National Aeronautics and Space Administration

Materials and Coatings

Aluminum Alloy for High Temperature Applications

A novel low cost cast aluminum alloy offers dramatic strength at high temperatures

NASA's Marshall Space Flight Center originally developed a high-performance piston alloy to meet U.S. legislative restrictions on vehicular exhaust hydrocarbon emissions. NASA 398 aluminum alloy exhibits excellent tensile and fatigue strength at elevated temperatures. NASA 398 alloy also offers superior wear resistance, surface hardness, dimensional stability, and lower thermal expansion compared to conventional aluminum alloys. NASA 398 has been used in mass production and has enabled award-winning and innovative commercial products, and the NASA Marshall Technology Transfer Office is seeking new licensees that may also benefit from its adoption.

BENEFITS

- Significant improvement in tensile strength at elevated temperatures (500F - 700F)
- Enables designs that require less material, thus reducing part weight and cost
- Is suitable for mass production using conventional casting techniques
- Improved performance and reduced emissions in automotive piston applications

technology solution

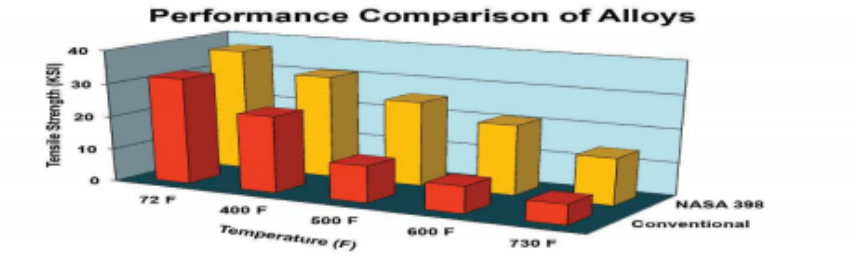
THE TECHNOLOGY

NASA 398 is an aluminum-silicon hypereutectic alloy (16% w. Si) with a microstructure that consists of small polygonal primary silicon particles evenly distributed in an aluminum matrix. The alloy can be utilized in automotive applications with high mechanical loading at elevated temperatures from 500 F (260C) to 700 F (370C), and can offer significant improvements in strength relative to most conventional aluminum alloys.

Material physical and mechanical properties for NASA 398-T5 (permanent mold) are provided in Table 1 below. Additional information is available on request. http://techtran.msfc.nasa.gov/technology/TOP31294-Aluminum-Alloy.php

Table 1 NASA 398-T5 (Permanent Mold): Typical Tensile Properties

Temperature		Time at test temperature (hour)	Tensile strength		Yield strength		Elongation in 4D, %	Hardness at 25°C	Modulus of elasticity	
°F	°C		ksi	Mpa	ksi	MPa		HRB	Msi	GPa
75	25	...	40	277	34	235	0.4	71	12.8	88.6
400	205	100	32	221	28	194	0.8	64	11.0	76.1
500	260	100	27	187	23	159	1.5	55	10.5	72.7
600	315	100	22	152	18	124	2.5	48	9.0	62.3
700	370	100	16	111	13	90	4.5	33	8.0	55.4



Comparison testing of tensile strength between a conventional aluminum alloy and NASA 398.

APPLICATIONS

The technology has several potential applications:

- Internal combustion engine pistons, manifolds, cylinder heads and heat exchangers
- Applications requiring light-weight, high-strength and wear-resistant alloys at high temperatures
- Potential replacement for cast titanium and iron-based alloys to reduce part weight and cost

PUBLICATIONS

Patent No: 6,918,970; 6,669,792; 6,592,687; 6,419,769; 6,399,020