

SupremEX Metal Matrix Composites and AyontEX Al-Si Alloys for Space and Optical Applications

SupremEX[®] metal matrix composites (MMCs) are a family of materials based on high-strength aluminum alloys that are reinforced with nano-to-micron sized ceramic particles. AyontEX[™] alloys are a series of hypereutectic aluminum-silicon alloys containing micron-sized silicon particles in an aluminum alloy matrix. This ultrafine reinforcement provides several key benefits: high specific stiffness and strength, reduced coefficient of thermal expansion (CTE), excellent fatigue performance, improved damping, low friction and outstanding wear resistance. A range of SupremEX and AyontEX materials are available for specific application and property requirements.

The applications for SupremEX MMCs and AyontEX alloys are varied and include mirrors, support structures, optical housings, electronic housings, waveguide structures, adapters and interface components.

Material Properties of SupremEX Forged Plate Materials*

Material Designation	225XE	640XA	620XF
UTS MPa (ksi)	620 (90)	590 (86)	490 (71)
0.2% Proof Strength MPa (ksi)	440 (64)	490 (71)	410 (59)
Elastic Modulus GPa (msi)	115 (16.7)	140 (20.3)	103 (14.9)
Strain to Failure %	3.5	1.7	7
CTE, 20 - 50°C ppm/°C (ppm/°F)	16 (8.9)	13 (7.2)	17 (9.4)
Thermal Conductivity at 25°C W/m ² K (BTU/hr.ft. ² °F)	150 (87)	150 (87)	150 (87)
Specific Heat Capacity at 25°C J/g ² K (BTU/lb. ² °F)	0.836 (0.20)	0.820 (0.192)	0.850 (0.203)
Density g/cm ³ (lb./in ³)	2.88 (0.104)	2.90 (0.105)	2.80 (0.101)
Poisson's Ratio	0.3	0.3	0.3
Fracture Toughness KIC MPa√m (ksi√in)	19 (17)	12 (11)	Not measured
Fatigue Strength at 10 ⁷ cycles, Kt=1, R=-1 MPa (ksi)	310 (45)	230 (33)	230 (33)
Specific Stiffness GPa/g/cm ³ (msi/lb./in ³)	39 (160)	48 (193)	37 (148)
Specific Strength MPa/g/cm ³ (ksi/lb./in ³)	215 (864)	203 (817)	169 (703)
Stress Corrosion Cracking (75% at 0.2% YS)**	Class 1	Class 1	Not measured

*Data is for information purposes only; it does not constitute a guarantee. Properties are typical of the forged plate product form and based on the T6 cold water quench (CWQ) heat treatment condition. Final properties are dependent on exact forge ratio and direction.

**SCC testing carried out according to ECSS-Q-70-37A (ESA).

SupremEX 640XA MMC is a high-quality, aerospace-grade aluminum alloy (6061B) reinforced with 40 vol % silicon carbide (SiC) particles. It has high specific stiffness and a low CTE (13 ppm/°C) which provides a good match for optical and instrument assemblies. Our 640XA has high strength and stiffness which allows weight saving over aluminum or titanium structures. Due to the strengthening mechanisms associated with particulate MMC's, it can be heat treated to provide both strength and thermal stability for dimensionally critical applications. NOTE: 640XA billet is available supplied to AMS 4368 designation: 6061B/SiC/40p (3 μm).

Data Sheet continued

SupremEX 225XE MMC is a high-quality aerospace grade aluminum alloy (2124A) reinforced with 25 vol % SiC particles. It has an excellent balance of mechanical properties and offers a titanium replacement option with a 35% reduction in density. 225XE has a close CTE match to copper (16 versus 17 ppm/°C) and therefore is an ideal, lightweight material for use in electronic applications that require reliability in thermal cycling applications such as those found in low Earth orbit (LEO) satellites. NOTE: 225XE is available supplied to AMS 4355 (billet) and AMS 4379 (extrusion) designations: 2124A/SiC/25p (3 µm).

Material Properties of AyontEX Hot Isostatically Pressed Billet Materials*

Material Designation	AyontEX 4632	AyontEX 17	AyontEX 13
UTS MPa (ksi)	440 (64)	355 (51)	345 (50)
0.2% Proof Strength MPa (ksi)	390 (57)	300 (44)	340 (49)
Elastic Modulus GPa (msi)	94 (13.6)	87 (12.6)	103 (14.9)
CTE, 20 - 50°C ppm/°C (ppm/°F)	17 (9.4)	17 (9.4)	13 (7.2)
Thermal Conductivity at 25°C W/m ² K (BTU/hr.ft. ² °F)	141 (82)	160 (98)	134 (77)
Specific Heat Capacity at 25°C J/g ² K (BTU/lb. ² °F)	0.84 (0.20)	0.88 (0.21)	0.85 (0.20)
Density g/cm ³ (lb./in ³)	2.70 (0.097)	2.60 (0.094)	2.54 (0.092)
Poisson's Ratio	0.3	0.3	0.3
Specific Stiffness GPa/g/cm ³ (msi/lb./in ³)	35 (140)	33 (134)	41 (162)
Specific Strength MPa/g/cm ³ (ksi/lb./in ³)	163 (658)	137 (548)	136 (544)

*Data is for information purposes only; it does not constitute a guarantee. Properties are typical of the T6 cold water quench (CWQ) heat treatment condition.

Design and Fabrication

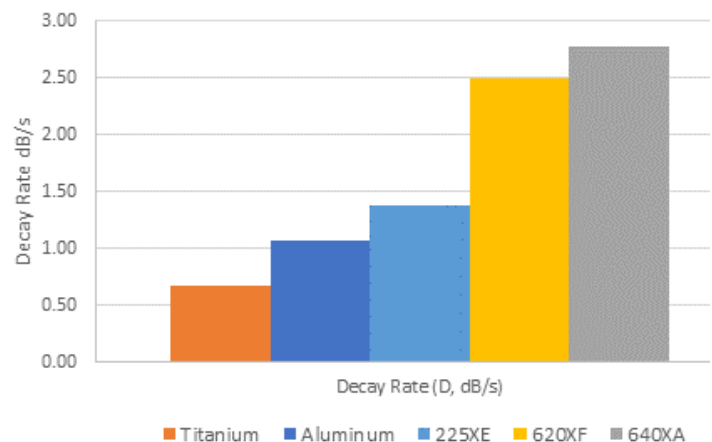
SupremEX MMCs and AyontEX alloys are isotropic metallic materials and can be designed and optimized using existing FEA techniques. All grades can be readily formed and high-speed machined into high-tolerance, complex parts using conventional and available techniques.

Fabrication and finishing guidelines are available on request. Billet, forged, extruded, rolled, machined and coated parts are available.

Mechanical and Acoustic Damping Properties

SupremEX and AyontEX materials exhibit excellent acoustic and mechanical damping which can be advantageous for a number of applications including vibration reduction during take-off and reducing line-of-sight jitter in precision optics.

This graph shows how the acoustic damping of SupremEX materials compares to that of other materials. SupremEX MMCs show increased decay rates (improved damping) compared to aluminum and titanium alloys



Technology Readiness Level, Specifications and Space Heritage

SupremEX MMCs have a proven, 20-year background in a wide range of mission-critical, high-performance applications. The range of materials has been used in numerous airborne precision optics applications that take full advantage of the low density and high stiffness of the material. 640XA is currently being used successfully onboard the European Space Agency's Sentinel as part of an Earth observation instrument. The space heritage of our SupremEX metal matrix composites is increasing all the time with development projects in progress for a number of other satellite applications including Sentinel 4 and Metosat.

Stress Corrosion Cracking (SCC) and Coating

SupremEX 640XA and 225XE MMCs have both passed the critical ESA SCC test (ECSS-Q-70-37A). SupremEX 640XA and 225XE metal matrix composites were both classed grade 1 SCC.

Conventional coating technologies such as chromate conversion, anodizing, electroplating and plasma electrolytic oxidation can all be applied to these materials to provide enhanced corrosion protection.