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# Electropulsing-induced Phase Transformation in Titanium Alloy

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Solid-state phase transformations under the electropulsing have been extensively researched [1-2]. However, our understanding of the detailed atomic mechanisms pertaining to the effects of a current on phase transformation is still very rudimentary hitherto. Especial needs are careful and definitive high-resolution transmission electron microscopy (HRTEM) observations of the transformation products under the electropulsing [1]. In this paper, by means of HRTEM an investigation of phase transformation in Ti-6Al-4V alloy induced by the electropulsing was reported.

The electropulsing was performed at ambient conditions, by the capacitor (1200μF) discharging with Xe flasher trigger. A commercial Ti-6Al-4V alloy plate with a thickness of 1mm was used in this work.

The original sample consists of equal-axial α-Ti phase and a small amount of intergranular β-Ti phase, as shown in Fig 1. However, many ultra-fine β-Ti laths occurred in the interior of α grains under electropulsing, revealing an obvious phase transformation from α-Ti to β-Ti as shown in Fig 2(a). From the diffraction pattern shown in Fig 2(b), it was found that the orientation relationship (OR) between α-Ti and β-Ti phases is that $(\bar{1}100)_{\alpha\text{-Ti}}//(\bar{1}\bar{1}2)_{\beta\text{-Ti}}$, $[0001]_{\alpha\text{-Ti}}//[110]_{\beta\text{-Ti}}$, instead of the conventional Burgers relation $(0001)_{\alpha\text{-Ti}}//(110)_{\beta\text{-Ti}}$, $[11\bar{2}0]_{\alpha\text{-Ti}}//[\bar{1}11]_{\beta\text{-Ti}}$ in titanium alloy [3], as shown in Fig 3(a). These can result from the Joule heat, instantaneous thermal stress and some other effects from the electropulsing. It was also found that there exists the $(\bar{1}\bar{1}2)_{\beta\text{-Ti}}$ twinning between many adjacent β-Ti laths, in which the dashed lines represent $(\bar{1}\bar{1}2)$ twinning planes as shown in Fig 3(b). It is known that it is difficult to twin in b.c.c. β-Ti phase, and therefore large amounts of β-Ti twins may be introduced from the considerable stress concentration under the electropulsing.

In summary, the phase transformation from α-Ti to β-Ti has occurred in the Ti-6Al-4V alloy under the electropulsing. The new OR between α-Ti and β-Ti phases is $(\bar{1}\bar{1}00)_{\alpha\text{-Ti}}//(\bar{1}\bar{1}2)_{\beta\text{-Ti}}$, $[0001]_{\alpha\text{-Ti}}//[110]_{\beta\text{-Ti}}$. Also there exists the {112} twinning in the formed β-Ti phase [4].

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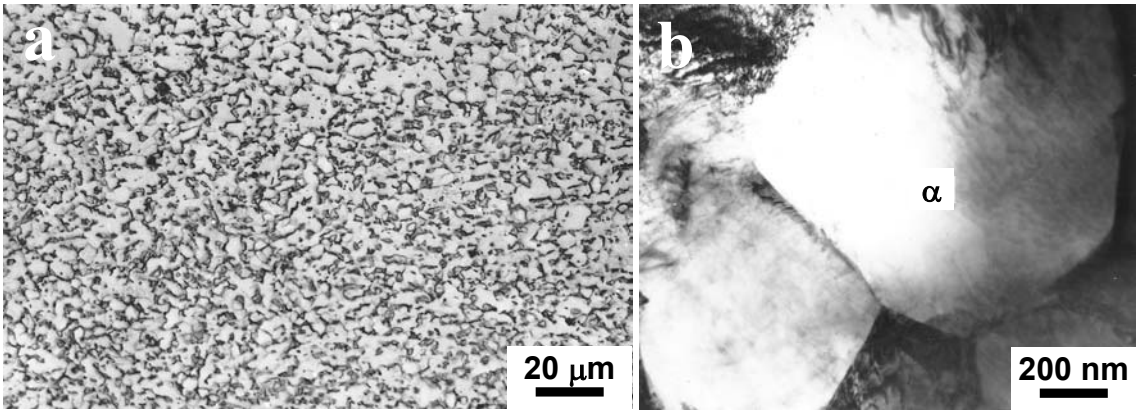


FIG. 1. Light micrograph (a) and typical TEM image (b) of the alloy before the electropulsing.

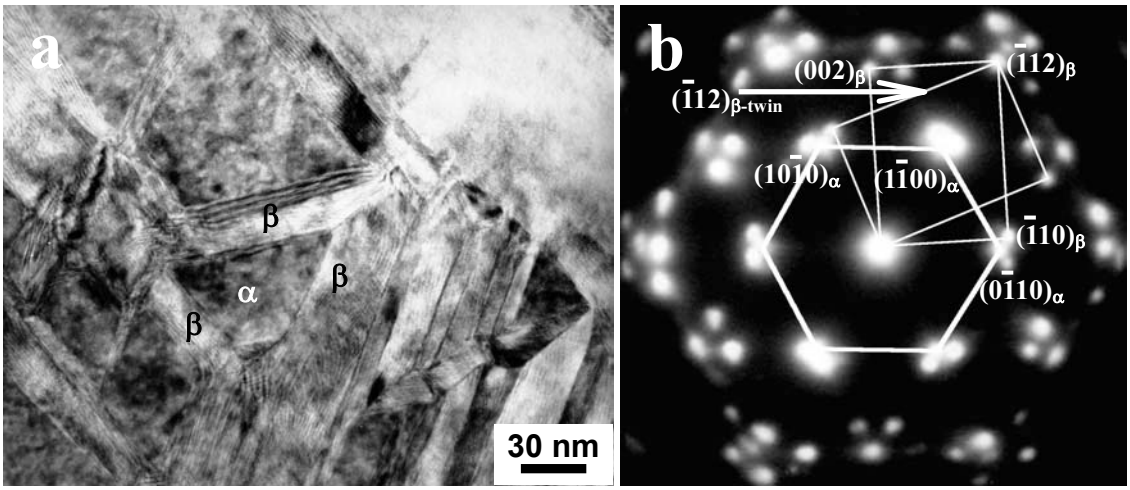


FIG. 2. TEM image (a) and corresponding electron diffraction pattern (b) of the basket-weave microstructure in the alloy after the electropulsing.

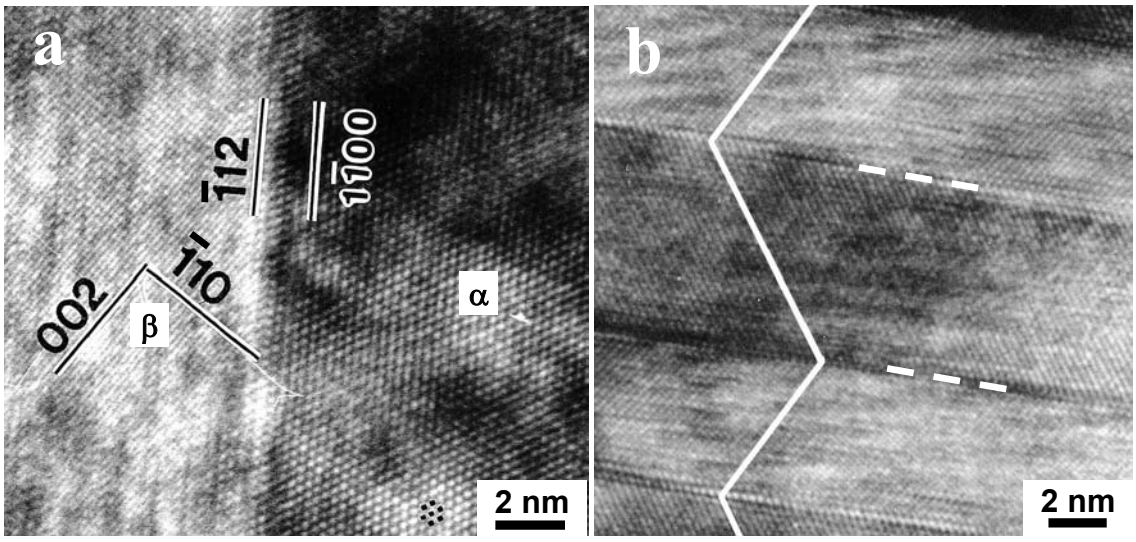


FIG. 3. HREM images of the new OR between α-Ti and β-Ti phases (a) and β-Ti twins (b) in the microstructure of Fig 2(a).

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