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静電浮遊炉実験した Ti6Al4V 試料内結晶粒の 3 次元構造解析

Three-Dimensional Analysis of Grains in Electrostatic Levitation Experimental Samples of Ti6Al4V

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1. Introduction

To understand the effects of TiC-induced nucleation in Ti6Al4V alloy, *Hetero-3D* mission was carried out in the electrostatic levitation (ESL) furnace. Traditionally, microstructure observations relied on a single cross-section of samples, lacking three-dimensional information for nucleation frequency. By analyzing multiple sections, it may be possible to connect grain identified as the same across different sections, which could potentially reveal the three-dimensional arrangement of grains within the sample. The objective of this study was to devise multiple sections analyses to identify a grain across the multiple-sections.

2. Experimental Procedures

For sample preparation, the powder of Ti6Al4V with TiC 5 mass% was sintered using spark plasma sintering (SPS) method and cut with a diamond wire saw into an approximately 30 mg sample. For stable levitation, the sample was formed into a sphere by arc melting. The sample was melted and solidified using ESL. For analyses, it was embedded in resin and polished. Electron backscatter diffraction (EBSD) analysis was conducted to obtain an inverse pole figure (IPF) map to represent the relative orientations of the crystalline lattices of grains within the cross-section. By grouping measurement points with orientation differences of 5 degrees or less as the same grain, a grain map was generated. The analysis procedures were replicated three times on the same sample. Moreover centroid coordinates of sections, crystal orientations and coordinates of grains on each cross-section were obtained using the software for EBSD analysis, TSL OIM Analysis 8.

3. Results

The IPF maps for the three cross-sections at depths of 40, 120, and 200 μm are presented in **Fig. 1**. Furthermore, centroid coordinates of sections, crystal orientations and coordinates of grains are obtained.

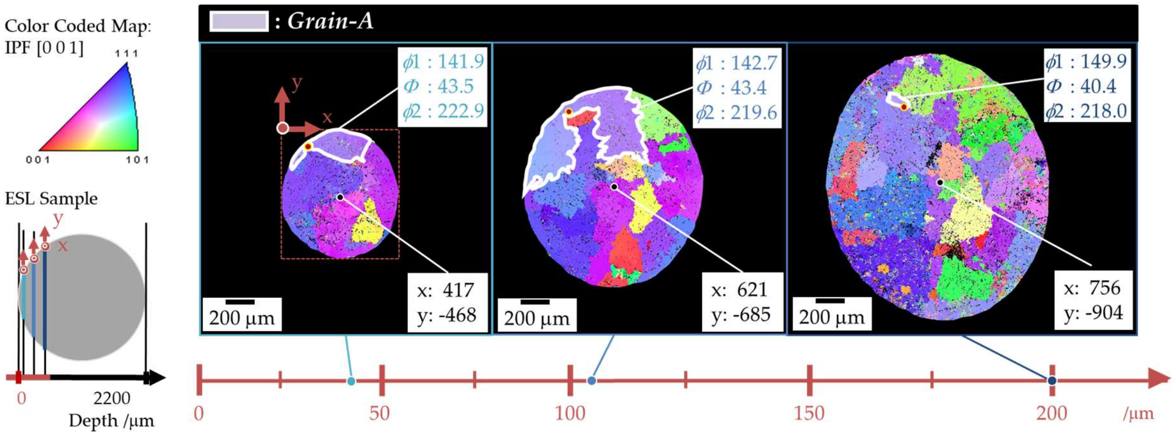

Figure 1. IPF maps analyzed across three parallel sections at different depths. When taking the origin at the top-left corner of each analysis image, the x-axis and y-axis are as indicated in the figure. The measurements were in units of μm. The crystal orientations as Euler angles ($\phi 1$, Φ, $\phi 2$) are presented in the upper boxes. These orientations are provided in units of degrees.

4. Discussion

Grain-A in **Fig. 1** satisfied the two criteria: (1) Sharing the same plane coordinates, and (2) Having a crystal orientation difference within 5 degrees. For the first criterion, after adjusting the coordinates of each section to align the centroid coordinates as the origin (0, 0), it was confirmed that *Grain-A* possessed the same coordinates (-214, 549) across all sections. In **Fig. 1**, the red points represent the locations of these coordinates. For the second criterion, orientation differences for *Grain-A* between the 40 - 120 μm and 120 - 200 μm sections were calculated using three Euler angles transformed via the Passive method. Euler angle differences averaged 1.4 and 3.9 degrees, respectively, within 5 degrees. Therefore, the *Grain-A* is considered to exist across three sections.

5. Conclusions

Grain-A in the three cross-sections at depths of 40, 120, and 200 μm of the ESL experimental sample were identified as the same grain based on the fulfillment of two criteria about coordinates and crystal orientation. This method may enable the identification of the same grain existing across multiple sections.

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