APPLICATION NOTE

Additive Manufactured Ti and CuAlZr Alloys

Visualization of internal structure leads to improved manufacturing

A complete workflow solution that implements the HeliScan microCT in conjunction with 3D visualization and analysis software to detect and analyze porosity, cracks, and inclusions.

Challenge

The high cost of titanium compared with other types of metals has led to investigations of lower-cost additive manufacturing processes. The aerospace and defense industries, in particular, are interested in processes that afford increased weight savings, while industries such as automotive are becoming more interested in additive manufacturing methods for better cost savings. All of these industries, however, are highly interested in achieving well-bonded metallic parts that are free of defects.

An efficient and cost-effective measure to implement in any additive manufacturing process is to accurately identify the microscopic defects in the final material. An artifact-free scanning method greatly improves this defect identification process, allowing for refinement of the selected additive manufacturing technique.

To improve the quality of the additive manufactured technology, new alloys are explored. In this example, a high-resolution scan of a large volume of the Ti and CuAlZr alloy sample was acquired. Typically, these samples are run on conventional microCTs with a cylindrical acquisition method that does not allow for scanning of the sample in only one sweep. However, due to the Thermo Scientific™ Heliscan™ microCT's helical single-scan ability, it is possible to avoid such artifacts induced by stitching of multiple circular scans.

Method

The sample was mounted on a glass tube post. Avizo™ software was used for visualization and analysis.

Scan parameters: Ti alloy

- Tube voltage: 100 kV
- Filter material: 0.2 mm stainless steel
- Voxel size: 1 µm
- Scan type: Double Helix and Filtered Back Projection reconstruction
- Total scanned volume: 2.6 × 2.6 × 6.4 mm (Aspect ratio: 2.5:1)
- Scan time: 14 hours

Scan parameters: CuAlZr

- Tube voltage: 120 kV
- Filter material: 0.2 mm stainless steel
- Voxels size: 1 µm
- Scan type: Space Filling™ and Iterative reconstruction
- Total scanned volume: 2.6 × 2.6 × 5.9 mm (Aspect ratio: 2.3:1)
- Scan time: 5 hours

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Results

Voids (porosity) and dense particles of approximately 20 microns in size can be seen in this very uniform sample (see Figure 1). The production quality of this sample is quite good,with a very high volume fraction of +95%.

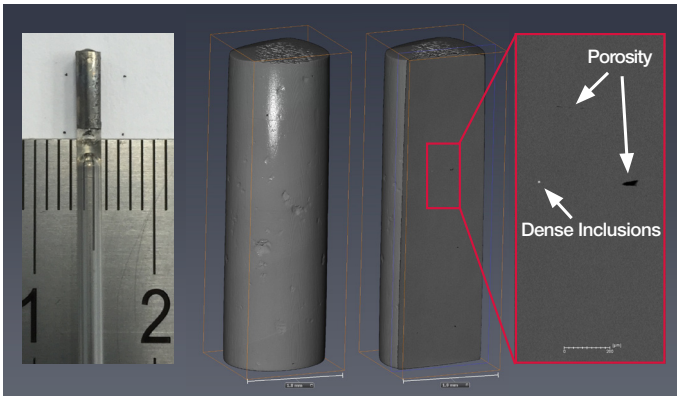

Figure 1. microCT-based 3D and 2D visualizations of the Ti alloy sample and its internal structure.

In Figure 2, the pores (voids) are shown in red while the dense particles are colored blue.

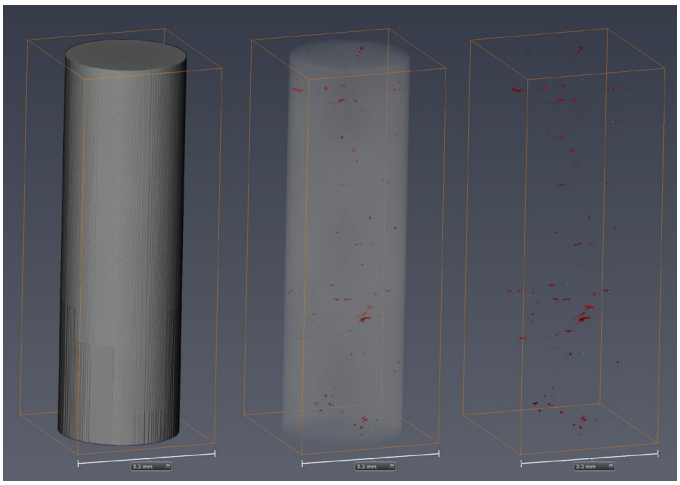

Figure 3. microCT-based 3D visualization of the internal porosity and dense inclusions within Ti alloy sample.

In Figure 3, micro and macro porosity, dense particles, and non-melded grains are readily apparent in this decidedly non-uniform sample.

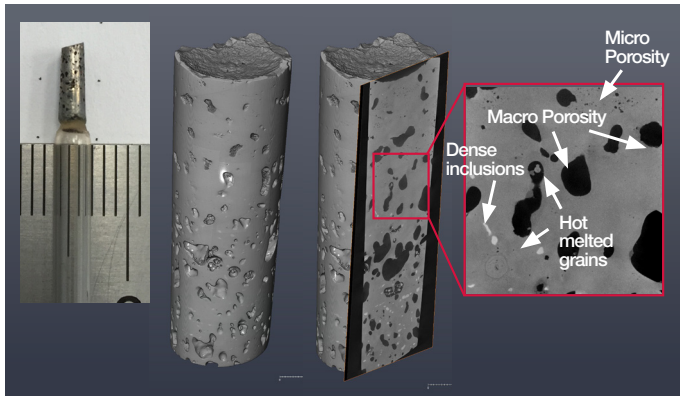

Figure 2. microCT-based 3D and 2D visualization of the CuAlZ alloy sample and its internal structure.

In Figure 4, the pores (voids) are shown in red while the dense particles are colored blue.

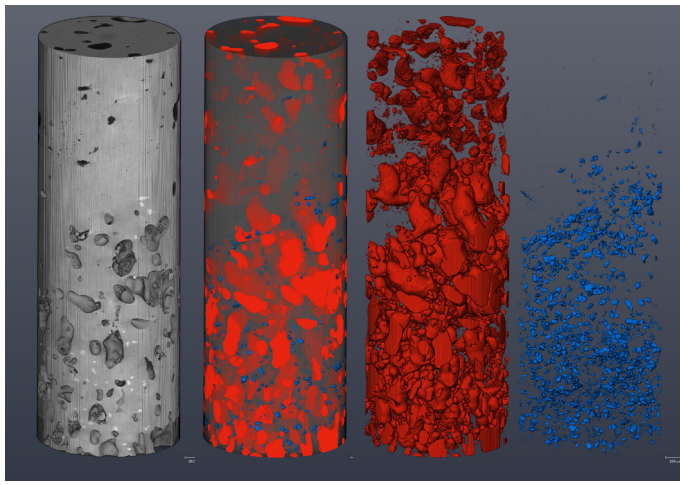

Figure 4. microCT-based 3D visualization of the internal porosity, dense inclusions, and non-melted particles within CuAlZr alloy sample.

Conclusion

HeliScan microCT is capable of visualizing pores (voids) and dense particles in larger volumes with a great deal of accuracy. Obtained results can be used for qualitative analysis to improve the additive manufacturing process.

Sample courtesy Prof. Hamish Fraser, The Ohio State University

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