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Quantification of Alpha Laths in α/β Titanium Alloys

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Titanium alloys have a wide range of applications in many industries. Alpha/beta titanium alloys have a very complex microstructure involving features spanning a wide range of size scales that can vary from sub micron to millimeters depending on thermo-mechanical history[1]. Researchers have found that microstructural features greatly impact deformation mechanisms and consequently the mechanical properties of alpha/beta titanium alloys are highly dependent on microstructural features. In order to develop accurate predictive models robust methods for quantifying the microstructure is necessary. Recent advances in stereology and microscopy have made quantification of titanium microstructures possible, but in order for stereology to be validated an inherent three-dimensional understanding of the features is necessary[2-3].

One such microstructural feature that has been identified as impacting mechanical properties is alpha lath aspect ratio obtained from two-dimensional SEM/OM images[4]. Due to the complex nature of these microstructures, two-dimensional images provide very limited information regarding the three-dimensional nature of the microstructure and can often be misleading. Stereological procedures have been developed for use on two-dimensional images of alpha/beta titanium SEM/OM micrographs to quantify the average microstructure[2-3]. These measurements, when used in conjunction with neural networks have been used to predict properties in alpha/beta titanium alloys to within 3%. In order to gain a better understanding and reduce the error due to stereological measurements, a FEI NOVA microscope was used to serial section through alpha/beta titanium microstructures for digital reconstruction of alpha laths. Three-dimensional reconstructions of alpha laths allowed for the rendered object to be rotated freely in space in order to provide a three dimensional image of the feature as it exists in the specimen. This allows visualization of the values measured by stereology from the two dimensional images and shows that the average value measured by stereology may not be as critical as the minimum or maximum values seen in the three-dimensional image. The three-dimensional image also provides a physical representation of the interaction between microstructural features.

References

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