NASA TECH BRIEF

Lewis Research Center

Cobalt Base Superalloy Has Outstanding Properties Up to 1478 K (2200°F)

NASA alloy VM-103 (cobalt-25W-3Cr-1Ti-0.5Zr-0.5C) can be produced in wrought form and has outstanding properties up to 1478 K (2200°F). Working schedules and specifications have been developed. This alloy is especially promising for use in applications requiring short time exposure to very high temperatures. Its properties over a broad range of temperatures are superior to those of comparable commercial wrought cobalt-base superalloys, L-605 and HS-188.

Alloy VM-103 was originally developed as a high strength cobalt-base cast superalloy (U.S. Patent No. 3,276,865). It has been demonstrated that its ductility allows it to be processed by hot and cold rolling. Ingots have been produced by induction plus vacuum arc remelting and by induction plus electroslag remelting. The ingots have been forged and hot rolled, typically at 1463 K (2174°F). Adding up to 10 percent nickel to the base composition is beneficial and further enhances alloy workability without adversely affecting other mechanical properties. The alloy can be rolled with reductions up to 25 percent per pass with intermediate anneals at 1478 K (2200°F).

Cold rolled sheet alloy in the solution heat-treated (1478 K (2200°F), one-half hour, water quench) condition has average tensile properties as follows:

Temperature		Ultimate Tensile Strength		Yield Strength		Elongation
K	°F	MN/m²	PSI (x 1000)	MN/m²	PSI (x 1000)	%
298	75	1095	159	705	102	17
923	1200	780	113	540	78	12
1143	1600	565	82	400	58	3
1238	1770	415	60	295	43	2
1368	2000	150	22			

At high strain rates (5 per minute), the tensile properties are higher:

Temperature		Ultimate Tensile Strength		Yield Strength		Elongation
K	°F	MN/m²	PSI (x 1000)	MN/m²	PSI (x 1000)	%
298	75	1140	165	850	123	22
923	1200	820	119	515	75	26
1143	1600	725	105	485	70	12
1253	1800	470	68	395	57	19
1368	2000	275	40	270	39	19
1478	2200	180	26	180	26	20

Comparatively, for L-605, the corresponding values are:

Temperature		Ultimate Tensile Strength		Yield Strength		Elongation
K	°F	MN/m²	PSI (x 1000)	MN/m²	PSI (x 1000)	%
1368	2000	217	31.5	192	27.8	25
1478	2200	123	17.8	123	17.8	25

Notes:

1. Potential applications for high temperature cobalt-base superalloy include high firing rate small caliber gun barrels and gun barrel liners, gas valve and hydraulic power system components for missiles, various static parts on jet engines, ramjets and rocket engines, where high temperature strength is required up to 1478 K (2200°F).
2. Further information is available in the following reports:

   NASA CR-121189 (N73-21457), Further Development and Characterization of VM-103, A NASA Wrought Cobalt-Base Alloy

   NASA CR-72726 (N70-37090), Development and Metallurgy Study of a NASA Cobalt-Base Superalloy

   Copies may be obtained at cost from:
   Aerospace Research Applications Center
   Indiana University
   400 East Seventh Street
   Bloomington, Indiana 47401
   Telephone: 812-337-7833
   Reference: B74-10081
3. Specific technical questions may be directed to:
   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B74-10081

(continued overleaf)

Patent Status:

NASA has decided not to apply for a patent.

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