Aluminum/Silicon carbide composite

Description

Image

Caption

Al-SiC brake disc.

The material

Metal matrix composites are metals reinforced with ceramic particles. The most widely used are based on aluminum reinforced with particles of silicon carbide or alumina. The reinforcement increases the stiffness, strength and maximum service temperature without seriously increasing the weight. Production now exceeds 10,000 tonnes per year, at a cost of 2 - 5 £/kg.

Composition (summary)

Al/10-40% SiC

General properties

Density	166	-	181	lb/ft^3
Price	* 2.82	-	3.76	USD/lb
Date first used	1982			

Mechanical properties

Young's modulus	11.7	-	14.5	10^6 psi
Shear modulus	* 4.41	-	5.58	10^6 psi
Bulk modulus	9.86	-	12	10^6 psi
Poisson's ratio	0.29	-	0.31	
Yield strength (elastic limit)	40.6	-	47	ksi
Tensile strength	42.1	-	52.9	ksi
Compressive strength	40.6	-	47.1	ksi
Elongation	1	-	5	% strain
Hardness - Vickers	70	-	140	HV
Fatigue strength at 10^7 cycles	7.25	-	16	ksi
Fracture toughness	13.7	-	21.8	ksi.in^0.5
Mechanical loss coefficient (tan delta)	* 0.001	-	0.009	

Thermal properties

Melting point	977	-	1.16e3	°F
Maximum service temperature	440	-	692	°F
Minimum service temperature	-460			°F
Thermal conductor or insulator?	Good conductor			
Thermal conductivity	57.8	-	92.4	BTU.ft/h.ft^2.F
Specific heat capacity	0.191	-	0.215	BTU/lb.°F
Thermal expansion coefficient				

Values marked * are estimates.
No warranty is given for the accuracy of this data

	8.33	-	12.8	µstrain/°F

Electrical properties

Electrical conductor or insulator?	Good conductor			
Electrical resistivity	5	-	12	µohm.cm

Optical properties

Transparency	Opaque			

Processability

Castability	3	-	4	
Formability	1	-	3	
Machinability	1	-	3	
Weldability	2			

Eco properties

Embodied energy, primary production	* 8.96e4	-	9.9e4	kcal/lb
CO2 footprint, primary production	* 48.6	-	53.7	lb/lb
Recycle	✓			

Supporting information

Design guidelines

The attraction of metal matrix composites such as Duralcan is their stiffness-to-weight and strength-to-weight ratios, allowing weight saving in automobiles and sports equipment.

Technical notes

Metal matrix composites ('MMCs') are made by stirring finely divided silicon carbide (SiC) or alumina (Al2O3) particles into the molten metal, which is then cast ('Stir-casting'), or by mixing metal and ceramic powders and sintering, followed by forging or extrusion. The most widely used are the DURALCAN range of alloys based on the 6061 grade of aluminum alloy, with 10 to 30% silicon carbide or alumina.

Typical uses

Pistons; engine parts; brake discs, drums and calipers, drive shafts, mountain bike frames; precision instruments and sports equipment such as mountain bike frames and golf club shafts.

Links

Reference

ProcessUniverse

Producers