

General

AM-SC1™ is a high temperature creep resistant alloy that has been developed specifically for use in sand and permanent mould cast automotive powertrain components. The alloy has very good castability and is particularly suitable for mass production. Both the composition of the alloy and the heat treatment conditions have been optimised for performance and cost. In particular, creep and bolt load retention properties have been tailored to match those of aluminium alloys, such as A380 and A319, used in powertrain applications.

Designation	AM-SC1
Composition	Mg-rare earth alloy
Fabrication	Sand casting permanent mould casting
Heat Treatment Condition	T6
Density	1.79 g/cm ³
Thermal Conductivity	106.6 W/m·K

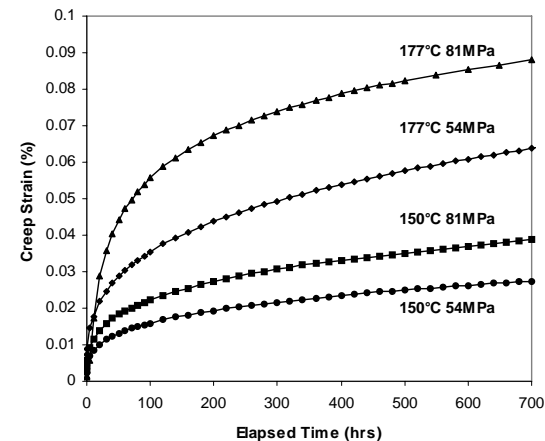
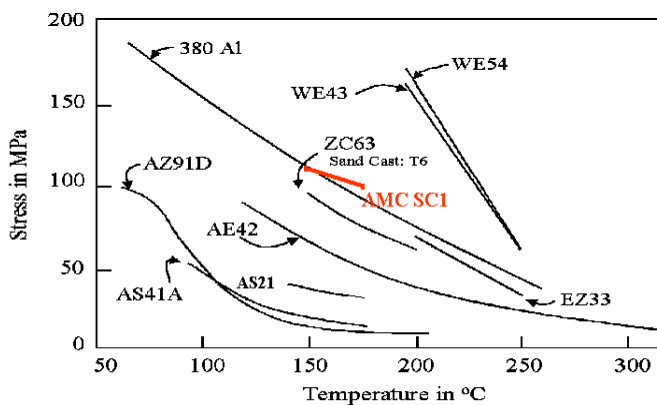
Mechanical Properties

There is only a minor decrease in tensile yield strength (0.2% offset proof stress) with increasing temperature from 20°C to 177°C. The compressive yield strength (0.2% offset compressive proof stress) remains unchanged over this temperature range.

Temperature		Tensile yield strength	Ultimate tensile strength	Fracture elongation	Compressive yield strength	Elastic Modulus
°C	°F	MPa	MPa	%	MPa	GPa
20	68	130 ± 4	206 ± 9	3.7 ± 0.4	133 ± 0.3	46
100	250	124 ± 9	184 ± 119	5.2 ± 2.2		44
150	300	128 ± 3	190 ± 7	11.0 ± 2.3	134 ± 2	43
177	350	114 ± 7	181 ± 5	10.5 ± 2.3	128 ± 6	42

Creep

The elevated temperature tensile creep strength of AM-SC1 in the T6 condition is considerably better than most other magnesium alloys that have been developed for automotive applications. In the temperature range of interest for many elevated temperature power train applications (150 – 177°C) the tensile creep strength is slightly better than sand cast aluminium alloy A319 in the T6 condition and also high pressure die-cast aluminium alloy A380.



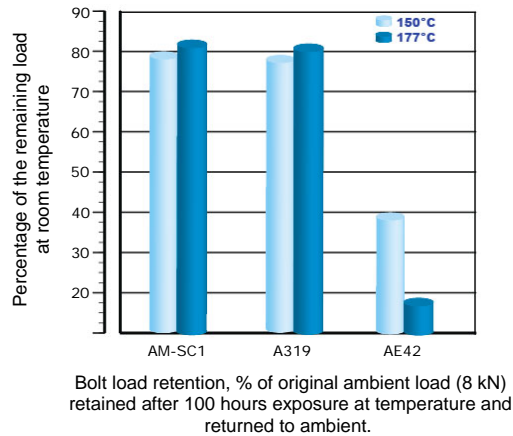
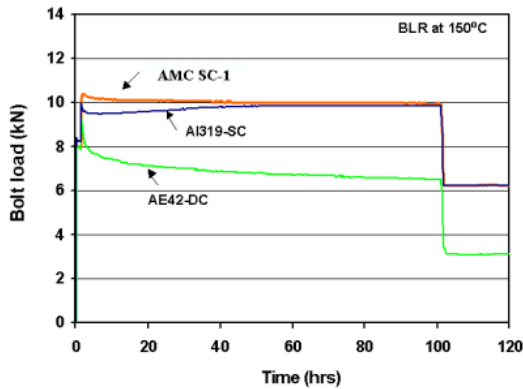
Stress to give 0.1% creep strain after 100 hours

Ref: Neife, Kubota, Higashi & Nehmenn "Magnesium-Based Alloys" Materials Science & Technology, Vol. 8 (1996)

Representative creep curves at 150 °C and 177 °C

Bolt load retention

Bolt load retention properties in the temperature range (150 – 177°C) are equally as good as aluminium alloys. This is of particular importance for maintenance of pressure tight bolted joints under the cyclic temperature conditions experienced by engine blocks and transmission components.



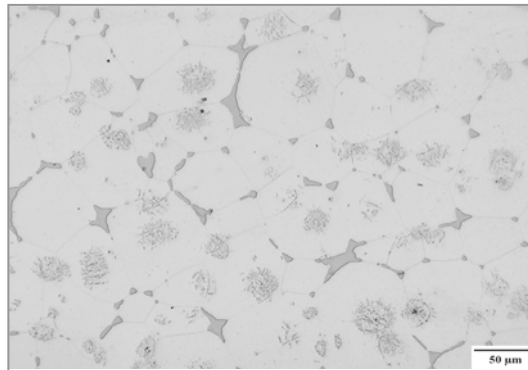
Fatigue strength

Fatigue strengths are highly dependent upon casting quality. The fatigue strengths of AM-SC1 sand castings have consistently met the requirements of engine designers.

Fatigue Strength at 10 ⁷ Cycles	
Temperature (°C)	Fatigue strength (MPa)
24	75 ± 18
120	71 ± 7

Microstructure

AM-SC1 has a fine-grained microstructure in the sand cast condition. The alloy is strengthened by a contiguous intermetallic phase at the grain boundaries and is further strengthened in the T6 heat treated condition by a distribution of very fine precipitates within the *a*-Mg matrix.



Application in engine blocks

Sand cast AM-SC1 has been utilised for the engine block of the Genios LE turbo diesel engine developed by AVL List GmbH. This innovative lightweight, low NVH engine was especially designed to demonstrate the commercial feasibility of a magnesium engine block under the demanding temperature and pressure conditions imposed by a modern diesel engine. AM-SC1 has also been selected for the engine block of the USCAR V6 magnesium intensive engine.

Development of alloy

AM-SC1 was developed by Advanced Magnesium Technologies and its research partner, CAST, in association with engine block manufacturer Hydro Aluminium (formerly VAW Automotive), engine designer AVL List GmbH, and speciality alloy producer Magnesium Elektron Ltd.

Reference

C.J. Bettles et al, AMC-SC1: An elevated temperature magnesium alloy suitable for precision sand casting of power train components, Magnesium Technology, Ed. H. Kaplan, TMS 2003, 223-2

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Further information on **AM-SC1™** can be obtained from Advanced Magnesium Technologies.