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FUSIBLE ALLOYS

Low Melting Point Bismuth Based Alloys

HISTORY OF FUSIBLE (LOW TEMP) ALLOYS

Prior to 1930, Bismuth alloys existed chiefly as laboratory curiosities. They were known to have very low-melting temperatures and low physical strength and a few had been used as low temperature melting solders for safety devices like sprinkler links, plugs in compressed gas tanks and in fire alarm devices.

Through experimentation and research conducted with many of our customers, a large number of new and practical applications have been developed. Informative literature is now available for a number of the applications listed on the following pages.

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, Cadmium and Indium, 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 449.4 ^{o}F and pure Indium at 313.5 ^{o}F but combined in proportion 48% Tin and 52% Indium, they form a Eutectic which melts at 243 ^{o}F.

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PHYSICAL PROPERTIES OF OUR MORE COMMON FUSIBLE ALLOYS

	EUTECTICS					NON-EUTECTICS			
PROPERTIES	**LOW 117**	**LOW 136**	**LOW 158**	**LOW 255**	**LOW 281**	**LOW 142-149**	**LOW 158-190**	**LOW 217-440**	**LOW 281-338**
Melting Temperature (°F) Range °F	117 117-117	136 136-136	158 158-158	255 255-255	281 281-281	147 142-149	165 158-190	240 217-440	302 281-338
Yield Temp °F Tensile Strength Lbs/In ^{2}	117 5400	136 6300	158 5990	255 6400	281 8000	147 4950	162.5 5400	240 13000	302 8000
% Elongation in Slow Loading Brinell Hardness No. * Specific Heat - Liquid * Specific Heat - Solid * Latent Heat - Fusion Btu/Lb.	1.5 12 .035 .035 6	50 14 .032 .032 8	200 9.2 .040 .040 14	60-70 10.2 .042 .03+ 7.2	200 22 .045 .045 20	13.5 11 .040 .039 7	220 9 .040 .040 10	< 1% 19 .040 .045 -	200 22 .047 .047 22
Conductivity (Electrical) Compared with Pure Copper	3.9%	3%	4%	3%	4.5%	4.4%	4%	3.2%	4.6%
* Maximum Load - 30 Seconds Lbs/In ^{2} * Maximum Load - 5 Minutes Lbs/In ^{2} * Safe Load Sustained - Lbs/In ^{2}	- - -	- - -	10000 4000 300	8000 4000 300	15000 9000 500	- - -	9000 3800 300	16000 10000 300	15000 9500 50

* Approximate

	EUTECTICS					NON-EUTECTICS			
Growth/Shrinkage Time after Casting	**LOW 117**	**LOW 136**	**LOW 158**	**LOW 255**	**LOW 281**	**LOW 142-149**	**LOW 158-190**	**LOW 217-440**	**LOW 281-338**
2 Minutes	+.0005	+.0003	+.0025	-.0008	+.0007	+.0020	-.0004	+.0008	-.0001
6 Minutes	+.0002	+.0002	+.0027	-.0011	+.0007	+.0022	-.0007	+.0014	-.0001
30 Minutes	.0000	+.0001	+.0045	-.0010	+.0006	+.0040	-.0009	+.0047	-.0001
1 Hour	-.0001	.0000	+.0051	-.0008	+.0006	+.0046	.0000	+.0048	-.0001
2 Hours	-.0002	-.0001	+.0051	-.0004	+.0006	+.0046	+.0016	+.0048	-.0001
5 Hours	-.0002	-.0002	+.0051	.0000	+.0005	+.0046	+.0018	+.0049	-.0001
7 Hours	-.0002	-.0002	+.0051	+.0001	+.0005	+.0046	+.0019	+.0050	-.0001
10 Hours	-.0002	-.0002	+.0051	+.0003	+.0005	+.0046	+.0019	+.0050	-.0001
1 Day	-.0002	-.0002	+.0051	+.0008	+.0005	+.0046	+.0022	+.0051	-.0001
4 Days	-.0002	-.0002	+.0051	+.0015	+.0005	+.0048	+.0025	+.0055	-.0001
8 Days	-.0002	-.0002	+.0051	+.0019	+.0005	+.0050	+.0025	+.0058	-.0001
21 Days	-.0002	-.0002	+.0051	+.0022	+.0005	+.0052	+.0025	+.0061	-.0001

Cumulative Growth and Shrinkage, Inch per Inch Compared to Cold Mould Dimensions. Test Bar 2" x 2" x 10".

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LOW 117	Typical End Use Melt Temp: 117°F (47°C)
Bismuth 44.7% **Lead** 22.6% **Tin** 8.3% **Cadmium** 5.3% **Indium** 19.1%	• Use in jigging or fixturing delicate parts for machining (honeycomb). • Dental models, prostethetic development work. • Fusible element in safety devices. • Radiopaque contrast medium in X-Ray • Low temperature Solder. • Sealing adjustment screws.
INDUSTRY EQUIVALENTS: AIM 47, CerroLOW 117, Indalloy 117, Ostalloy 117	

LOW 136	Typical End Use Melt Temp: 136°F (58°C)
Bismuth 49% **Lead** 18% **Tin** 12% **Indium** 21%	• Anchor parts for machining (jet blades), testing, inspection. • Block lenses in Optical Manufacturing. • Proof Casting. • Fusible element in safety devices (sprinkler heads). • Fusible cores in compound cores. • Low temperature Solder. • Sealing adjustment screws.
INDUSTRY EQUIVALENTS: AIM 58, AsarcoLo 136, CerroLOW 136, Indalloy 136, Ostalloy 136	

LOW 142-149	Typical End Use Melt Temp: 142-149°F (61-65°C)
Bismuth 48% **Lead** 25.63% **Tin** 12.77% **Cadmium** 9.6% **Indium** 4%	• Will function about as well as LOW 158 (slightly lower melt temperature), if slight freezing range is not objectionable.
INDUSTRY EQUIVALENTS: CerroLOW 147, Ostalloy 142149	

LOW 158	Typical End Use Melt Temp: 158°F (70°C)
Bismuth 50% **Lead** 26.7% **Tin** 13.3% **Cadmium** 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	Typical End Use Melt Temp: 158-190°F (70-88°C)
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	

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LOW 203	**Typical End Use** **Melt Temp: 203°F (95°C)**
Bismuth 52.5% **Lead** 32% **Tin** 15.5%	• Cadmium Free alternative for LOW 158 for Nuclear Medicine.
INDUSTRY EQUIVALENTS: AIM Bi46, CerroSHIELD, Indalloy 42	

LOW 217-440	**Typical End Use** **Melt Temp: 217-440°F (103-227°C)**
Bismuth 48% **Lead** 28.5% **Cadmium** 14.5% **Antimony** 9%	• Originated by GE for anchoring punches in dies. • Anchor non-moving parts in machinery; hold down bolts in concrete floors, locator parts in tooling docks. • Split jaw chucks, jigs, fixtures. • Metal forming dies, form blocks, joggle jaws. • Repairing broken dies. • Filling blowholes in castings.
INDUSTRY EQUIVALENTS: AsarcoLo 217-440, CerroMATRIX, Indalloy 217-440	

LOW 255	**Typical End Use** **Melt Temp: 255°F (124°C)**
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	**Typical End Use** **Melt Temp: 281°F (138°C)**
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	**Typical End Use** **Melt Temp: 281-338°F (138-170°C)**
Bismuth 60% **Tin** 40%	• 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, AsarcoLo 281, CerroTRU, Indalloy 281, Ostalloy 281	