MSFC-388 Material Properties Data Sheet

(Revision date: April 20, 2001)

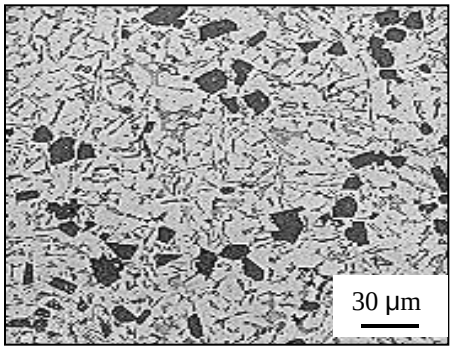
Applications

High performance pistons for gasoline and diesel engines, cylinder blocks, air-cooled engines, compressors and pumps requiring good abrasive resistance at elevated temperatures. Other applications where high wear resistance, hardness, low thermal expansion, low dimensional distortion, and superior tensile and fatigue strengths at elevated temperatures are required. Suitable for sand, permanent mold and die castings in hypereutectic (MSFC-398) and eutectic form (MSFC-388). In permanent mold, both alloys can provide three to four times the tensile strengths of conventional alloys test at 600°F-800°F for more than 100 hrs.

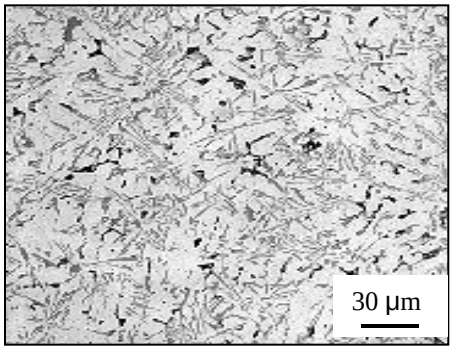
Specification Equivalents

MSFC-398 hypereutectic alloy (16% w. Si): Similar to SAE A390.0, Mahle 126, Zolloy Z16 and AE 425. A heat treatable Al-Si alloy consists of small polygonal primary silicon particles evenly distributed in aluminum matrix for high strength and wear resistance applications at elevated temperatures.

MSFC-388 eutectic alloy (<13% wt. Si): Similar to A384.0, A413.0, AE 413, Mahle 124. A heat treatable Al-Si alloy for high ductility, high strength and hardness applications at elevated temperatures.



MSFC-398 typical microstructure
(Hypereutectic alloy)



MSFC-388 typical microstructure
(Eutectic alloy)

Mechanical Properties

Tensile strength, yield strength, elongation, hardness and elastic modulus: See Tables 1.
Axial push-pull fatigue strengths: See Table 2.
MSFC-388 data from permanent mold casting with T5 heat treatment. T6 type properties are available.

Density and Thermal Properties

Density: 2.76 g/cm^3 (0.099 lb/in^3) at 25°C for MSFC-398, and 2.73 g/cm^3 (0.098 lb/in^3) for MSFC-388.
Liquidus temperature: 619°C (1156°F) for MSFC-398, and 581°C (1078°F) for MSFC-388.
Solidus temperature: 486°C (907°F) for MSFC-398, and 483°C (901°F) for MSFC-388.
Solidification temperature range: 619°C-486°C for MSFC-398, and 581°C-483°C for MSFC-388.
Thermal expansion coefficient, thermal conductivity, thermal diffusivity and specific heat: See Table 3.
MSFC-388 data from permanent mold casting with T5 heat treatment. T6 type properties are available.

Additional Technical Data

Additional non-proprietary data is available on request from NASA-Marshall Space Flight Center, Metallic Materials & Processes Group (ED33), Huntsville, AL 35812. E-mail: Jonathan.Lee@msfc.nasa.gov.
Phone: (256) 544-9290, Fax: (256) 544-5877.

Table 1 MSFC-388-T5 Permanent Mold Cast: Typical Mechanical Properties

Temperature		Time at test temperature	Tensile strength		Yield strength		Elongation in 4D, %	Hardness (HRB)	Modulus of elasticity (b)	
°F	°C	(hour)	ksi	MPa	ksi	MPa	(a)		10^6 psi	GPa
72	25	…	41	283	33	228	1.0	72	12.2	84.1
400	205	1	34	235	30	208	1.5	…	12.0	82.7
		100	33	228	26	179	1.6	58	11.5	79.3
		1,000	33	228	27	186	1.5	…	11.8	81.4
500	260	1	30	208	25	172	2.6	…	10.3	71.0
		100	25	172	20	138	3.1	53	10.5	72.4
		1,000	24	165	20	138	3.2	…	10.0	68.9
600	315	1	24	165	19	131	3.6	…	9.5	65.5
		100	20	138	16	118	4.1	47	8.9	61.4
		1,000	19	131	16	118	4.4	…	9.0	62.0
700	370	1	20	138	15	103	4.8	…	9.7	66.9
		100	14	97	11	76	5.8	31	8.8	60.7
		1,000	13	90	10	69	6.2	…	7.6	52.5

(a) Elongation given for eutectic alloy (12 % Si).
(b) The modulus of elasticity in compression is about 2% greater than in tension.
Source data are in English unit; metric values are converted and rounded.

Table 2 MSFC-388-T5 Permanent Mold Cast: Typical Fatigue Properties

Temperature		Soak time at temperature before test	Fatigue strengths at indicated temperatures and cycles (a)							
			10^5 cycles		10^6 cycles		10^7 cycles		10^8 cycles	
°F	°C	(hour)	ksi	MPa	ksi	MPa	ksi	MPa	ksi	MPa
72	25	…	25	172	22	152	17	117	14	97
400	205	1	23	159	18	124	15	103	12	83
		100	20	138	16	110	14	97	10	69
500	260	1	20	138	15	103	12	83	10	69
		100	15	103	12	83	10	69	8.0	55
600	315	1	18	124	13	90	10	69	7.0	48
		100	13	90	10	69	8	55	5.0	34

(a) Average values as determined by axial push-pull stress fatigue machines with smooth test specimens.
Source data are in English units; metric values are converted and rounded for eutectic alloy (12% Si).

Table 3 MSFC-388-T5 Permanent Mold Cast: Thermal and Physical Properties

Temperature		Thermal expansion (a)	Thermal diffusivity	Specific heat	Thermal conductivity	Density
°F	°C	(10^{-6}.K)	(cm^2/sec)	(J/kg.K)	(W/m.K)	(g/cm^3)
72	25	19.6	-	-	122.0	2.73
212	100	19.9	-	-	129.0	…
392	200	20.2	-	-	134.0	…
572	300	20.8	-	-	136.0	…
662	350	21.1	-	-	136.0	…

(a) Thermal expansion coefficients given for eutectic alloy (12% Si).