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## Material Description and Customer Uses

### Beryllium

PRODUCT	FORM	AVIONICS	OPTICAL STRUCTURES	OPTICAL STRUCTURES	DESCRIPTION
S200FH	HIPed Shape; Machined Shape; Rod; Bar; or Block		First Mode Frequency 3x over aluminum	Mechanisms, Gimbals, Yokes	A lightweighted, highly stiff material with typical metal properties. Used when weight and inertia factors exceed those of lower cost Al.
			Operating Speed 2x bar code readers, laser printers & other scanners	Optical Sensors	AMS 7908; 44 Msi Elastic Modulus; Density 1.84 g/cc
			Optical Sensors: NPOESS/CRIS, APL-5, Mass Mounted Sites, SNIPER, LANTIRN	ATP-5, T-Moss	
I70H, O-30H	HIPed Shape; Rod, Bar, or Block		Low Scatter Optics; Cryogenic Optical Substrates; High Thermal Isotropy; Optical Benches; Metering Rods		O-30H is the lowest oxide grade of Be at 0.5% max. Has the highest isotropy of thermal & mechanical properties of any grade of beryllium & is ideally suited for cryogenic applications.
					44 Msi Elastic Modulus; Density 1.84 g/cc
S200F	VHP'd Shapes; Machined Shape; Rod, Bar, or Block		Nickel-Plated Optical Substrates; NPOESS/CRIS; Structures, gimbals, mechanisms	Spacecraft Structures; Small Rocket Nozzles; Inertial Guidance Systems	A versatile material for when weight & inertia factors exceed those of lower cost Al. With its low mass, it can be driven through the scanning cycle much faster with lower power requirements.
S65C	HIP'd Shapes; Rod, Bar, or Block		Fusion energy applications		Selected when weight and volume are a consideration or a high neutron flux is desired. Be useful as both a moderator and reflector of neutrons.
I220H	Rod, Bar, or Block	Inertial guidance industry	Used as nickel-plated optical substrates for high dimensional stability	Telescope Support in Spacecrafts to Explore Space	Has the highest microyield strength of beryllium and for low creep.
		Trident, Minuteman & Peacekeeper Guidance	VLT Optics; LIDARS		
SR200	Rolled Sheet 0.375"-0.020" thick	Combination heat sink & structural support in military elec. & avionics			Rolled Sheet in pure beryllium
S200FC	CIPed Shape		Optical Substrate for Fire Control systems in Tanks and Aircrafts		Available by CIPing. Useful for apps requiring lesser properties than obtained by HIPing. Tooling is reusable. Good for parts in the hundreds.
			Mirrors		

### Metal Matrix Composites -- E-Materials

PRODUCT	FORM	AVIONICS	OPTICAL STRUCTURES	SATELLITE STRUCTURES	DESCRIPTION
E20	Bar	Aircraft avionics, SEM-E modules, 6UV Modules	Optical Benches	Have demonstrated their value in airborne ad space-based electronic applications	Offers improved electronic component life due to lower displacement, improved solder joint life
E40	Shapes	Iridium MCM-L Electronic Substrates	Lens Housing Material to Match CTE of lens material	Iridium	High stiffness, low CTE, High Therm. Cond.
E60	Plates	Heat Sinks/Chill Plates		Global Star	E20 Density 2.1 g/cc, 4 Msi Elastic Modulus
		F22, F16, F18, JSF			E40 Density 2.3 g/cc, 46 Msi Elastic Modulus
					E60 Density 2.55 g/cc, 48 Msi Elastic Modulus



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### AlBeMet

PRODUCT	FORM	AVIONICS	OPTICAL STRUCTURES	SATELLITE STRUCTURES	DESCRIPTION
AlBeMet 140	Rolled Sheet; Extrusions	Min. stress from vibration on leads, solder joints & substrates, increases fatigue life of electronic packages, reduced section thickness, design flexibility, JSF. Heatsinks, Dip brazed chassis		-Honeycomb Panel skins versus composites, Al; 0.010" thick. -Microwave tubes 20% lighter than Al -Lighter, stiffer, thermally-stable versus aluminum & composites	By weight, contains 40% commercially pure beryllium and 60% commercially pure aluminum. Cold formable, can be stamped, EB & TIG weldable, DIP and Vacuum Brazing, machines like aluminum
					Density 2.3 g/cc, 22 Msi Modulus
AlBeMet 162	Rolled Sheet; HIPed Bar; Extruded Bar; Near Net Shapes	Minimizes stress from vibration on leads, solder joints & substrates, increases fatigue life of electronic packages, reduced section thickness, adjusts for platform req.	Higher first mode frequencies; Improved LOS Jitter; Simple design, more room inside housing	Faster designs versus composites; Lighter, stiffer, thermally-stable versus Al; Flying on 150 satellites; Not susceptible to SSC, AEHF, KAP	By weight, contains 62% commercially pure beryllium and 38% commercially pure aluminum EB Weldable, TIG weldable, DIP and Vacuum brazing & machines like aluminum, can be coated like aluminum, AMS 7911, 7912, 7913.
		F-22, JSF, F18, Tammac	IFTS, APACHE, SPIRIT, JSF, F18 FLIR, EOTS, SNIPER, ATP, Damocles		Density 2.1 g/cc; 28 Msi Modulus

### Material Property Comparison

PROPERTY	BERYLLIUM S200F/AMS7906	ALBEMET AM162H/ AMS7911	ALBEMET AM140 (SHEET/EXT)	E-MATERIAL E-60	MAGNESIUM AZ80A T6	ALUMINUM 6061 T6	STAINLESS STEEL 304	COPPER H04	TITANIUM GRADE 4
Density (Lbs/Cu In (g/cc))	0.067 (1.85)	0.076 (2.10)	0.082 (2.28)	0.091 (2.51)	0.065 (1.80)	0.098 (2.70)	0.29 (8.0)	0.32 (8.9)	0.163 (4.5)
Modulus MSI (GPa)	44 (303)	28 (193)	22 (150)	48 (331)	6.5 (45)	10 (69)	30 (205)	16.7 (115)	15.2 (105)
UTS KSI (GPa)	47 (324)	38 (262)	40 (276)	39.3 (273)	49 (340)	45 (310)	75 (515)	45 (310)	95.7 (660)
YS ksi (GPa)	35 (241)	28 (193)	27 (186)	N/A	36 (250)	40 (275)	30 (205)	40 (275)	85.6 (590)
Elongation %	2	2	14/16	<0.05	5	12	40	20	20
Fatigue Strength KSI (MPa)	39 (261)	14 (97)	21 (145)/14 (97)	N/A	14.5 (100)	14 (95)	N/A	N/A	N/A
Thermal Cond. Btu/hr/ft/F (W/m-K)	125 (216)	121 (210)	119 (204)	138 (230)	44 (76)	104 (180)	9.4 (16)	225 (391)	9.75 (16.9)
Heat Capacity Btu/lb-F (J/g-C)	0.46 (1.95)	0.373 (1.56)	0.334 (1.416) Est.	0.310 (1.26)	0.251 (1.05)	0.214 (0.896)	0.12 (0.5)	0.092 (0.385)	0.129 (0.54)
CTE ppm/F (ppm/C)	6.3 (11.3)	7.7 (13.9)	9.1 (16.5)	3.4 (6.1)	14.4 (26)	13 (24)	9.6 (17.3)	9.4 (17)	4.8 (8.6)
Electrical Resistivity ohm-cm	4.20E-06	3.5 E-6	TBD	N/A	14.5 E-6	4 E-6	72 E-6	1.71 E-6	60 E-6