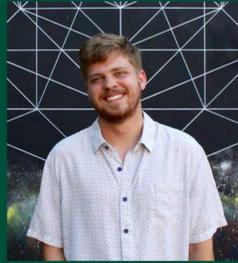


# EBSD AND SEM CHARACTERIZATION OF TI-6AL-4V TITANIUM ALLOY

## METHODOLOGY AND PROCEDURE

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### ABSTRACT

Microscopy has been used to help categorize materials and discover trends and properties that help deepen the understanding of materials. Techniques such as using optical and light microscope have been used for centuries but now with electron scanning microscopes (SEM), new ways to study materials are used and help study materials in new ways. By using a mixture of microscopic, scanning electron microscope (SEM), electron backscatter diffraction (EBSD) and mass spectrometry on an uncategorized unknown Ti-6Al-V4 sample, many properties were found without needing to destroy the sample. More advanced techniques are explored and by using a mixture of SEM and EBSD to help identify the Ti-6Al-V4 phases, grain maps. Using the data, photos and comparing it to other previously done samples can find how the sample was processed or prepared before observing. Observations show that the material has a majority coarse beta phase when which concludes the material wasn't heat treated enough to get a majority of alpha phases. Studies have already shown SEM and EBSD are great tools for characterizing complex sample, however this thesis will go over the process of characterizing unknown samples and the methodology if this can be used for future experiments.

### INTRODUCTION

Using microscopy tools such as the SEM and EBSD can be used to make studying, categorizing, and analyzing complex materials easy. When studying materials that have multiple crystalline structures such as BCC and HCP using tradition methods such as light microscopes to study materials become difficult. Ti-6Al-4V is a complex material that has both bcc and hcp crystalline structure and using tools such as the SEM and EBSD make analysis and categorization the samples easy.

### EXPERIMENT

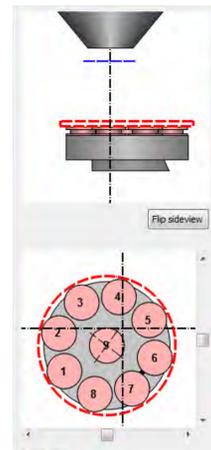
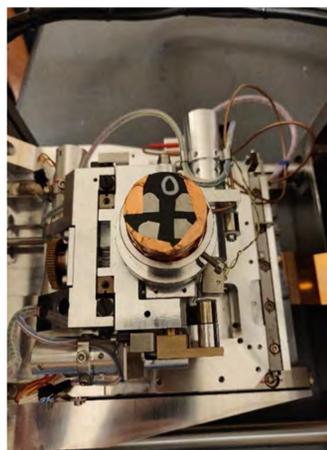


Figure 1 (Above) Ti-6Al-4V in the SEM holder with the stage attachment. The top left section is aligned in between the one and two.

Figure 2 (Above and right) Stage location and coordinate system using the SEM

### Ti-6Al-4V, SEM, EDS & DISCUSSION

#### Ti-6Al-4V Basics

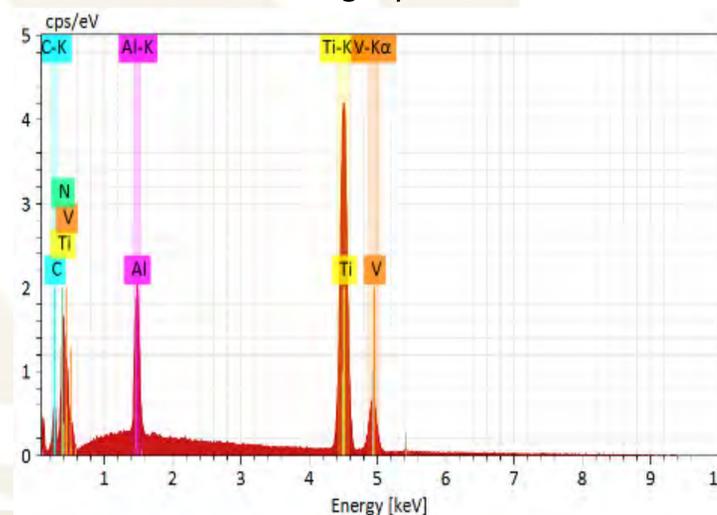
- Mixture of both bcc and hcp structure
- Depending on manufacturing ratio between two phases alpha and beta
- Generally alpha phase grains are globular and beta phase grains are 'basket woven' long and sharp grains



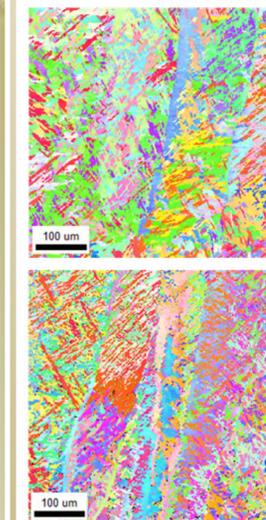
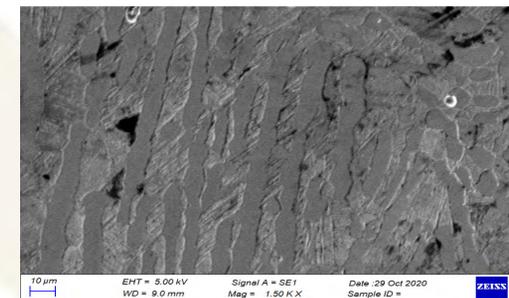
Figure 3 (above): SEM image at 1500x, long globular grains are alpha phase when the 'basket weaved' looking grains are beta phase

Figure 4 (left): EDS image of Ti-6Al-4V at 1000x

Figure 5 (below): SEM EDS graph of Ti-6Al-4V



The ratio of alpha and beta phase grains define the material properties. Generally, higher heated temps leads to more alpha grains. More alpha grains lead to higher creep strength and weldability. Beta grains increase strain rate sensitivity, and density.



### EBSD

Images from previous experiments using EBSD on Ti-6Al-4V to help categorize which planes the alpha and beta phases lie on throughout the material. General trends show alpha phase grains tend to lie on a common plane while beta phase grains vary in texture throughout the material.

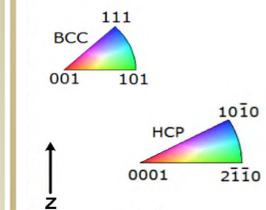


Figure 6 & 7 (Top): Ti-6Al-4V EBSD maps from the Y-plane coordinate system using the SEM

Figure 8 (Left): Index and color code for viewing all planes on Ti-6Al-4V

Wang, Xiaoqing, and Kevin Chou. "EBSD Study of Beam Speed Effects on Ti-6Al-4V Alloy by Powder Bed Electron Beam Additive Manufacturing." *Journal of Alloys and Compounds, Elsevier*, 14 Mar. 2018,

### FUTURE WORK

EBSD images of as received samples was not observed. EBSD images were obtained from previous studies using EBSD. Future work will be finding trends of alpha and beta phases crystalline orientation.