MATERION

DATA SHEET

Extruded AlBeMet®162 Wrought Powder Metallurgy

KEYWORDS:

Fatigue, Fatigue Crack Growth, da/dn, Paris slope, Temperature, Extruded, AlBeMet®, 162, Material Process

DESCRIPTION:

Extruded AlBeMet® 162 is wrought powder metallurgy product made from prealloyed gas atomized powder that is cold isostatically pressed (CIP), canned, degassed, extruded and annealed at 1100 ^{O}F for 24 hours per AMS 7912 spec.

SUMMARY:

AlBeMet®162 Extruded material has a room temperature 10^7 endurance limit of about 30 ksi and 25 Ksi in the longitudinal and transverse directions respectively, as measured by rotating beam fatigue machine (also known as R. R. Moore) that subjects the specimen to fully reversed bending (R = -1). Limited results on laboratory processed material suggests about a 5 Ksi reduction in the 10^7 endurance limit at 250 ^{O}C. Experimental results from Lewandowski and Larose[i] indicate that the Paris slope varies between about 3 and 11 depending on temperature and R value. AlBeMet® materials have an endurance limit, not a fatigue strength that has a threshold stress.

RESULTS FOR ROTATING BEAM:

This test, (also known as R. R. Moore) subjects the radially symmetric specimen to fully reversed bending (R = -1). Typical cycle rates are 9,000 to 10,000 rpm. Since the loading is by bending, only the outside surface is subjected to the positive and negative peak stress. Testing was discontinued after the specimens attained 10 million (10^7) cycles. Fatigue stress is known to be dependent on the strength of the material. Tensile strength for some of the materials as summarized in Table I.

Table 1: Tensile Strength for Extruded AlBeMet®162

Variable	Orientation	UTS (Ksi)	YS (Ksi)	Elongation
R&D3	L	68.6	49.6	8.0%
R&D3	T	61.7	49.5	5.0%
Fatigue Tested STD Production Lot A	L	66.7	48.35	14%
Fatigue Tested STD Production Lot A	T	57.8	46.1	6.4%
Production Average	L	65.5	47	3.1%
Production Average	T	56.2	45.7	2.6%

CRACK GROWTH RATE

Rectangular specimens of production extrusion were provided to J. Lewandowski of Case Western Reserve University for crack growth rate evaluation. The results were published in Reference i and summarized.

Temperature ^{O}C	Stress Ratio R	Paris Slope m	ΔK_{th} MPa $\sqrt{m}$
-125	0.1	11.4	<6
25	0.1	1.4	5
25	0.1	3.0	ND
225	0.1	3.1	<4
-125	0.4	8.8	7
25	0.6	5.7	4
225	0.4	3.0	<3.5

MAAB-030

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ROOM TEMPERATURE ON STANDARD PRODUCTION MATERIAL

AlBeMet®162 Extruded material has a room temperature 10^7 endurance limit of about 30 Ksi in the longitudinal and about 25 Ksi transverse direction

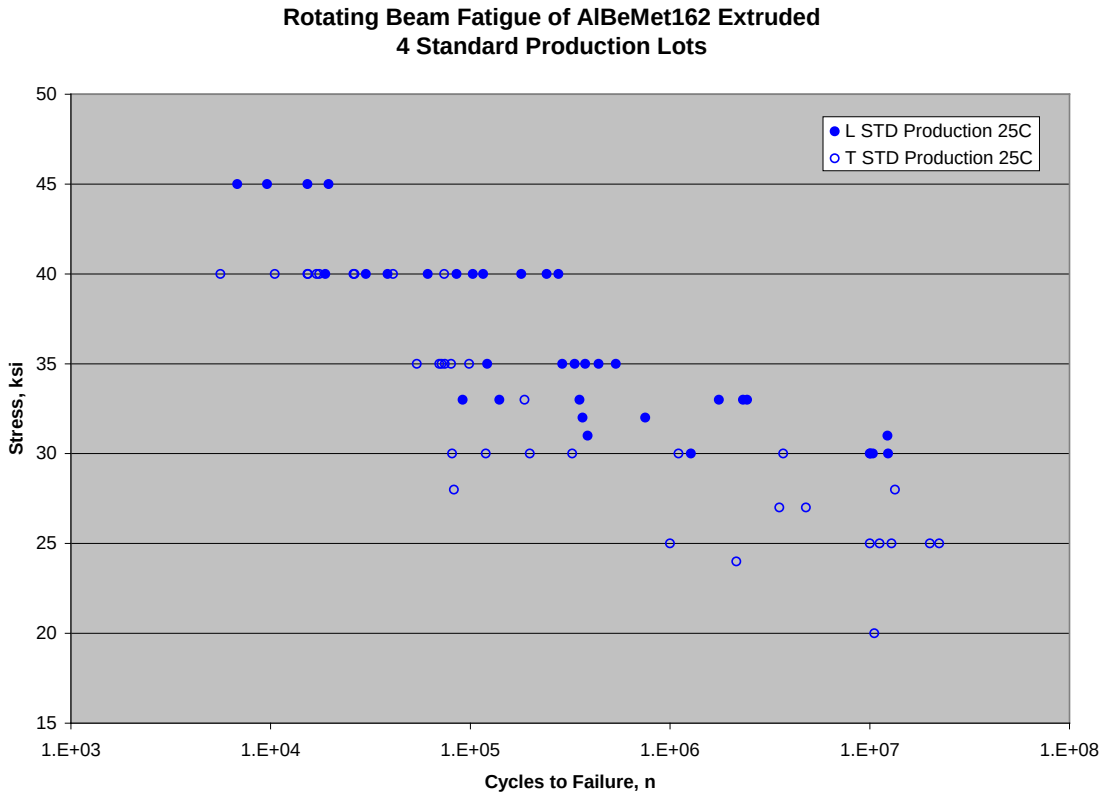

Figure 1: Fatigue Results for Extruded AlBeMet® 162 at Room Temperature

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Table 1 Room Temperature Rotating Beam Fatigue Results for AlBeMet® 162 Extruded from 4 Production Lots.

Orientation	Stress (Ksi)	Cycles to Failure	Orientation	Stress (Ksi)	Cycles to Failure
L	30	10,068,000	T	20	10,538,900
L	30	1,272,100	T	24	2,148,800
L	30	10,363,100	T	25	19,994,100
L	30	12,366,100	T	25	12,867,700
L	30	10,000,000	T	25	998,800
L	30	10,000,000	T	25	11,193,100
L	31	12,255,700	T	25	22,298,100
L	31	386,800	T	25	10,000,000
L	32	364,600	T	25	10,000,000
L	32	751,400	T	25	10,000,000
L	33	2,434,000	T	27	3,529,700
L	33	91,600	T	27	4,787,600
L	33	1,756,100	T	28	13,366,600
L	33	2,321,500	T	28	82,700
L	33	351,900	T	30	3,685,600
L	33	139,700	T	30	1,102,500
L	35	288,500	T	30	323,400
L	35	535,300	T	30	119,400
L	35	438,400	T	30	81,100
L	35	375,700	T	30	198,700
L	35	121,600	T	33	186,700
L	35	332,800	T	35	98,600
L	40	275,800	T	35	74,500
L	40	85,400	T	35	71,700
L	40	38,500	T	35	80,100
L	40	102,800	T	35	53,900
L	40	61,200	T	35	69,900
L	40	18,800	T	40	15,400
L	40	30,000	T	40	26,300
L	40	116,000	T	40	5,600
L	40	180,000	T	40	17,500
L	40	241,000	T	40	10,500
L	45	19,500	T	40	15,300
L	45	15,300	T	40	17,000
L	45	9,600	T	40	74,000
L	45	6,800	T	40	41,000
			T	40	26,000

Elevated Temperature (250 ^{O}C (482 ^{O}F)) on Laboratory Produced Extruded AlBeMet®162 Material
Elevated temperature (250 ^{O}C (482 ^{O}F)) Rotating Beam fatigue data is only available for laboratory material. Although standard production parameters were followed, the resulting laboratory material had higher strength in the transverse direction than typical production material (Table 1: Tensile Strength for Extruded).

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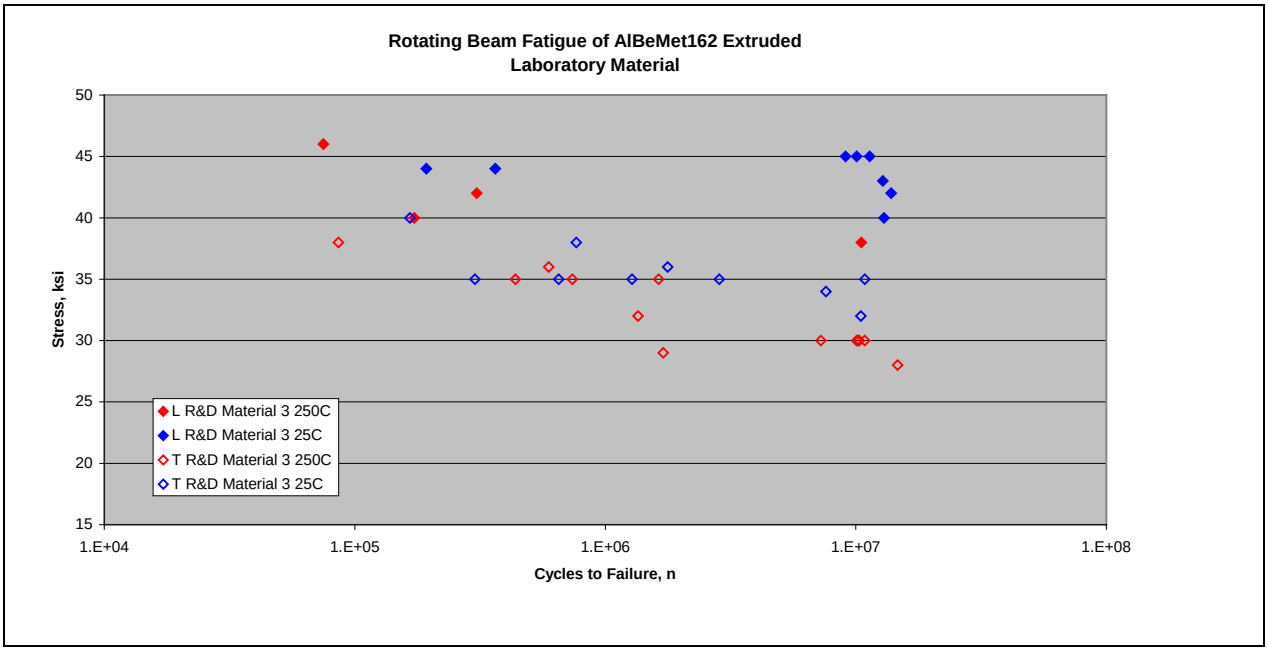
The 10^7 endurance limit at room temperature of the laboratory material is about 10 Ksi higher than the production material. Some, but not all of this increase in endurance limit can be attributed to the higher tensile strength of laboratory material. The other factors that resulted in the higher endurance limit have not been established.

Comparing the room temperature results with the 250 °C (482 °F) results for both the longitudinal and transverse specimens shows about a 5 Ksi reduction in the endurance limit. These results suggest that standard material would also lose about 5 Ksi at this temperature.

This is consistent with elevated temperature results for AlBeMet® 162 sheet that is extruded and rolled. The sheet specimens were subjected to axial fatigue with R = 0.1 at 350 °F (177 °C) had about a 2 Ksi reduction in the 10^7 endurance limit[ii].

Figure 1 Fatigue Results for Extruded AlBeMet® 162 at 250 °C (482 °F)



MATERIAL:

Specification: AMS 7912

Material:
Rotating Beam standard production data is from 4 standard production lot of extruded AlBeMet® 162.
Rotating Beam R&D material data is from 1 lot of extruded AlBeMet® 162.
Crack Growth Rate standard production data is from 1 standard production lot of extruded AlBeMet® 162.

TESTING:

Specifications: Rotating Beam
Materion Beryllium & Composites Internal Specification. (No current ASTM specification apply.)
R = -1 Tested at 9,000 to 10,000 RPM.

Specimen Information: (BWI DWG# PED-143)
Specimens were ¼ inch diameter with a 2.08 inch radiused 1 inch long gauge length. Overall length is 3 inches.

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Comments:
Rolled sheet has similar properties to extruded material. Elevated temperature fatigue data for rolled sheet is available through Materion Beryllium & Composites.

Internal Materion Beryllium & Composites Study by Mark Svilar

[i] John J. Lewandowski, Joel Larose, "Effects of processing conditions and test temperature on fatigue crack growth and fracture toughness of Be-Al metal matrix composites", Materials Science and Engineering A344 (2003) 215-228, Elsevier.

[ii] Dave Bowden, Rick Martin, Don Kaczynski, Charles Pokross, and Gil London, "The Application of Aluminum Beryllium in Fighter Aircraft Structure", TMS Fall Meeting presentation, Nov2,99

HEALTH AND SAFETY

Handling AlBeMet® in solid form poses no special health risk. Like many industrial materials, beryllium-containing materials may pose a health risk if recommended safe handling practices are not followed. Inhalation of airborne beryllium may cause a serious lung disorder in susceptible individuals. The Occupational Safety and Health Administration (OSHA) has set mandatory limits on occupational respiratory exposures. Read and follow the guidance in the Material Safety Data Sheet (MSDS) before working with this material. For additional information on safe handling practices or technical data on AlBeMet®, contact Materion.

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