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Hetero-3D の静電浮遊実験における Ti6Al4V 中に添加した TiC の溶解現象

Dissolution Phenomenon of TiC Added in Ti6Al4V in Electrostatic Levitation Experiments for *Hetero-3D*

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1. Introduction

To elucidate the mechanism of prior-β grain refinement of Ti6Al4V alloy due to heterogeneous nucleation site particles (TiC), the space mission *Hetero-3D* was carried out to melt and solidify the samples in the electrostatic levitation furnace in the International Space Station (ISS-ELF). However, preliminary experiments conducted in a ground based electrostatic levitation (ESL) furnace revealed that some TiC particles were dissolved during heating[1,2)]. The objective of this study was to clarify the effect of dissolution phenomenon of TiC on the prior-β grain refinement of Ti6Al4V in the ESL experiments.

2. Experimental Procedures

Ti6Al4V powder with 5 mass% TiC particles was mixed homogeneously. The powder was sintered by the spark plasma sintering method and solidified into spherical shapes in a plasma arc melting furnace. Then, each sample was heated using three laser beams in an ESL furnace. The temperature history of the sample was obtained by a pyrometer. Based on the result in a previous study[3)] that the diffusion coefficient in liquid metal is a proportional to a square of its temperature, a parameter of integral value of heating T^2t was introduced, which was calculated by integrating the square of the temperature T^2 and the heating time t. The calculation range was from the sample first reached the melting point of Ti6Al4V (1923 K) until its temperature fell below 1923 K after the laser beams were turned off. Prior-β grain maps were obtained by reconstructing crystal orientation data of the cross-section of the samples measured by an electron back scattered diffraction detector. In addition to that, images of microstructures were observed with a scanning electron microscope (SEM).

3. Results

Integral values of heating T^2t of the refined samples were smaller than 1.5×10^8 K²s whereas those of the non-refined samples were larger than that value. The amount of residual TiC was calculated using the equation[1)] from the area ratio of carbon precipitates. **Figure 1** shows that the amount of residual TiC in Ti6Al4V decreased as T^2t increased. Furthermore, more than 1 mass% of TiC remained, and prior-β grains were refined when T^2t was less than 1.5×10^8 K²s.

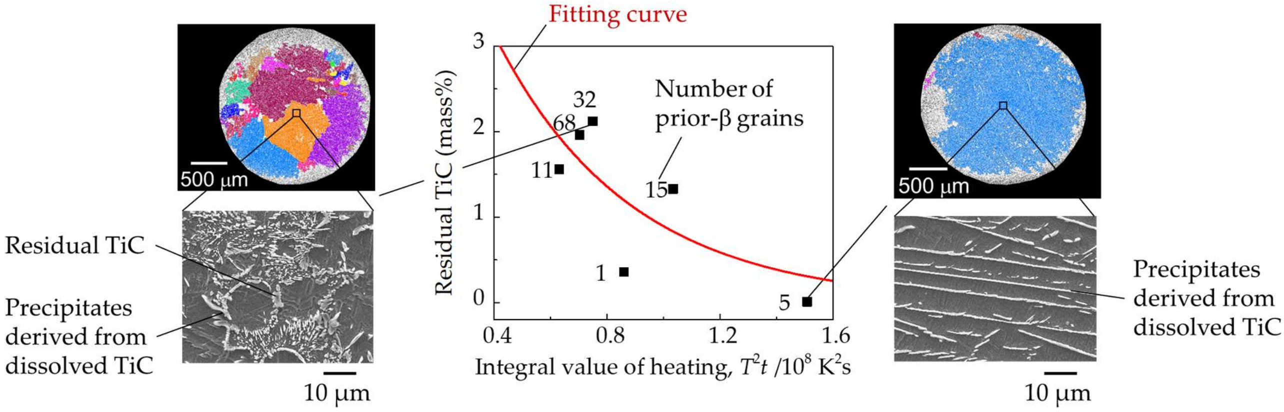

Figure 1. Relationship between the integral value of heating and the amount of residual TiC in Ti6Al4V. The images[2)] on either side of the graph show the prior-β grain map on the top and the SEM image on the bottom, respectively.

4. Discussion

According to Johnson-Mehl-Avrami-Kolmogorov (JMAK) equation, the solid phase ratio increases exponentially with the solidification time, and dissolution can be considered as an opposite phenomenon of solidification. The fitting curve in **Fig. 1** shows that the amount of residual TiC decreases exponentially with increasing T^2t, therefore the symmetry of JMAK equation was established during dissolution of TiC.

5. Conclusions

Dissolution of TiC was suppressed as the integral value of heating T^2t decreased, and prior-β grains were refined when T^2t was less than 1.5×10^8 K²s. The amount of residual TiC in Ti6Al4V increased exponentially with increasing T^2t along with the symmetry of JMAK equation.

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