Case Study: Additive Manufacturing of Aerospace Brackets

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16ME420

CASE_STUDY 2

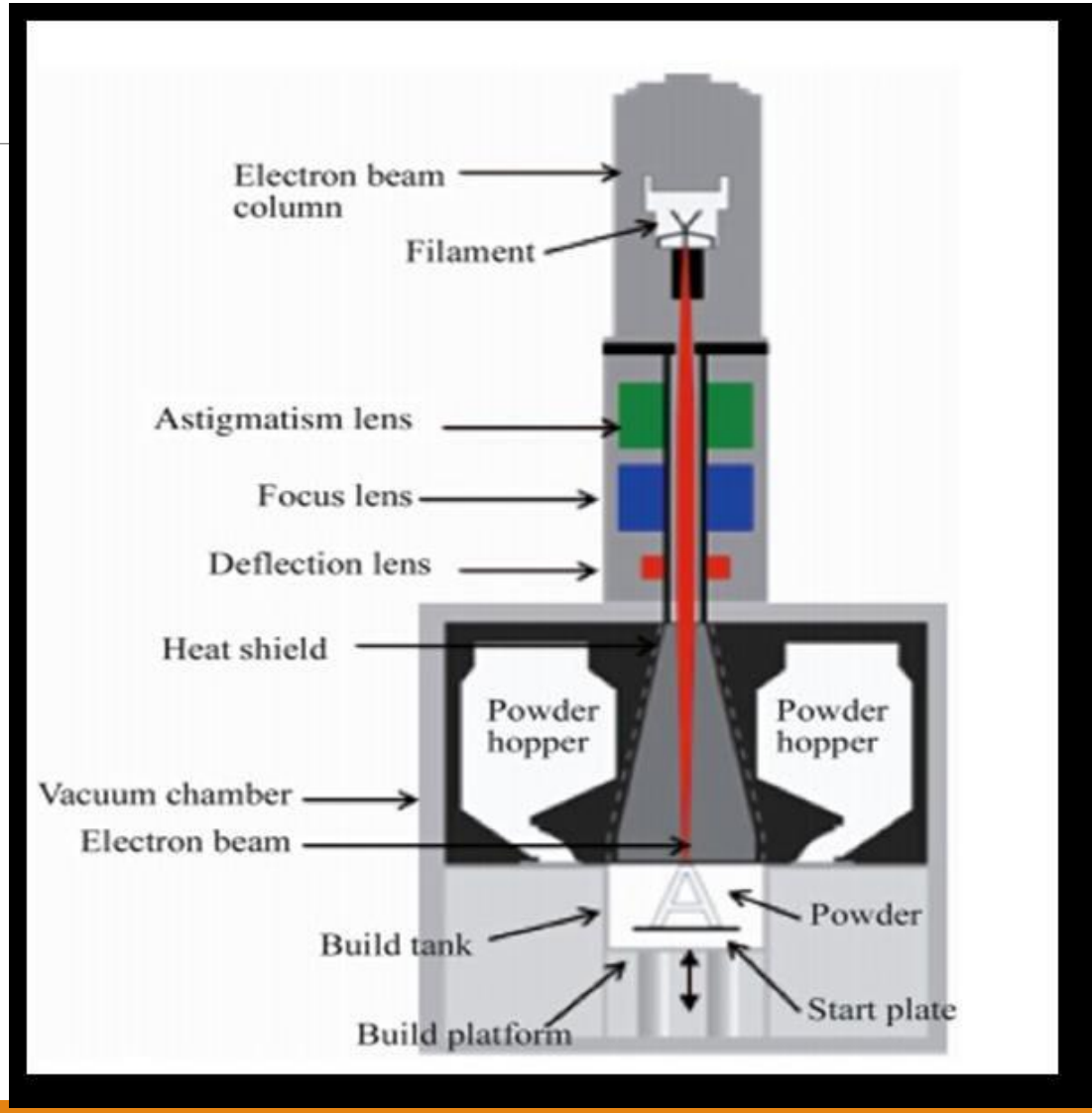
ORNL demonstrated the capability of additive manufacturing technologies to drastically reduce the cost and material scrap associated with the production of aerospace components

Electron beam melting

Electron beam melting (EBM), developed by Arcam, is a powder bed AM technology that fabricates fully dense metal parts by selectively melting specific regions within a 50-200 mm layer of powder.

Successive layers are fused together to build up a near-net three-dimensional (3-D) structure.

The process is conducted under vacuum to eliminate the potential for contamination/oxidation at elevated temperatures.



About this case study

Electron beam melting technology is a suitable additive manufacturing technology to produce complex aerospace components

The case study examines the mechanical properties of Ti-6Al-4V samples as a function of orientation and layout within the build chamber, and examines the associated business case for production.

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Fig. 1 — *Ti-6Al-4V bleed air leak detect (BALD) bracket fabricated using additive manufacturing.*

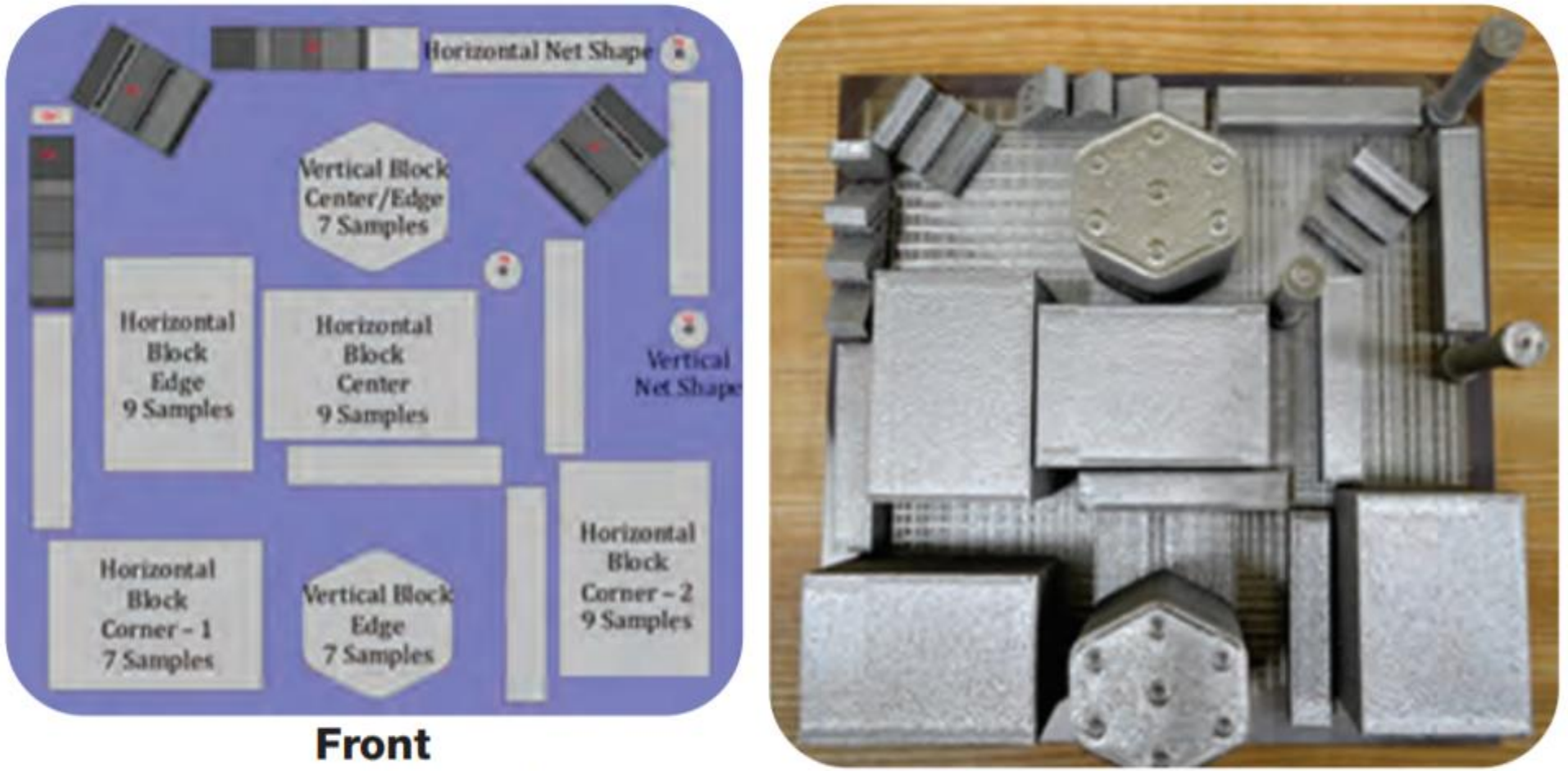
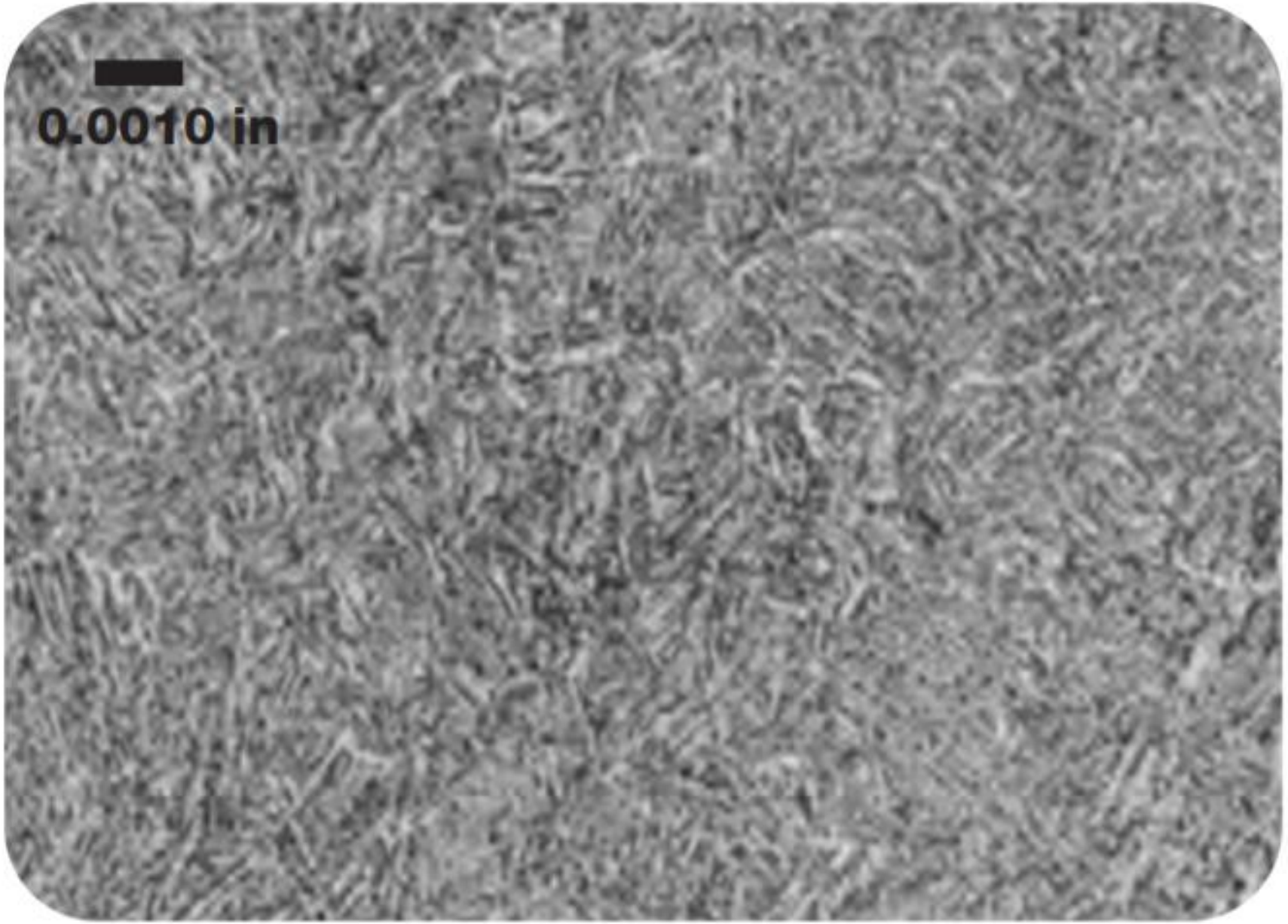


Fig. 2 — *Arcam EBM build layout (left) and as-built samples (right) showing large blocks and near-net-shape tensile samples. Samples were fabricated in both the horizontal and vertical direction at specified locations within the build volume.*

Fig. 3 — *Microstructure of Ti-6Al-4V coupon after hot isostatic pressing.*



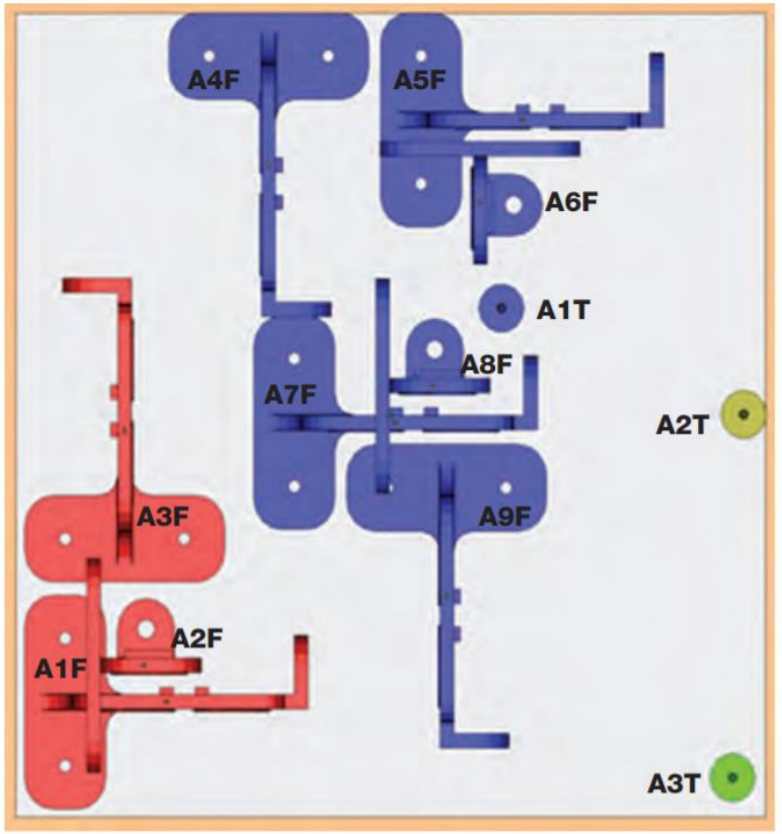


Fig. 5 — *Layout of BALD brackets within the Arcam build chamber. Colored circles with black dots inside represent tensile samples parallel to the z axis.*

TABLE 1 — CHEMICAL COMPOSITION OF SAMPLES FABRICATED USING ARCAM EBM TECHNOLOGY[a]

	Chemical composition, wt%								
	Al	V	Fe	O	C	N	H	Other, each	Other, total
AMS4928	5.5-6.75	3.5-4.5	0.30 max	0.2 max	0.08 max	0.05 max	0.0125 max	0.1 max	0.4 max
Build in Fig. 2	6.06	4.08	0.07	0.17	0.01	0.02	0.0043	<0.1	<0.4
BALD bracket (build 1)	6.06	4.10	0.07	0.14	0.01	0.02	0.0016	<0.1	<0.4
BALD bracket (build 2)	6.34	4.13	0.15	0.26(b)	<0.1	0.02	0.0019	<0.1	<0.4

(a) Chemical composition of the component is identical to that of the starting powder material. (b)Value is outside of ASTM chemical specification.

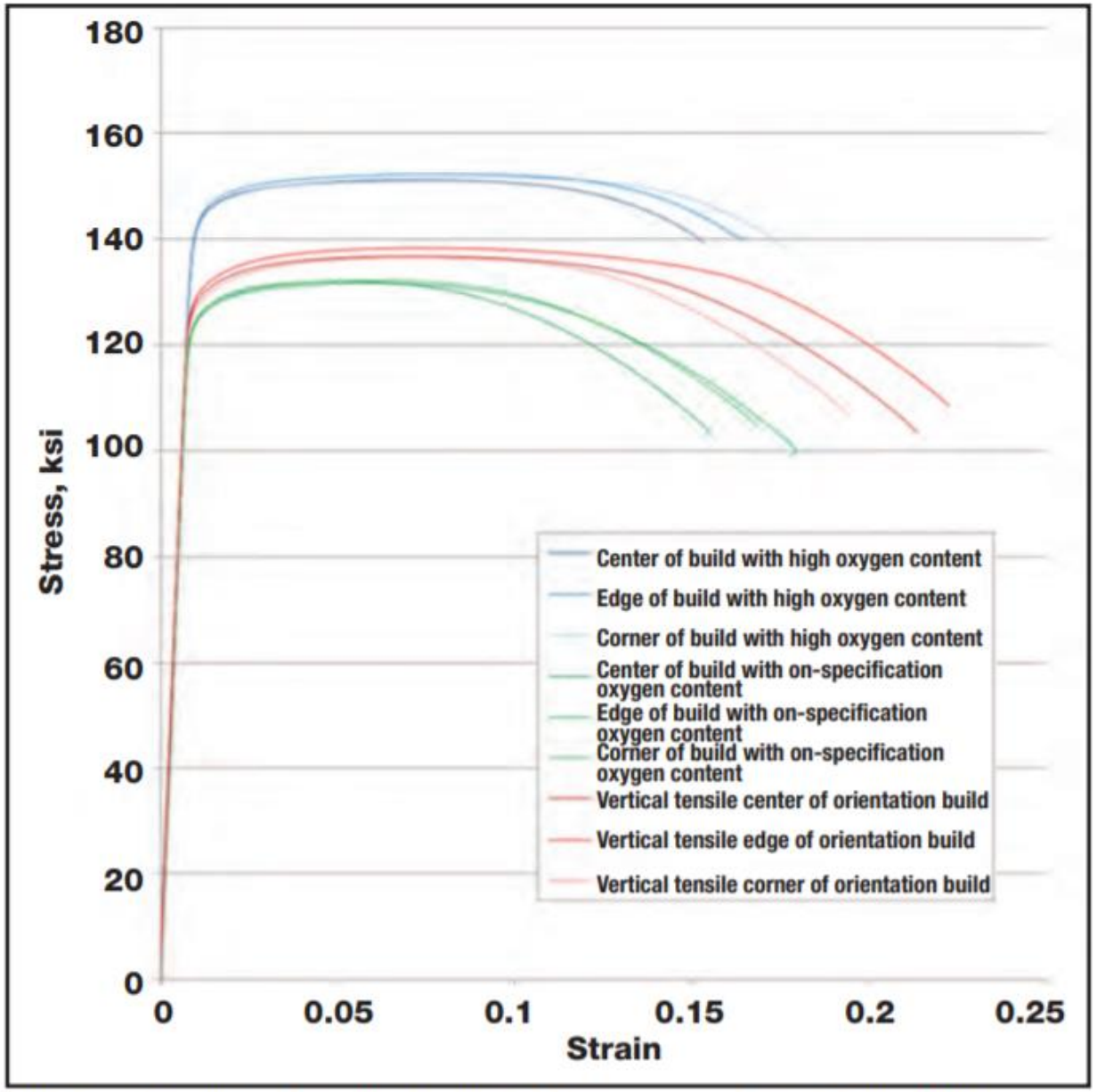


Fig. 6 — *Tensile-test results for vertical samples included in the BALD bracket build and initial sample.*

Conclusion

EBM technology is a suitable additive manufacturing technology to produce complex aerospace components, such as the BALD bracket.

As deposited and HIPed brackets have consistent mechanical properties regardless of location or orientation within the build chamber, meeting the ASTM specification for wrought Ti6Al-4V material for yield strength, ultimate tensile strength, and elongation.

Component testing also satisfied the required mechanical performance for nonflight-critical hardware.

Numerous brackets can be placed into the build chamber at various locations and orientations to maximize the production rate without sacrificing component quality.

A simple cost analysis shows that EBM technology provides a 50% cost reduction over the current production method. Additional certification will be required prior to full production.

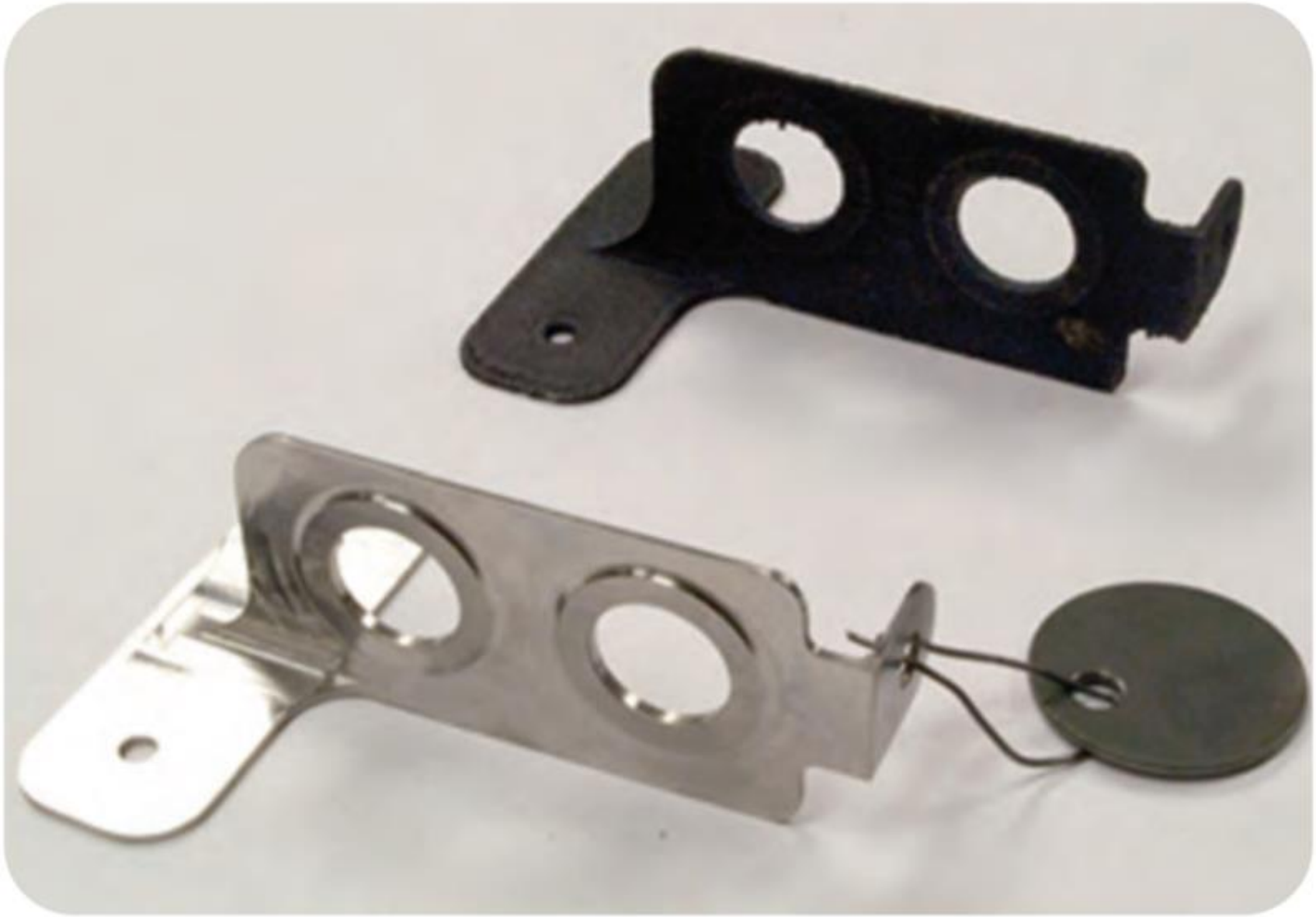


Fig. 7 — *As-deposited (top) and post-machined BALD bracket (bottom).*