Tin, pewter, type 2 sheet alloy

General information

Designation

pewter

Typical uses

Ornamental domestic utensils and vessels, e.g. mugs, trays, bowls, candlesticks, etc.; Organ pipes;

Composition overview

Compositional summary

Sn90-93 / Sb5-7.5 / Cu1.5-3 (impurities: As<0.05, Pb<0.05, Fe<0.015, Zn<0.005)

Material family	Metal (non-ferrous)
Base material	Sn (Tin)

Composition detail (metals, ceramics and glasses)

As (arsenic)	0	-	0.05	%
Cu (copper)	1.5	-	3	%
Fe (iron)	0	-	0.015	%
Pb (lead)	0	-	0.05	%
Sb (antimony)	5	-	7.5	%
Sn (tin)	90	-	93	%
Zn (zinc)	0	-	0.005	%

Price

Price	* 10.2	-	11.3	USD/lb

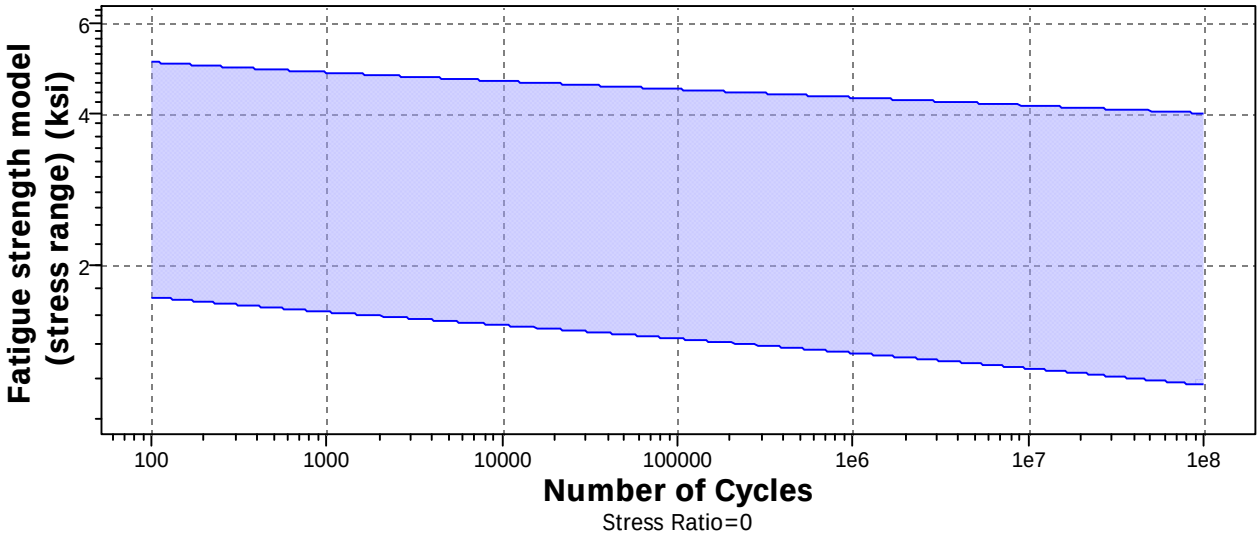
Physical properties

Density	0.26	-	0.266	lb/in^3

Mechanical properties

Young's modulus	7.4	-	7.98	10^6 psi
Yield strength (elastic limit)	* 1.45	-	5.8	ksi
Tensile strength	3.63	-	9.43	ksi
Elongation	12	-	56	% strain
Compressive strength	* 1.45	-	5.8	ksi
Flexural modulus	* 7.4	-	7.98	10^6 psi
Flexural strength (modulus of rupture)	* 1.45	-	5.8	ksi
Shear modulus	* 2.18	-	3.63	10^6 psi
Bulk modulus	* 7.25	-	9.43	10^6 psi
Poisson's ratio	* 0.33	-	0.35	
Shape factor	30			
Hardness - Vickers	13	-	25	HV
Fatigue strength at 10^7 cycles	* 3.63	-	4.79	ksi
Fatigue strength model (stress range)	* 1.25	-	4.14	ksi

Parameters: Stress Ratio = 0, Number of Cycles = 1e7cycles



Mechanical loss coefficient (tan delta)	* 0.005	-	0.03	

Impact & fracture properties

Fracture toughness	* 18.2	-	50.1	ksi.in^0.5

Thermal properties

Melting point	471	-	563	°F
Maximum service temperature	194	-	212	°F
Minimum service temperature	-459			°F
Thermal conductivity	* 23.1	-	40.4	BTU.ft/hr.ft^2.°F
Specific heat capacity	* 0.049	-	0.0549	BTU/lb.°F
Thermal expansion coefficient	* 11.1	-	13.3	µstrain/°F
Latent heat of fusion	* 25.8	-	32.2	BTU/lb

Electrical properties

Electrical resistivity	* 11	-	22	µohm.cm
Galvanic potential	* -0.52	-	-0.44	V

Optical properties

Transparency	Opaque

Magnetic properties

Magnetic type	Non-magnetic

Bio-data

RoHS (EU) compliant grades?	✓
Food contact	No

Processing properties

Metal casting	Unsuitable
Metal cold forming	Limited use
Metal hot forming	Excellent
Metal press forming	Acceptable
Metal deep drawing	Acceptable

Durability

Water (fresh)	Excellent
Water (salt)	Acceptable
Weak acids	Limited use
Strong acids	Unacceptable
Weak alkalis	Acceptable
Strong alkalis	Limited use
Organic solvents	Acceptable
Oxidation at 500C	Unacceptable
UV radiation (sunlight)	Excellent
Flammability	Non-flammable

Primary production energy, CO2 and water

Embodied energy, primary production	* 8.99e4	-	9.89e4	BTU/lb
CO2 footprint, primary production	* 14.6	-	16.1	lb/lb
NOx creation	* 0.0155	-	0.0171	lb/lb
SOx creation	* 0.0265	-	0.0293	lb/lb
Water usage	* 2.69e5	-	2.99e5	in^3/lb

Processing energy, CO2 footprint & water

Casting energy	* 2.37e3	-	2.62e3	BTU/lb
Casting CO2	* 0.414	-	0.457	lb/lb
Casting water	* 289	-	433	in^3/lb
Rough rolling, forging energy	* 197	-	218	BTU/lb
Rough rolling, forging CO2	* 0.0344	-	0.0381	lb/lb
Rough rolling, forging water	* 48.4	-	72.5	in^3/lb
Extrusion, foil rolling energy	* 272	-	301	BTU/lb
Extrusion, foil rolling CO2	* 0.0475	-	0.0525	lb/lb
Extrusion, foil rolling water	* 50.4	-	75.6	in^3/lb
Wire drawing energy	* 684	-	756	BTU/lb
Wire drawing CO2	* 0.119	-	0.132	lb/lb
Wire drawing water	* 16.6	-	24.9	in^3/lb
Metal powder forming energy	* 2.07e3	-	2.29e3	BTU/lb
Metal powder forming CO2	* 0.385	-	0.426	lb/lb
Metal powder forming water	* 145	-	218	in^3/lb
Vaporization energy	* 1.15e6	-	1.27e6	BTU/lb
Vaporization CO2	* 201	-	222	lb/lb
Vaporization water	* 3.09e4	-	4.63e4	in^3/lb
Coarse machining energy (per unit wt removed)	* 215	-	238	BTU/lb
Coarse machining CO2 (per unit wt removed)	* 0.0376	-	0.0415	lb/lb
Fine machining energy (per unit wt removed)	* 317	-	350	BTU/lb
Fine machining CO2 (per unit wt removed)	* 0.0552	-	0.061	lb/lb
Grinding energy (per unit wt removed)	* 429	-	474	BTU/lb
Grinding CO2 (per unit wt removed)	* 0.0748	-	0.0827	lb/lb
Non-conventional machining energy (per unit wt removed)	* 1.15e4	-	1.27e4	BTU/lb
Non-conventional machining CO2 (per unit wt removed)	* 2.01	-	2.22	lb/lb

Recycling and end of life

Recycle	✓			
Embodied energy, recycling	* 1.49e4	-	1.65e4	BTU/lb
CO2 footprint, recycling	* 2.73	-	3.01	lb/lb
Recycle fraction in current supply	5.68	-	6.28	%
Downcycle	✓			
Combust for energy recovery	✗			
Landfill	✓			

Biodegrade	✗

Possible substitutes for principal component

Aluminum, glass, paper, plastic, or tin-free steel substitute for tin in cans and containers. Other materials that substitute for tin are epoxy resins for solder; aluminum alloys, copper-base alloys, and plastics for bronze; plastics for bearing metals that contain tin; and compounds of lead and sodium for some tin chemicals.

Geo-economic data for principal component

Principal component	Tin			
Typical exploited ore grade	1.9	-	2.1	%
Minimum economic ore grade	0.002	-	4	%
Abundance in Earth's crust	2	-	2.2	ppm
Abundance in seawater	4e-6	-	1e-5	ppm
Annual world production	3.02e5			ton/yr
Reserves	5.51e6			l. ton

Main mining areas (metric tonnes per year)

Australia, 5.9e3
Bolivia, 18e3
Brazil, 11.9e3
Burma, 11e3
China, 100e3
Congo, 4e3
Indonesia, 40e3
Laos, 800
Malaysia, 3.7e3
Nigeria, 570
Peru, 26.1e3
Russia, 300
Rwanda, 1.6e3
Thailand, 300
Vietnam, 5.4e3
Other countries, 70

Notes

Warning

Tin(II) salts can be poisonous by ingestion and other routes, and there is evidence that tin can have experimental carcinogenic and human mutagenic effects. Some organotin compounds are very toxic.

Keywords

W.M. 903, Billiton International Metals BV (NETHERLANDS);

Links

ProcessUniverse

Producers

Reference

Shape