BERYLLIUM METAL MATRIX COMPOSITES FOR AEROSPACE & COMMERCIAL APPLICATIONS

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ABSTRACT

There is a growing need in both the aerospace and commercial markets for lighter weight, higher stiffness, higher thermal stability materials to solve the design engineers problems of reduced mass, higher access speeds, improved mechanical and thermal stability for today's advanced technology.
To address those needs, Materion Brush Inc., Inc. has developed, characterized and put into high volume production a family of beryllium metal matrix composites. There are two classes of materials that have been developed to provide these engineering benefits to the designer in both the commercial and aerospace markets.
The first family of materials is Aluminum Beryllium (AlBeMet®). This material is a metal matrix composite consisting of pure beryllium and aluminum, in the ratio's ranging from 20% -62% Be by volume, with the remainder being aluminum. The material is produced by both powder metallurgy and net shape technologies such as investment casting and semi-solid forming. The materials properties that make it attractive for the design engineer are a density 25% less than aluminum, 4X the specific stiffness of aluminum, titanium, steel, magnesium, higher dampening capacity than aluminum, and a coefficient of thermal expansion almost 50% lower than aluminum.

The second family of materials is a Beryllium-Beryllium Oxide metal matrix composite, called E Materials. This material was developed to address the thermal management needs of the electronic package design engineer. The material properties that make this material attractive to the electronic packaging engineer are: density 4-5X lower than Kovar, Invar, CuMoCu, and 30% less than AlSiC; thermal conductivity's ranging from 210-240 W/m-k and a tailorable thermal coefficient of expansion, ranging from 6 ppm/C to 8.7 ppm/C.

Introduction

Requirements for aircraft avionics, satellites, and commercial applications continue to increase, requiring higher packaging densities, lower junction temperatures, higher heat loads, improved access time, and smaller, lighter, stiffer structures. These all continue to challenge materials development. To address these increased performance needs Materion Brush Inc., Inc. has developed a family of new metal matrix materials, **AlBeMet® and E Materials**, for these increased performance applications.

These materials offer the design engineer a combination of lightweight, high thermal conductivity, tailorable coefficient of thermal expansion, high specific stiffness, thermally stability, with mechanical properties that have a high degree of isotropy. These materials are manufactured by conventional powder metallurgy technology, while at the same time parts can be fabricated with conventional aluminum technology.

AlBeMet®

AlBeMet® is a family of metal matrix composite made up principally of beryllium and aluminum. We can vary the ratio of the two metals to alter the physical, thermal and mechanical properties. The first composition offered to the market is **AlBeMet® 162**, a 62% Beryllium / 38% aluminum composite. This material is a powder metallurgy product produced by gas atomization. The final product forms, rod, bar, tube, sheet, are derived by consolidating the aluminum/beryllium powder by Hot Isostatic Pressing (HIP), and Cold Isostatic Pressing (CIP) followed by extrusion or sheet rolling processes. The material is also available as an investment casting form under the trade name of **AlBeCast®**.

Physical Properties

High performance aerospace and commercial systems are requiring reduction in weight, while needing to increase the first mode frequency (deflection) of the system to decouple the components from the systems other frequencies. This minimizes the stress from vibration on things like, solder joints and substrates in the electronic packaging world. It also increases the fatigue life of the electronic packages, as well as applications like automotive brake calipers and IC chip wire bonding machines. **AlBeMet® 162** with a density of 2.1g/cc (0.076Lb/in^3), combined with a elastic modulus of 180 Gpa (28Msi) provides a unique combination of physical properties, specific stiffness (E/ρ) that is 4 X aluminum, to address those needs(Table 1). It also has a higher dampening capability, 2-7 times more, depending on frequency and temperature, than conventional aluminum materials like 6061T6, there by minimizing deflections and increasing fatigue life of the components, see Figure 1.[ref 1]

COMPARISON PROPERTIES OF SELECTED ALUMINUM'S AND AlBeMet ® 162 WROUGHT PRODUCT

PROPERTY	2024T6	6061T6	AM 162
DENSITY g/cc (Lbs/in^3)	2.77 (0.100)	2.70 (0.100)	2.10 (0.076)
MODULUS Gpa (Msi)	72 (10.5)	69 (10.0)	193(28)
POISSON'S RATIO		0.23	0.17
COEFFICIENT of THERMAL EXPANSION @25C ppm/C(ppm/F)	22.9 (12.7)	23.6 (13.1)	13.9 (7.7)
THERMAL CONDUCTIVITY, W/mk	151	180	210
SPECIFIC HEAT @ 20C J/kg °K	875	896	1506
ELECTRICAL CONDUCTIVITY % IACS	38	43	49
DAMPING CAPACITY @ 25C AND 500 HZ	$1.05 X10^{-2}$	$1.05 X 10^{-2}$	$1.5 X 10^{-3}$
FRACTURE TOUGHNESS $K_{1 C}$, KSI√IN	23 (T-L)	23 (T-L)	10-21 (T-L)

Table 1 - Physical Properties AlBeMet® 162

Mechanical Properties

TENSILE

The mechanical properties of AM 162 have been extensively characterized in all 3 product forms, with the most extensive design data base being developed for the extruded product form. The extruded bar is fabricated by CIP'ing the spherical aluminum-beryllium powder into semi-dense billets and then canning the billet for subsequent extrusion with a minimum of a 4:1 reduction ratio. Tensile testing was conducted using tapered-end specimens with a 0.25" (0.635cm) diameter gauge in both the longitudinal and long-transverse directions. Testing was performed using the ASTM-E8 guidelines. The room temperature typical tensile properties are given in Table 2. The room temperature tensile strength of the wrought forms of AM 162 compare favorably to 6061T6 aluminum, and are less than the 2024T6 aluminum. This property was important to the ORBCOMM satellite(Figure 2), where high loads resulting from the Pegasus launch transient meant that a high strength material was needed for the spacecraft construction, equal to or better than 6061T6. Also the spacecraft structure needed ductility in the material in order to accommodate the shock loads at the interface of the non-explosive separation bolts and the spacecraft, and the release of the pre-load energy on the bolts. Like many metals, the tensile properties increase with decreasing temperature and decrease with increasing temperature [ref 1].

TYPICAL ROOM TEMPERATURE TENSILE PROPERTIES AM 162

PRODUCT	HEAT TREATMENT	YIELD STRENGTH Mpa (Ksi)	ULTIMATE STRENGTH Mpa (Ksi)	ELONGATION %
HIP'ed	593°C/ 24 hrs	221 (32)	288 (42)	4
EXTRUDED (L)	593°C/ 24 hrs	328 (47)	439 (63)	9
SHEET (L)	593°C/ 24 hrs	314(45)	413 (60)	7

TABLE 2

<u>Notched Strength / Pin Bearing Strength</u>

There is no observable notch brittleness in AM 162 extruded material. The strength ratios for all conditions were greater than 1, with a stress concentration factor of Kt= 3. The sharp-notch strength to yield-strength ratio(NRS) values were higher in the longitudinal direction compared to the transverse direction. Also the NRS tended to increase slightly at elevated temperatures, indicating plastic flow(Table 3). There was no indication of hole tearing or breakout in the holes, during bolt bearing testing. The notch strengthening indicated in the AM 162 extruded material was of significant design value to the ORBCOMM satellite. Shock loading of the spacecraft is accomplished by simultaneously releasing three separation bolts that connect the spacecraft to each other. While the release is non-explosive, the shock levels are high due to the stored energy in the preloaded bolts. Even after repeated separation tests, no cracks were observed in the separation brackets or vertical gussets that were made from AM 162 material.

Notched/Bearing Properties of AlBeMet ®162 Extruded

TEST CONDITIONS	NOTCH STRENGTH Mpa (Ksi)	NSR	BEARING STRAIN %	BEARING STRESS Mpa (Ksi)
195°C L	556 (80.8)	1.5		NT
T	482 (70.0)	1.3		
21°C L	513 (74.4)	1.6	8.9	349 (50.6) L
T	435 (63.1)	1.3	6.4	333 (48.3) T
200°C L	641(50.3)	1.6		NT
T	344 (50.0)	1.3		

TABLE 3

<u>Fatigue Properties</u>

The fatigue properties of AlBeMet® 162 extruded material, Figure 2, have been tested using the Krause rotating beam fatigue test utilizing fully reversed cycles with a R= -1. The fatigue limit, 1 x 10^7 cycles, was about 207 Mpa (30Ksi) in the longitudinal direction and 165 Mpa (24Ksi) in the transverse direction. This property is approximately 75% of the minimum RT yield strength, which is 2X that of typical fatigue properties for 6061T6 aluminum. This is important for applications where cyclic fatigue is critical to the life of the component.

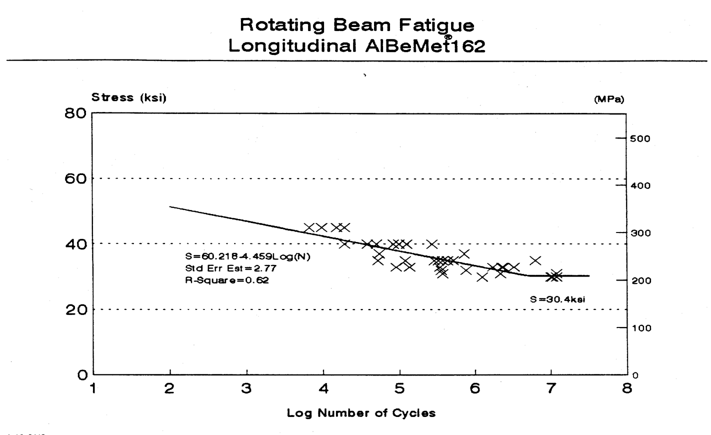


Figure 2

<u>Stress Corrosion Cracking</u>

AlBeMet® 162 sheet and extruded products have been tested for stress corrosion by Materion Brush Inc. and independent laboratories like European Space Agency (ESTEC) materials laboratory. The testing at Materion Brush Inc. consisted of using the ASTM G38-73 test procedure, C-Ring Stress Corrosion Testing, and subjecting the specimens to 30 days in a 3.5% sodium chloride (NaCl) solution .

The testing at ESTEC was done utilizing the ASTM E8-m subsize specimen were subjected to 75% of the 0.2% proof stress (yield strength) and immersed in 3.5% NaCl solution for 10 minutes and dried for 50 minutes, which was repeated over a 30 day period. This was done to both sheet and extruded material. These results, as seen in Table 4, indicate that none of the specimens failed during the 30 days testing, and in subsequent tensile testing no degradation, even a slight increase in mechanical strength [ref 2], was observed. ESTEC / ESA have given their approval for the use of AlBeMet® 162 and 150 grades for use on satellite structures for European spacecraft. Since then Alenia has applied the material on a mechanism for the Hot Bird Satellite.

ESTEC STRESS CORROSION CRACKING TEST RESULTS

Specimen	Stress during SCC test (Mpa)	R_p O.2 Mpa (Yield)	R_m (UTS)	Elongation % after fracture	E Gpa	Time to Failure Hours	Max. Depth of pits µm
AM 150 RL	244.5	356.8	398.6	1.3	167.3	no failure	120
AM 150 RT	244.5	344.4	391.5	2.23	176.2	"	20
AVG.	244.5	350.6	395.1	1.77	171.8		
AM162 RL	291	411	425.1	1.0	198.0	no failure	120
AM162 RT	291	403	408.1	1.0	244.6	"	280
AVG.	291	407	416.6	1.0	221.3	"	

Table 4

FABRICATION TECHNOLOGIES

Machining Fabricating AlBeMet® materials is very similar to fabricating aluminum. The material can be conventionally machined using carbide cutters, at speeds and feeds that are approximately 15-20% slower than machining 6061T6 aluminum. The significant difference is increased tool wear over aluminum due to the abrasive nature of the beryllium portion of the matrix, typically 2x that of aluminum. Forming of the sheet material is similar to aluminum, in that the same tooling and temperatures ranges can usually be used, but at a higher forming temperature - typically over 200°C (

400°F). The forming rate is slightly slower for AlBeMet® materials, especially if severe bending is required. For the ORBCOMM satellite(Figure 3) [ref 3], the forming of the AM 150 sheet material was done at the same rate as an aluminum panel. The principal fabrication difference between AlBeMet® and aluminum, is the need for a facility that can handle beryllium containing materials to remove the fine, airborne particles that could pose a health risk in individuals that are sensitive to the material. Contact Materion Brush Inc. for further information on safe handling of Beryllium containing materials.

Coating Like aluminum, AlBeMet® materials, depending on the service environment, can be coated with typical aluminum protective coatings from ChemFilm(Alodine) to Cadmium over nickel. One application for electronic modules required the AlBeMet® to pass a 500 hour salt fog test. That has been successfully accomplished by either anodizing (Class 1, Type 1), electroless nickel plating or cadmium plating over nickel. Another coating that provides not only corrosion protection but also is useful for adhesive bonding of structures together, that was used for the ORBCOMM honeycomb panels(Figure 3), is BR 127, a sprayed on adhesive primer. Using this coating allows the coated parts to be stored for months, if necessary, prior to final assembly. After storage, the primed surface only needs to be wiped with an alcohol solution to prepare it for active bonding. This coating eliminates the need for the final user to do anything to the AlBeMet® bare surface prior to bonding.

Joining Technologies AlBeMet® materials can be joined utilizing many of the same joining technologies for aluminum. The material can be vacuum and dip brazed, electron beam and TIG welded. There currently is work being done on developing laser welding technology . Table 5 indicates the typical values obtained utilizing these processes, based on limited test data [ref 4].

AlBeMet ® AM 162	TYPICAL JOINT STRENGTHS
EPOXY BONDING PHEONLIC EPOXY BR 127 PRIMER HYSOL HIGH STRENGTH EPOXY	4,000 Psi (27Mpa) (Shear)
DIP BRAZING, 580°C, Braze Alloy 718	14,500 Psi (98Mpa) (Shear)
FLUXLESS VACUUM BRAZING	10,000 Psi (68Mpa) (Tensile)
TIG WELDING	30,000 Psi

EB WELDING	**(203Mpa) (Tensile)** **42,000 Psi** **(285Mpa) (Tensile)**

Table 5

Designing joints for AlBeMet ® materials is quite different from those designed for aluminum. Aluminum usually fails in a ductile manner, so bending occurs before failure, which usually occurs in the joint. With AlBeMet ®, the metal is stiffer, so the joint is designed so the parent metal fails before the joint. In this fail-safe design, the joints are not the weak link in the design and therefore will take the stress build-up without failure .

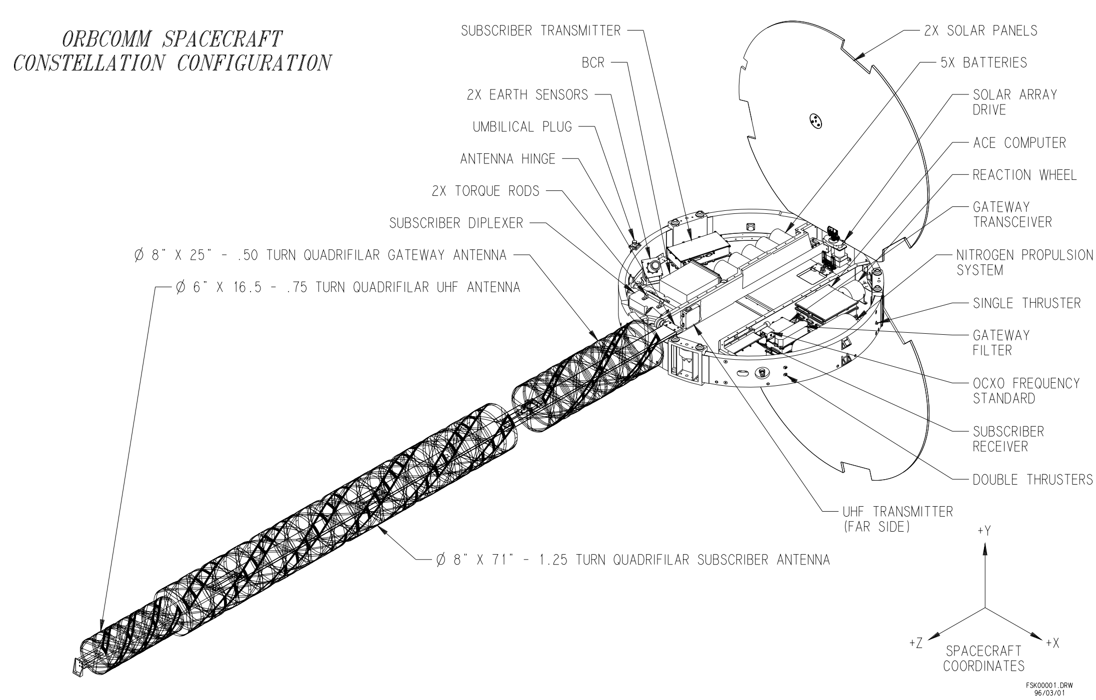


Figure 3

Net Shape Technologies

Investment Casting Technology

To meet the market needs for net shapes and rapid prototyping capability in aluminum beryllium, an investment casting grade of AlBeMet® was developed. The AlBeCast® product line is a result of that development effort.

AlBeCast® is a family of investment cast aluminum beryllium materials that provides the designers a " near net shape" capability in aluminum beryllium, utilizing the casting technology developed for the aluminum and titanium casting industries. The AlBeCast® process meets the standard cast aluminum design guidelines and requires minimal design changes. It also utilizes the same basic equipment used in producing aluminum investment castings. The only unique features of the AlBeCast® process are the need for particulate collecting equipment and the use of vacuum casting versus the more traditional air melt casting process. The first investment casting grade available is AlBeCast® 910 [ref 5].

AlBeCast® 910 offers the designer reduced mass, 22% lower than aluminum A356; a 400% improvement in stiffness versus A356; a 40% lower coefficient of thermal expansion(CTE) and an increase in dampening properties compared to A356.

AlBeCast® can be successfully cast utilizing the following rapid prototype processes:

- Sterelithography (SLA)
- Selective Laser Sintering (SLS)
- Laminated Object Manufacturing (LOM)

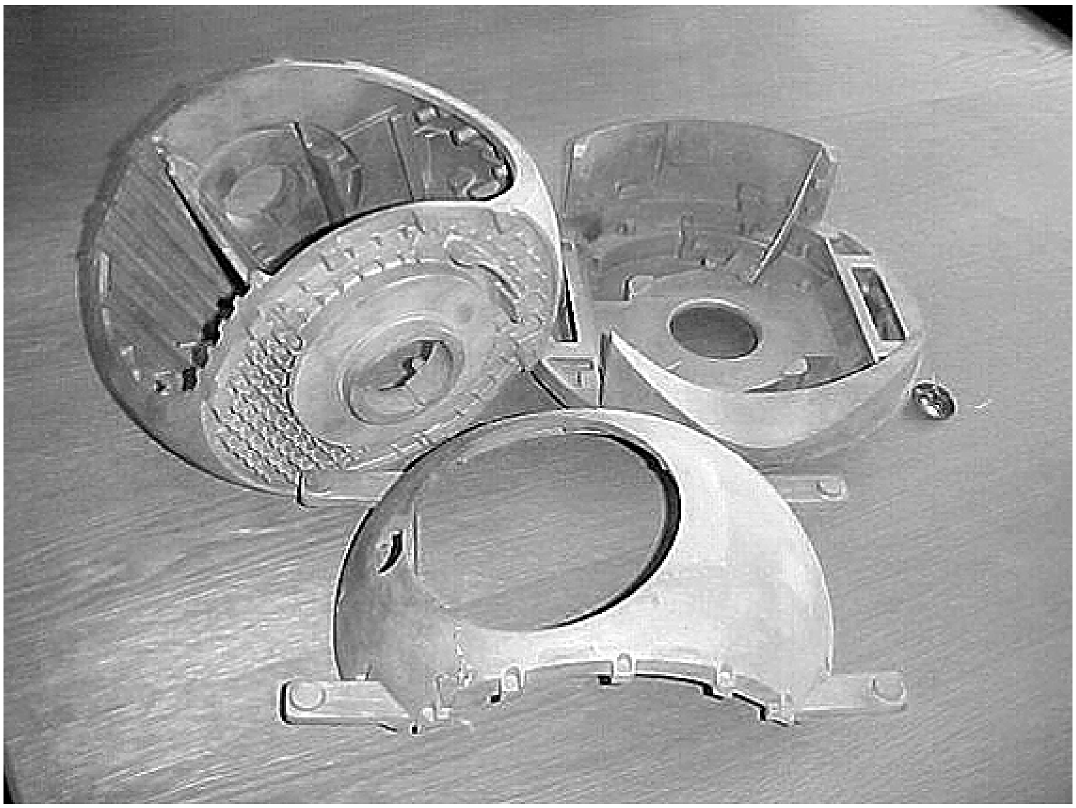
Mechanical Properties of AlBeCast® 910

AlBeCast® 910 is a moderate strength alloy, ideally suited for applications requiring high specific stiffness, low mass, and low CTE(See Table 6)

Typical AlBeCast® 910 Properties

Property	-58C (-72F)	23C (70F)	149C (300F)
Ultimate TensileStrength – Mpa (ksi)	207 (30)	207(30)	117 (17)
Yield Strength – Mpa (ksi)	152 (22)	158 (23)	96 (14)
Elongation - %	4	4	6
Poisson's Ratio @ 24C (72F)		0.154	
Fatigue Strength at 10^7 cycles,R= -1		86 (12.5)	

Table 6



AlBeCast Castings - Figure 4

Semi – Solid Forming (SSF) Technology

A powder metallurgy based SSF forming process(see Figure 5) has been developed to produce low cost net shapes of beryllium-reinforced aluminum alloys. The beryllium acts as a reinforcing additive to the aluminum in which there is nearly no mutual solid solubility. The modulus of elasticity of the alloy dramatically increases, while the density and thermal expansion decrease with increasing beryllium content.

The forming process involves heating a blank of material to a temperature at which the aluminum is semi-solid and the beryllium is solid. The semi-solid blank is then injected without turbulence into a permanent mold. High quality, net shape components can be produced which are functionally superior to those produced by other permanent mold processes. Dimensional accuracy is equivalent to or better than that obtained in high pressure die casting [ref 6].

Materion Brush Inc. Inc. has evaluated a number of compositions, including 30% beryllium by weight combined with 70% A356 aluminum, up to 40% by weight of beryllium combined with 6061 aluminum. The composition with the most characterization in terms of properties and processes is the 30% beryllium by weight + the 70% A356 aluminum. Table 7 provides some of the mechanical and thermal properties of this composition.

Typical Properties SSF 30% Beryllium, 70% A356 Aluminum

Material	Density g/cc	UTS – Mpa	Y.S. – Mpa	Elong. %	T.C.W/m-k
30% Be / 70% A356	2.36	340	275	6	181
30% Be / 70% 6061Al	2.36	310	240	4	180

Table 7

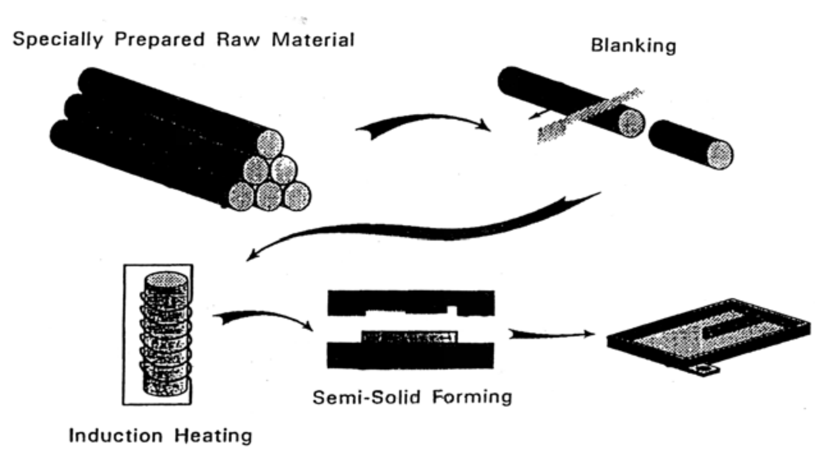


Figure 5

E Materials

Recent advances in electronic packaging designs for multichip modules(MCM's) used in spacecraft electronics, and standard electronic modules for aircraft avionics(SEM-E & Double Euro), have created a need for substrate materials that must have improved fundamental characteristics such as: high thermal conductivity(TC), low weight, high stiffness, improved thermal cycle reliability over broad temperature ranges, and a coefficient of thermal expansion(CTE) that ideally matches the components installed in the package or helps in constrainment of the total package in order to minimize the thermal mismatch of the printed wiring board(PWB) materials and the packages. These advanced packaging designs also need materials to accommodate increased power demands, while enduring the harsh environments of military applications.

To address those needs, Materion Brush Inc. has developed a family of lightweight Beryllium based metal matrix composites. This family of materials, called **E Materials (grades E20, E40, E60)** offers a range of tailorable properties and a significant improvement over other electronic packaging materials, such as copper moly copper(CMC), AlSiC, CuW, Kovar, and aluminum, in meeting the thermal performance needs of MCM's, SEM-E's, to R/F and digital microwave packages.

MATERIAL DESCRIPTION

The Beryllium metal matrix composites consist of a fine single crystal Beryllium Oxide(BeO) platelet surrounded by a continuous Beryllium(Be) matrix. The volume fraction of the BeO in the matrix is altered, 20-60%, to tailor the thermal and mechanical properties, as well as the density of the composite, see **Table 8**. Unlike many of the new advanced thermal performance materials, the properties of the Beryllium composites, **E Materials**, are isotropic and thermally stable [Ref. 7]. The resulting composites exhibit a high modules, good thermal conductivity, low density, and a lower CTE.

MATERIAL PROPERTIES

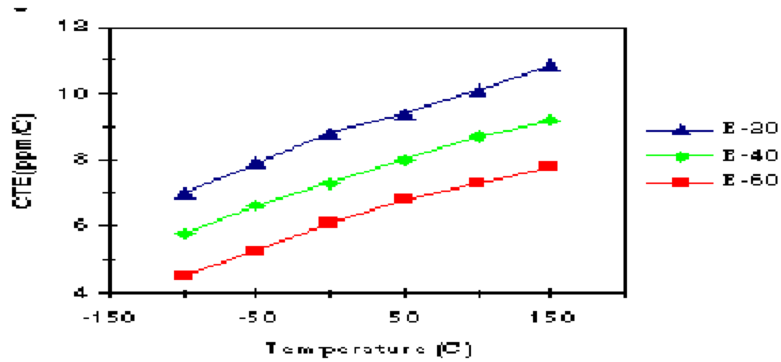
The properties of principal interest to the electronic packaging engineer, designing MCM-L, SEM-E, and RF/Microwave baseplates used in the package to dissipate heat and provide a good CTE match to the ceramic package are; a tailorable CTE, high thermal conductivity, high elastic modules to reduce transmissibility, low weight, ease of fabrication using either net shape technologies or conventional machining practices, and reduced cost.

TABLE 8 - MATERIALS AND THEIR PROPERTIES FOR MICROELECTRONIC PACKAGES

MATERIAL	DENSITY g/cc(Lbs/cu.in.)	E MODULES Gpa(Msi)	THERMAL CONDUCTIVITY W/m/K	CTE ppm/°C avg. 25-50°C
Be/BeO Composites **E20** **E40** **E60**	2.06(.075) 2.30(.084) 2.52(.091)	303(44) 317(46) 330(48)	210 220 230	8.7 7.5 6.1
AlSiC -~ 70% **AlSiC - 45/55%**	3.01(.111) 2.95(.109)	220(32) 195(28)	~170 160	6.7 8.5
Kovar	8.1(.300)	140(20)	14	5.9
CuMoCu 13/74/13%	9.9(.360)	269(39)	181	5.8
CuW-25/75%	14.8(.538)	228(34)	190	8.3
Aluminum 6061T6	2.75(.100)	70(10)	170	23.6

Coefficient of Thermal Expansion - The CTE of the three(3) grades of Be-BeO metal matrix composites, E20, E40, E60, have been measured by using a linear dilatometer per ASTM E 228-85. The data presented in Figure 6, represents the averages of a heating and cooling cycle. [Ref 8] Additional testing by outside sources[Ref 9], on the E60 composite shows that after thermally cycling 10 times from -55°C to + 125°C the CTE averaged, 7.0 ppm/°C, over that temperature range.

Figure 6 - CTE MEASUREMENTS



Stiffness and Vibration Resistance Analysis - One of the potential failure modes of electronic packages is the dynamic stress exerted on the solder joints by random and sinusoidal vibration experienced in an actual flight environment of military aircraft or in launching of a telecommunications satellite. One way to reduce the effects of this vibration on component life, is to have a core material that has a high elastic modules, thereby increasing the first mode natural frequency to isolate module from the frequency of its mating hardware and reducing the transmissibility. The benefits of the high specific stiffness of the family of **E Materials** (**E20, E40, E60**) can be seen in the testing that was done at Naval Air Warfare Center.[Ref 10], see Table 9.

TABLE 9 - VIBRATION TESTING RESULTS

MATERIAL	**E MODULES** (MPa)	**NATURAL FREQUENCY** (HZ)	**G**	**TRANSMISSIBLITY** (OUTPUT G/ INPUT G)	**THICKNESS** (cm)	**DENSITY** (g/cc)
AL 6061 T6	68	430	265	8.8	0.250	2.7
AlSiC - 65%	255	498	120	4.0	0.216	3.0
BeBeO - E60	330	720	66	1.9	0.241	2.5
BMI/P130(60 %)	280 x axis	630	78	2.6	0.244	1.9
COPPER	120	230	525	17.5	0.250	8.2

Case History

Satellites - Motorola Satellite Communications Division recently developed for IRIDIUM® a MCM-L packaging design that serves as a transmit/receive module. A large number of packaging design drivers were addressed in the design. One of those was the chassis design and material selection. There were four(4) material factors that were evaluated in choosing the right material.

First, due to the high MMIC wattage's, a direct physical attachment of the die to a metallic chassis is desired. The chassis's material thermal properties play an important role in maintaining junction temperatures at or below 70°C, thermal conductivity greater than 180 W/m°C is needed to provide sufficient thermal conduction.

Secondly, the chassis's materials thermal expansion coefficient(CTE) should be slightly higher than that of the GaAs(5.5-5.7ppm/°C) but within several ppm/°C. This is important due to both the low fracture toughness of the GaAs and the fragility of a .004" finished die thickness. The higher CTE will preferably put the GaAs into a slight compression upon cooling. Also you want the chassis to partially constrain the circuit board material in order to reduce the stress on the copper transmission lines over the temperature cycles. Therefore a CTE of 8-9 ppm/°C was the targeted range.

The third factor was the chassis's weight, especially on a satellite system where it is not unusual for a launch cost on a per pound basis to be in excess of $10,000/Lb. Therefore the chassis materials weight target was not to exceed 3.1g/cc(0.12lb/in^3).

The fourth factor was the manufacturability/cost of the chassis. The chassis had to be plateable with gold and electroless nickel for wirebonding for ground connections. Further the chassis material had to have good machinability, due to the tight dimensional control of the part dimensions. Also because the design was some what immature, there is great benefit to having the flexibility to change dimensions, hole locations, or in general modify the design without having to change expensive net shape tooling. Also the material had to be available in the size needed, 0.550" x 5.5" x 7.5", and in the production time frame.

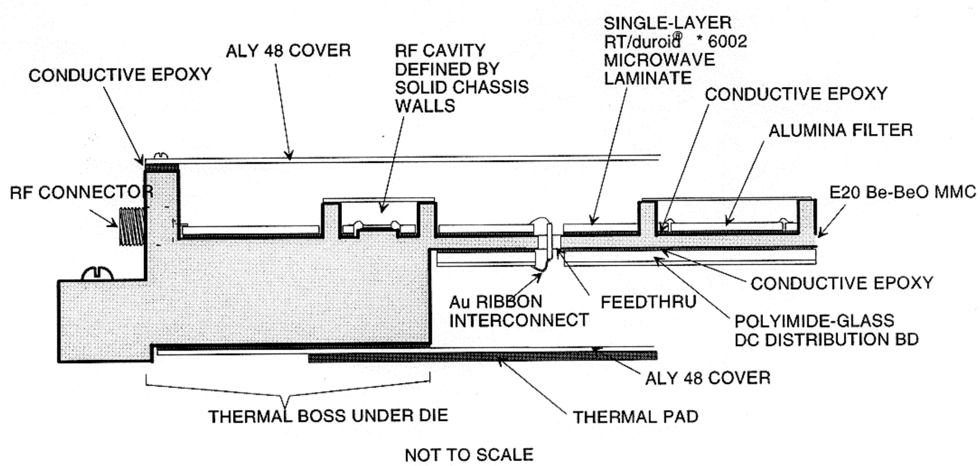
All of these factors led to Motorola evaluating four materials, AlSic(50% Vol.), a CuW (75-25%), Sumitomo's A40 (Al-40%Si)material, and the Beryllium/BeO composite E20(see Table 10).

Table 10 - Materials Selection Chart

Density	MATERIAL	MODULES	THERMAL	CTE	PLATEABILITY	Machinability	Manufacturing

g/cc		Gpa(Msi)	CONDUCTIVITY @ 25°C - W/m-°C	Ppm/°C	Electroless Nickel/Gold		Capability(Size)
14.8	Thermkon 75%W-25%Cu	228 (34)	190	8.3	Good	Good	
3.1	Sumitomo A40	70 (11)	125	13.5	Excellent	Fair	Module size exceeds Current mfg.capability
3.0	AlSiC 55% Volume SiC	168(25)	180	9.0	Fair: Results Not Always Predictable	Poor - Need Diamond Tools or EDM	.125" x 7.5" x 10"
2.06	Materion Brush Inc. E20® Be/BeO composite	303(44)	215	8.7	Excellent	Good - Can Use Carbide, EDM, Laser	20" x 20" x 20"
8.77	TI - Silvar	110(16)	153	6.6	Excellent	Good-Can Use Carbide	1" x 6" x 7"

The advantages of the E20 material in meeting all of the design criteria, low weight, controlled CTE, high thermal conductivity, excellent manufacturability, and a cost that was acceptable within the guidelines and reduced the launch cost, made E20 the material of choice in building the IRIDIUM®chassis(see Figure 7).



Approach #2: Solid Chassis Walls Define RF Cavities

CONCLUSIONS

Beryllium based metal matrix composites, AlBeMet®, AlBeCast®, and E Materials, have been developed to meet the needs and enhance the performance of advanced aerospace and commercial applications. The materials have demonstrated in test and production, for both aircraft, satellite, automotive, and semi-conductor processing equipment applications, that they can meet the designers needs for a high modules, high thermal conductivity, low density, and tailorable coefficient of thermal expanison material. At the same time they can provide a cost-effective solution to the systems needs for improved reliability, lower life cycle costs, and reduced weight.

Health and Safety

Handling AlBeMet®, AlBeCast®, and E Materials in solid form poses no special health risk. Like many industrial materials, beryllium-containing materials may pose a health risk if recommended safe handling practices are not followed. Inhalation of airborne beryllium may cause a serious lung disorder in susceptible individuals. The Occupational Safety and Health Administration (OSHA) has set mandatory limits on occupational respiratory exposures. Read and follow the guidance in the Material Safety Data Sheet (MSDS) before working with this material. For additional information on safe handling practices or technical data on AlBeMet®, AlBeCast®, and E Materials, contact Materion Brush Inc. Inc., Beryllium Products Group, A/C 419-862-4173.

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