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FUSIBLE ALLOYS Low Melting Point Bismuth Based Alloys

PROPERTIES OF FUSIBLE ALLOYS

The chief component of Fusible Alloys is Bismuth, a heavy, coarse crystalline metal that expands when it solidifies. Water and Antimony also expand on freezing, but Bismuth expands much more than the former, namely 3.3% of its volume. When Bismuth is alloyed with other metals, such as Lead, Tin, and Cadmium, this expansion is modified according to the relative percentages of Bismuth and other components present. As a general rule, Bismuth alloys of approximately 50 percent Bismuth exhibit little change of volume during solidification. Alloys containing more than this tend to expand during solidification and those containing less tend to shrink during solidification.

After solidification, alloys containing both Bismuth and Lead in optimum proportions grow in the solid state many hours afterwards. Bismuth alloys that do not contain Lead expand during solidification, with negligible shrinkage while cooling to room temperature.

Most molten metals when solidified in moulds shrink and pull away from moulds, failing to reproduce fine mould detail. Because Fusible Alloys expand and push into mould detail when they solidify, they are excellent for duplication and reproduction processes. This characteristic of expansion and/or non-shrinkage, combined with low melting temperature and ease of handling, are the major reasons for their extensive use. A number of eutectic* and non-eutectic alloys have been standardized.

*** The word "EUTECTIC" describes an alloy, which, like pure metals, has a single melting point. This melting point is usually lower than that of any of the constituent metals. Thus pure Tin melts at 450 ^{o}F and pure Bismuth at 520 ^{o}F but combined in proportion 42% Tin and 58% Bismuth, they form a Eutectic which melts at 281 ^{o}F.**

PHYSICAL PROPERTIES OF OUR MORE COMMON FUSIBLE ALLOYS

PROPERTIES	LOW 117°	LOW 136°	LOW 158°	LOW 255°	LOW 281°	LOW 158-190°	LOW 281-338°
Melting Temperature (°F)	117	136	158	255	281	158-190	281-338
Melting Temperature (°C)	47.2	57.8	70	124	138	71.1-87.8	138-170
Yield Temperature (°F)	117	136	158	255	281	162.5	302
Yield Temperature (°C)	47.2	57.8	70	124	138	72.5	150
Density Lb./In.^{3}	0.32	0.31	0.339	0.38	0.315	0.341	0.296
Specific Gravity @ 20°C	8.9	8.8	9.4	10.3	8.7	9.4	8.2
Tensile Lb./In.^{2}	5400	6300	5990	6400	8000	5400	8000
* Elongation in 2" Slow Loading %	1.5	50	200	60-70	200*	220*	200*
Brinell Hardness #	12	14	9.2	10.2	22	9	22
* Specific Heat Liquid	0.035	0.032	0.04	0.42	0.045	0.04	0.047
* Specific Heat Solid	0.035	0.032	0.04	.03+	0.045	0.04	0.047
* Latent Heat - Fusion Btu./LB.	6	8	14	7.2	20	10	22
Coefficient of Thermal Expansion	.000025/°C	.000023/°C	.000022/°C	.000021/°C	.000015/°C	.000024/°C	.000015/°C
Thermal Conductivity (Solid) Cal/Cm^2/°C/Sec .94 = Copper	---	---	.045*	.04*	.05*	.05*	.09*
Conductivity (Electrical) Compared with Pure Copper	3.34%	2.43%	4.17%	1.75%	5.00%	4.27%	7.77%
Resistivity OHMS based on volume standard (Meter, MM^2)	0.518	0.7081	0.4135	0.8825	0.3445	0.4037	0.2219
* Maximum Load - 30 seconds Lb. - In.^{2}	---	---	10000	8000	15000	9000	15000
* Maximum Load - 5 minutes Lb. - In.^{2}	---	---	4000	4000	9000	3800	9500
* Safe Load - Sustained Lb. - In.^{2}	---	---	300	300	500	300	500
Volume Change (Liquid to Solid)	-1.40%	-1.40%	-1.70%	-1.50%	0.77%	-2.00%	0.5%*
Volume Change (Linear growth after solidification)	< 0.05%	< 0.05%	0.60%	0.30%	0.05%	0.03%	0%

*** Approximate**

Cumulative Growth & Shrinkage

Inch per inch compared to cold mold dimensions. Test Bar ½" x ½" x 10"

Time After Casting	LOW 117°	LOW 136°	LOW 158°	LOW 255°	LOW 281°	LOW 158-190°	LOW 281-338°
2 Minutes	0.0005	0.0003	0.0025	-0.0008	0.0007	-0.0004	-0.0001
6 Minutes	0.0002	0.0002	0.0027	-0.0011	0.0007	-0.0007	-0.0001
30 Minutes	0	0.0001	0.0045	-0.001	0.0006	-0.0009	-0.0001
1 Hour	-0.0001	0	0.0051	-0.0008	0.0006	0	-0.0001
2 Hours	-0.0002	-0.0001	0.0051	-0.0004	0.0006	0.0016	-0.0001
5 Hours	-0.0002	-0.0002	0.0051	0	0.0005	0.0018	-0.0001
7 Hours	-0.0002	-0.0002	0.0051	0.0001	0.0005	0.0019	-0.0001
10 Hours	-0.0002	-0.0002	0.0051	0.0003	0.0005	0.0019	-0.0001
24 Hours	-0.0002	-0.0002	0.0051	0.0008	0.0005	0.0022	-0.0001
96 Hours	-0.0002	-0.0002	0.0053	0.0015	0.0005	0.0025	-0.0001
200 Hours	-0.0002	-0.0002	0.0055	0.0019	0.0005	0.0025	-0.0001
500 Hours	-0.0002	-0.0002	0.0057	0.0022	0.0005	0.0025	-0.0001

OUR MOST COMMON FUSIBLE ALLOYS

LOW 117	End Use	Yield Temp: 117°F (47.2 °C)	Density: 0.320 lb/in^3 (8.86 g/cm^3)
Bismuth 44.7% **Lead** 22.6% **Tin** 8.3% **Cadmium** 5.3% **Indium** 19.1%	• Proof Casting (Internal dimensions) • Jigging or fixturing delicate parts for machining, dental molds, prosthetic development work • Radiopaque contrast medium in X-rayFusible mandrels in filament winding. • Fusible element in safety devices • Lens Blocking • Low temperature solder for Hobby applications		
INDUSTRY EQUIVALENTS: AIM 47, AsarcoLo 117, CerroLOW 117, Indalloy 117, Ostalloy 117			

LOW 136	End Use	Yield Temp: 136°F (57.8°C)	Density: 0.310 lb/in^3 (8.57 g/cm^3)
Bismuth 49% **Lead** 16% **Tin** 12% **Indium** 21%	• Anchor parts for machining (Jet blades) • Block lenses in optical manufacturing • Proof casting. testing and inspection • Fusible element in in fire sprinkler heads and other safety devices • Fusible cores on compound cores • Sealing adjustment screws. • Low temperature solder for Hobby		
INDUSTRY EQUIVALENTS: AIM 58, AsarcoLo 136, CerroLOW 136, Indalloy 136, Ostalloy 136			

LOW 158	End Use	Yield Temp: 158°F (70°C)	Density: 0.339 lb/in^3 (9.38 g/cm^3)
Bismuth 50% **Lead** 26.7% **Tin** 13.3% **Indium** 10%	• Anchor bushings in drill jigs. • Internal or external support of delicate parts for machining. • Cores for spinning. • Fusible mandrels in filament winding. • Fiberglas lamination. • Drop hammer and embossing dies. • Tube bending filler (up to 1-3/4" diameter). • Heat transfer medium in processing plastics, chemicals, etc. (up to 255 °F). • Shielding Blocks for Nuclear Medicine		
INDUSTRY EQUIVALENTS: AIM 70, AsarcoLo 158, CerroBEND, Indalloy 158, Ostalloy 158			

LOW 158-190	End Use	Yield Temp: 165°F (72.5°C)	Density: 0.341 lb/in^3 (9.44 g/cm^3)
Bismuth 42.5% **Lead** 37.7% **Tin** 11.3% **Cadmium** 8.5%	• Toy soldier casting. • Proof casting cavities (threads, dies, moulds, blind holes). • Duplicate patterns in foundry match-plate making, • Supporting work pieces while machining. • Spray coating wood patterns. • Masks for electroplating and spray-painting.		
INDUSTRY EQUIVALENTS: AIM 70/88, AsarcoLo 158-190, CerroSAFE			

LOW 203	End Use	Yield Temp: 203°F (95°C)	Density: 0.350 lb/in^3 (9.85 g/cm^3)
Bismuth 52.5% **Lead** 32% **Tin** 15.5%	• Cadmium Free alternative for LOW 158 for Nuclear Medicine.		
INDUSTRY EQUIVALENTS: AIM Bi46, CerroSHIELD, Indalloy 42			

OUR MOST COMMON FUSIBLE ALLOYS-Continued

LOW 255	End Use	Yield Temp: 255°F (124°C)	Density: 0.380 lb/in^3 (10.27 g/cm^3)
Bismuth 55.5% **Lead** 44.5%	• Anchor cutlery handles, inserts in wood, metal parts in glass (Tuflex doors). • Make fusible spinning chucks. • Mandrel for electroforms. • Drop hammer dies, stretch form blocks. • Moulds for plaster, plastics. • Tube bending filler (over 1-3/4" diameter). • Hydrodynamic forming, seamless fittings. • Duplicate patterns in pottery and foundry. • Liquid metal in autoclaves, heat-treating. • Heat transfer (Up to 327 °F). • Shielding Blocks for Nuclear Medicine.		
INDUSTRY EQUIVALENTS: AIM 124, AsarcoLo 255, CerroBASE, Indalloy 255, Ostalloy 255			

LOW 281	End Use	Yield Temp: 281°F (138°C)	Density: 0.315 lb/in^3 (8.72 g/cm^3)
Bismuth 58% **Tin** 42%	• Anchor shafts in permanent magnet rotors, locator members in aircraft assembly fixtures, metal parts in glass, magnets in fixtures. • Make nests for parts in jigs and dial feed stations. • Cores for electroforming. • Embossing dies, form blocks. • Joggle jaws. • Lost wax pattern dies. • Duplicate foundry patterns. • Tracer models in profiling. • Moulds for plastics, sheet plastics, plastic teeth, prostethetic development. • Potting electronic components. • Laps for rifle barrels.		
INDUSTRY EQUIVALENTS: AIM 138, AsarcoLo 281, CerroTRU, Indalloy 281, Ostalloy 281			

LOW 281-338	End Use	Yield Temp: 302°F (150°C)	Density: 0.296 lb/in^3 (8.20g/cm^3)
Bismuth 40% **Tin** 60%	• Parallels LOW 281 in its end uses. • Electroforming mandrels, lost wax pattern dies due to greater dimensional accuracy. • Holding jet turbine engine blades for machining.		
INDUSTRY EQUIVALENTS: AIM 138/170, CerroCAST, Ostalloy 281338			

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LIST OF FUSIBLE ALLOYS MANUFACTURED BY ALCHEMY CASTINGS INC.

ALCHEMY PART No.	CERRO ALLOY #	Bi BISMUTH	Pb LEAD	Sn TIN	Cd CADMIUM	In INDIUM	Melting Range °F	Yield Temp °F
LOW 117	4470-2	44.7	22.6	8.3	5.3	19.1	117-117	117
LOW 136	4900-2	49	18	12		21	136-136	136
FIELD'S METAL	3250-1	32.5		16.5		51	139-144	144
LOW 158	5000-7	50	26.7	13.3	10		158-158	158
WOOD'S METAL	5000-8	50	25	12.5	12.5		158-165	158
LOW 158-190	4250-2	42.5	37.7	11.3	8.5		158-190	165
LOW 170-180	5000-3	50	39	3	8		170-180	179
LOW 197	5160-1	51.6	40.2		8.2		197-197	197
LOW 203	5250-1	52.5	32	15.5			203-203	203
LOW 203-219	5600-1	56	22	22			203-219	205
ROSE METAL	5000-22	50	28	22			212-212	212
LOW 208-221	5220-2	52.2	37.8	10			208-221	212
LOW 215-226	5452-2	54.52	39.48	6			215-226	219
LOW 217	5400-1	54		26	20		216-217	217
LOW 217-243	5298-1	52.98	42.49	4.53			217-243	227
LOW 242-248	5500-1	55	44	1			242-248	246
LOW 255	5550-1	55.5	44.5				255-255	255
LOW 255-259	5800-1	58	42				255-259	256
LOW 281	5800-2	58		42			281-281	281
LOW 281-338	4000-4	40		60			281-338	302
LOW 291	6000-1	60			40		291-291	291
LOW 338-388	0400-1	4	55.5	40.5			338-388	343
LOW 361	0000-25		37	63			361-361	361