MATERION

TECH BRIEF

MATERION'S AMC 4632® ALLOY AS A LIGHTWEIGHT THERMAL MANAGEMENT SOLUTION

CHALLENGE

Thermal management using lightweight substrates and heat sinks for electronic assemblies are key material challenges for increasing power density requirements in both hand-held and weight-critical components. High thermal conductivity is important to remove heat from the source, but some materials that have the highest thermal conductivity are also very dense. Excess weight can hinder the performance for fuel constrained flight and space hardware where every pound counts.

Besides thermal conductivity and weight, another key challenge is to minimize movement and flexure that could lead to a circuit fracture or open circuit failure. Thermal fatigue can often occur in devices that are cyclically turned on and off if components do not have matched coefficients of thermal expansion (CTE). The problem is finding a material solution that combines appropriate thermal conductivity, low density, and avoids thermal fatigue.

High electrical conductivity copper is often used in printed circuit boards and connectors and has a linear CTE of 17 ppm/°C in the 20°C to 100°C temperature range (9.4 ppm/°F at 68°F to 212°F); therefore, it is important to have material options that closely match copper's CTE. Aluminum is a common lightweight solution with high thermal conductivity, but it falls short in one regard - in Table 1 below, notice that a standard Aluminum 6061 T6 has a greatly mismatched CTE compared to copper.

TABLE 1 - PHYSICAL PROPERTIES

MATERIAL	Density, g/cm³ (lbs/in³)	Modulus, GPA (msi)	Specific Stiffness, GPa/g/cm³ (msi/lbs/in³)	Thermal Conductivity (25C), W/m/K (BTU/hr/ft/F)	CTE (20-100C), ppm/C (ppm/F)	Specific Heat (25C), J/g·C (BTU/lb·F)
Copper	8.96 (0.324)	110 (16.0)	14.2 (56.9)	395 (228)	17.1 (9.5)	0.385 (0.092)
CuW 25/75	14.3 (0.517)	260 (37.7)	18.2 (72.9)	190 (110)	9.5 (5.3)	-
Al 6061-T6	2.75 (0.100)	70 (10.2)	25.5 (102.0)	170 (98)	23.6 (13.1)	0.896 (0.214)
Osprey CE17	2.60 (0.094)	92 (13.3)	35.4 (141.5)	160 (93)	16 (8.9)	0.846 (0.202)
AMC 4632	2.70 (0.097)	94 (13.6)	34.8 (140.2)	141 (82)	17.1 (9.5)	0.840 (0.201)

SOLUTION

Materion's AMC 4632 alloy is a hypereutectic aluminum silicon alloy that remedies this issue. It is manufactured using a proprietary powder metallurgy route that refines the microstructure, resulting in an alloy that has:

- >3.3 times lower density versus copper
- Excellent machinability, especially when compared to similarly performing metal matrix composites (MMCs)
- CTE matching copper
- Elastic modulus far surpassing nominal aluminum alloys
- Excellent plateability
- Adequate elongation in the T1 condition to avoid cracking during component assembly

AMC 4632 PRODUCT FORMS
Billet/shaped HIP consolidated forms
Forged plate
Extrusions
Rolled plate

AMC 4632 - 3X LIGHTER THAN COPPER

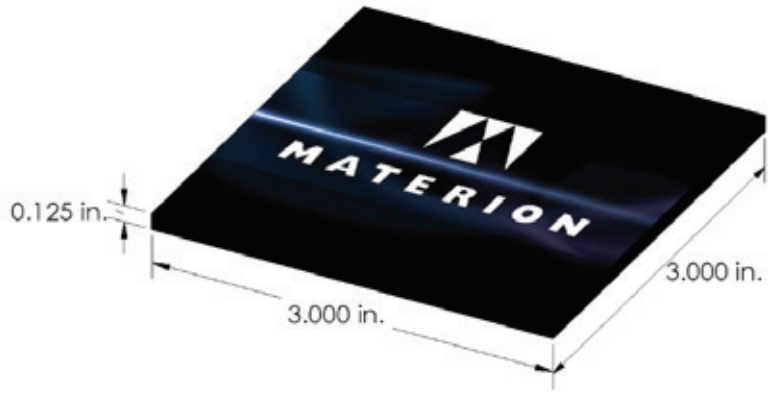

Figure 1: The 3"x3"x0.125" structure to the above would weigh 0.36 lbs if made from copper, but only 0.11 lbs if made from AMC 4632

TYPICAL MECHANICAL PROPERTIES – AMC 4632

PRODUCT FORM	BILLET	EXTRUSION	FORGING
Heat Treatment	T6CWQ	T1	T6CWQ
Rp0.2 MPa (ksi)	390 (57)	172 (25)	380 (55)
Rm MPa (ksi)	440 (64)	255 (37)	430 (62)
Elongation %	1	5	2