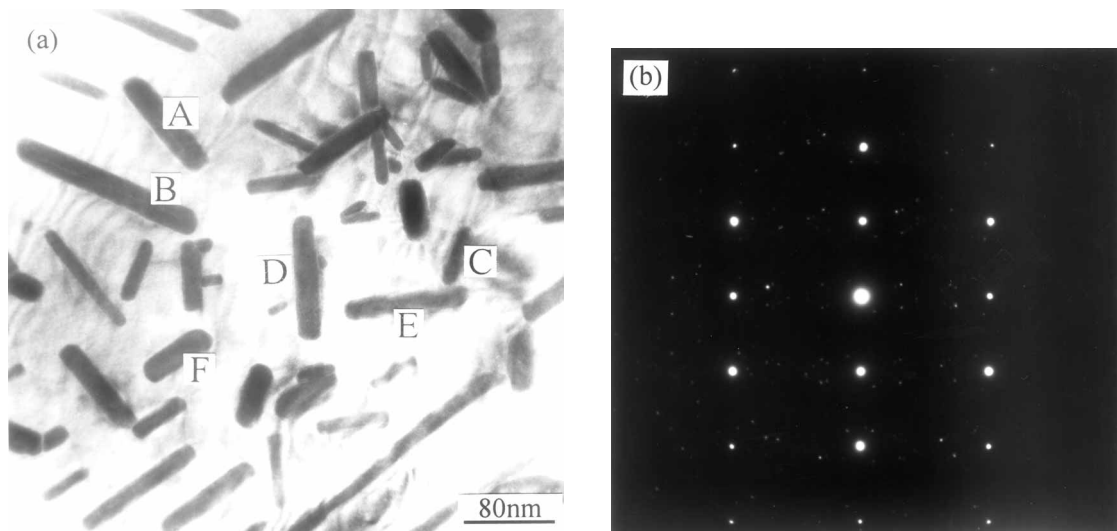


FIG. 2(a) A typical TEM image of β precipitates, viewed along $[111]_{\gamma}/[\bar{1}10]_{\beta}$ (b) The corresponding SAED.

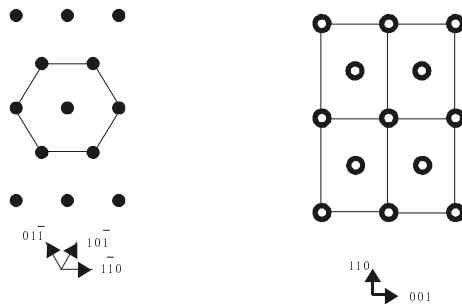


FIG. 3 Lattice points of $(111)_{\gamma}$ (full circle) and $(\bar{1}10)_{\beta}$ (open circle) planes.