

General information

Designation

Bismuth, commercial purity

Typical uses

Alloying element, pharmaceuticals, electronics, catalysts, cosmetics, pigments, medicines, thermocouples, carrier for uranium fuel in nuclear reactors, fire sensing equipment

Included in Materials Data for Simulation



Materials Data for Simulation name

Bismuth, pure

Composition overview

Compositional summary

Bi100

Material family

Metal (other)

Base material

Bi (Bismuth)

Composition detail (metals, ceramics and glasses)

Bi (bismuth)

100

%

Price

Price

* 3.53 - 7.8 USD/lb

Price per unit volume

* 2.15e3 - 4.79e3 USD/ft^3

Physical properties

Density

0.352 - 0.354 lb/in^3

Mechanical properties

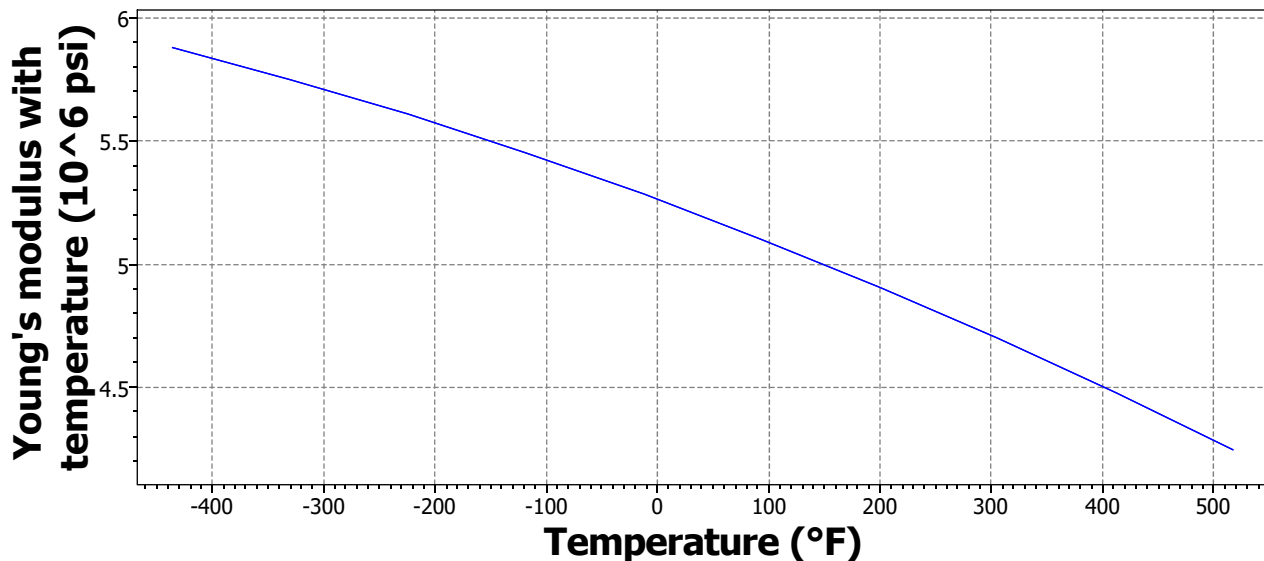
Young's modulus

4.79 - 5.08 10^6 psi

Young's modulus with temperature

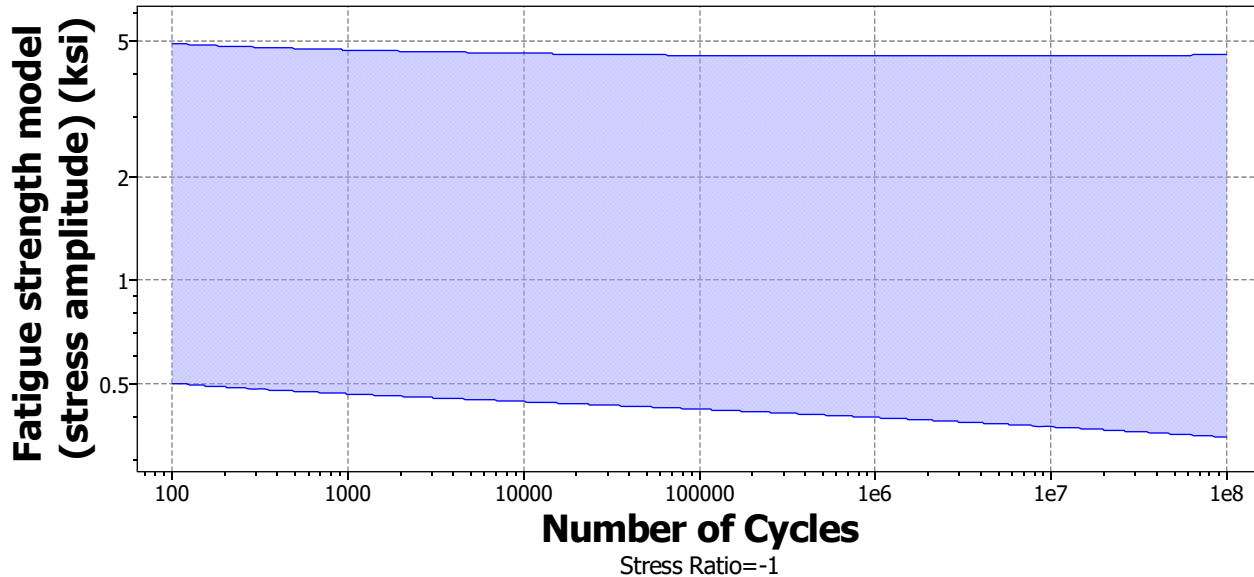
5.14 - 5.14 10^6 psi

[Parameters:](#) Temperature = 73.4°F



Specific stiffness	1.13e6	-	1.2e6	lbf.ft/lb
Yield strength (elastic limit)	* 0.29	-	2.03	ksi
Tensile strength	0.58	-	2.9	ksi
Specific strength	* 68.6	-	478	lbf.ft/lb
Elongation	* 20	-	30	% strain
Tangent modulus	3.32			ksi
Compressive strength	* 0.29	-	2.03	ksi
Flexural modulus	* 4.79	-	5.08	10 ⁶ psi
Flexural strength (modulus of rupture)	* 0.29	-	2.03	ksi
Shear modulus	1.74	-	1.96	10 ⁶ psi
Bulk modulus	4.5	-	5.22	10 ⁶ psi
Poisson's ratio	0.325	-	0.335	
Shape factor	30			
Hardness - Vickers	* 5	-	10	HV
Elastic stored energy (springs)	* 0.00116	-	0.0214	ft.lbf/in ³
Fatigue strength at 10 ⁷ cycles	* 1.16	-	1.45	ksi
Fatigue strength model (stress amplitude)	* 0.373	-	4.51	ksi

[Parameters:](#) Stress Ratio = -1, Number of Cycles = 1e7cycles



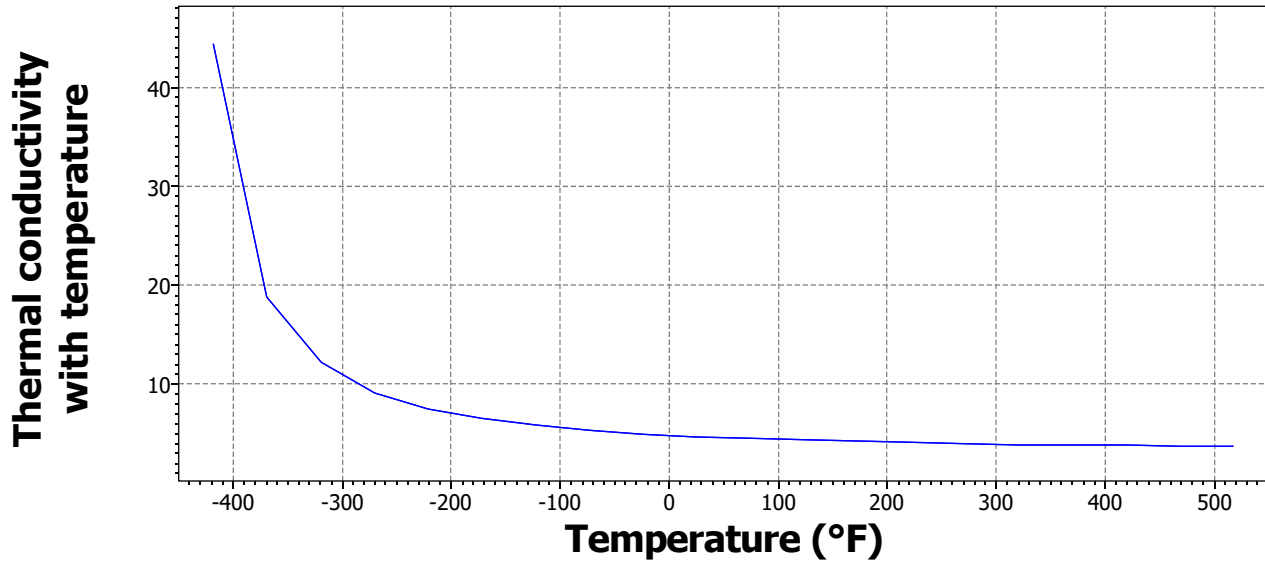
Impact & fracture properties

Fracture toughness	* 4.55	-	18.2	ksi.in ^{0.5}
Toughness (G)	* 0.467	-	4.2	ft.lbf/in ²
Ductility index	0.0229	-	0.028	mil

Thermal properties

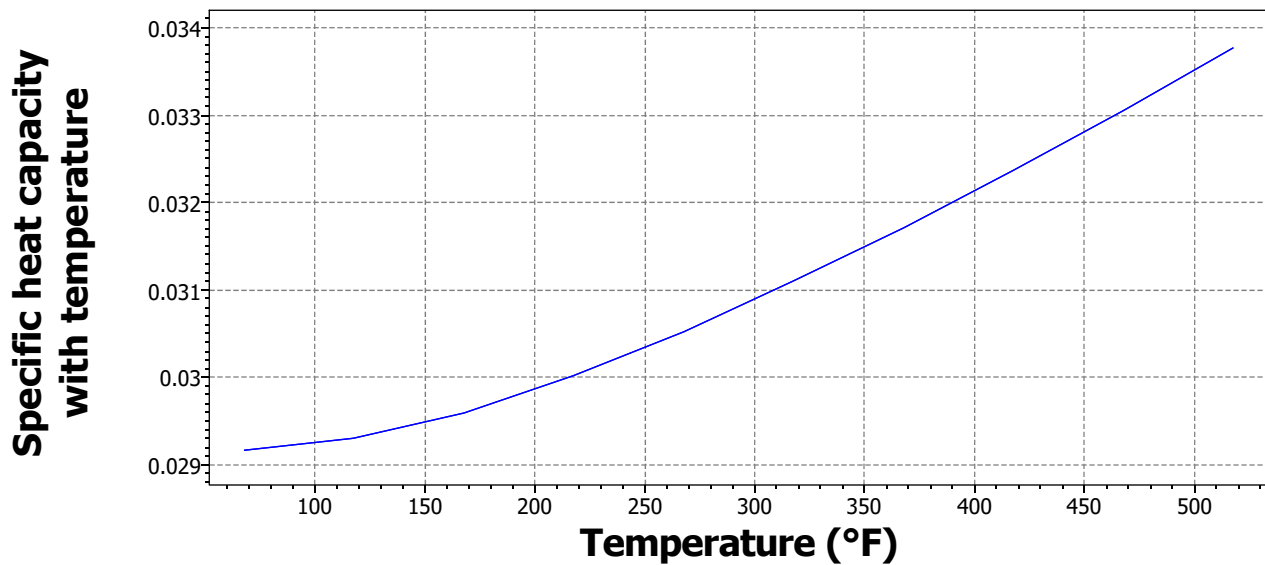
Melting point	513	-	522	°F
Maximum service temperature	464	-	482	°F
Minimum service temperature	-459			°F
Thermal conductivity	4.68	-	5.03	BTU/hr.ft.°F
Thermal conductivity with temperature	4.54	-	4.54	BTU/hr.ft.°F

[Parameters:](#) Temperature = 73.4°F



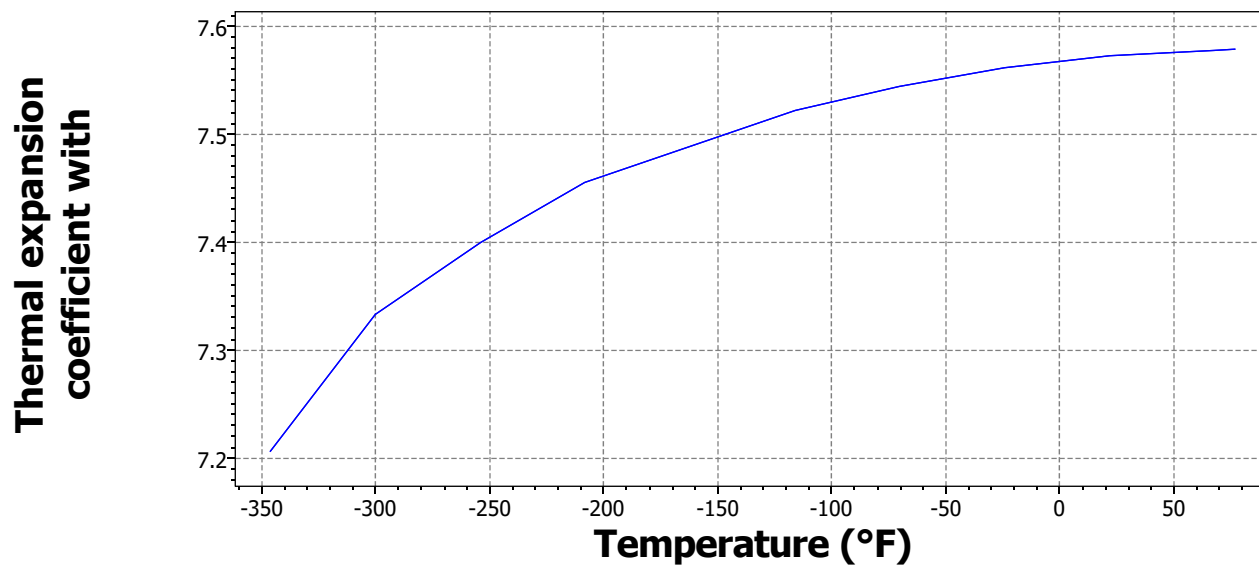
Specific heat capacity	0.0275	-	0.031	BTU/lb.°F
Specific heat capacity with temperature	0.0292	-	0.0292	BTU/lb.°F

[Parameters:](#) Temperature = 73.4°F



Thermal expansion coefficient	7.22	-	7.56	μstrain/°F
Thermal expansion coefficient with temperature	7.58	-	7.58	μstrain/°F

[Parameters:](#) Temperature = 73.4°F

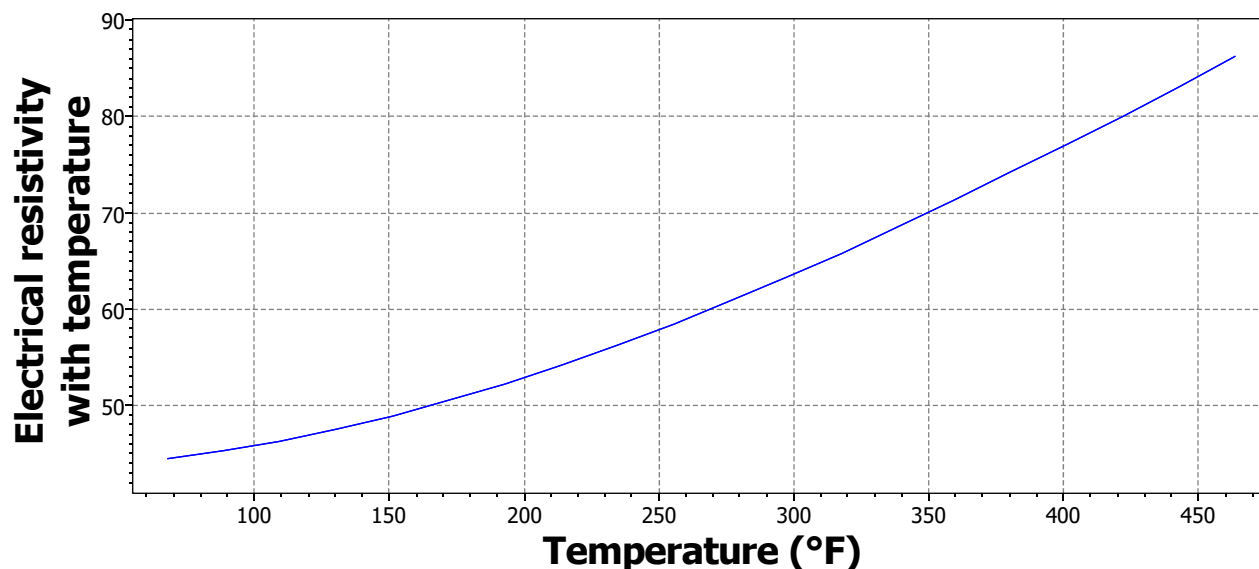


Reference temp	68		°F
Thermal shock resistance	* 40	-	87.8 °F
Thermal distortion resistance	6.29e5	-	6.84e5 BTU/hr.ft
Latent heat of fusion	20.6	-	24.1 BTU/lb

Electrical properties

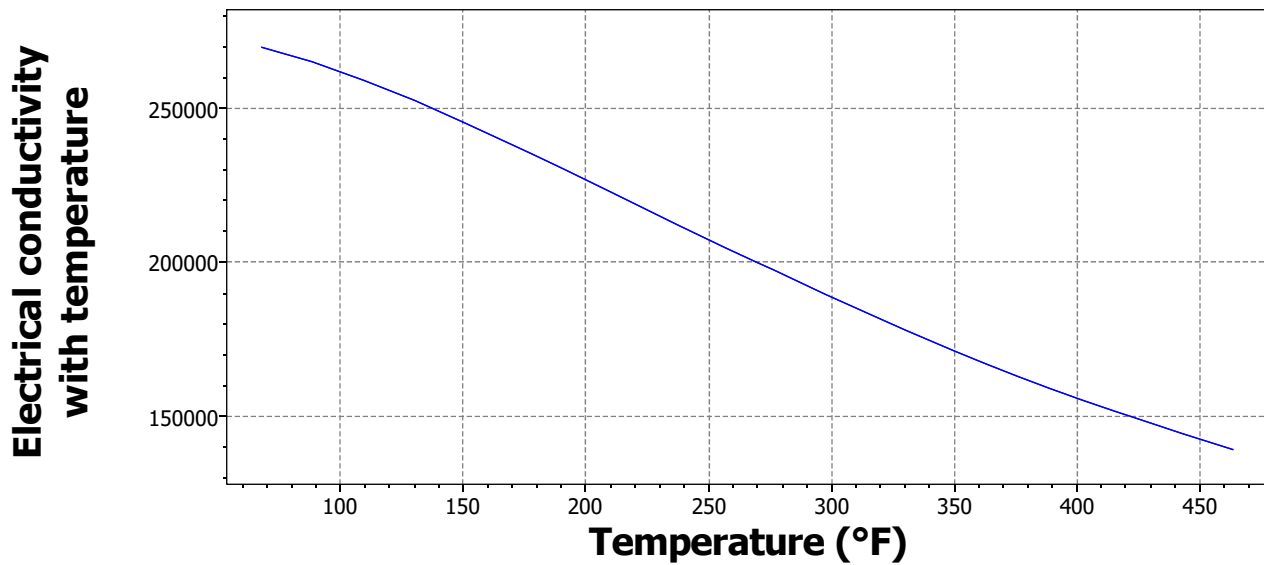
Electrical resistivity	41.3	-	42.9 μohm.in
Electrical resistivity with temperature	44.7		μohm.in

[Parameters:](#) Temperature = 73.4°F



Electrical conductivity	1.58	-	1.64 %IACS
Electrical conductivity with temperature	2.69e5		Siemens/ft

[Parameters:](#) Temperature = 73.4°F



Galvanic potential	* -0.25	-	-0.17	V
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Magnetic properties

Magnetic type	Non-magnetic
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Optical, aesthetic and acoustic properties

Transparency	Opaque			
Softness to touch	* 23	-	28	
Warmth to touch	30.5	-	32.7	
Acoustic velocity	7.24e4	-	7.44e4	in/s
Mechanical loss coefficient (tan delta)	* 0.02	-	0.2	

Healthcare & food

Food contact	No
Guidance for MRI Safety	Low Risk for Potential Interaction

Restricted substances risk indicators

RoHS 2 (EU) compliant grades?	✓
REACH Candidate List indicator (0-1, 1 = high risk)	0
SIN List indicator (0-1, 1 = high risk)	0

Critical materials risk

Abundance risk level	High
Highest risk elements	
Bismuth	
Sourcing and geopolitical risk level	High
Highest risk elements	
Bismuth	
Environmental country risk level	High
Highest risk elements	
Bismuth	
Price volatility risk level	Medium
Highest risk elements	

Bismuth	
Conflict material risk level	None

Durability

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

Corrosion resistance of metals

Stress corrosion cracking	Not susceptible
Notes	Rated in chloride; May be susceptible in halide, ammonia, nitrogen, acidic, caustic, carbonate environments

Primary production energy, CO2 and water

Embodied energy, primary production (virgin grade)	* 5.93e4	-	6.54e4	BTU/lb
Embodied energy, primary production (typical grade)	* 5.42e4	-	6.03e4	BTU/lb
CO2 footprint, primary production (virgin grade)	* 8.63	-	9.51	lb/lb
CO2 footprint, primary production (typical grade)	* 7.93	-	8.81	lb/lb
Water usage	* 7.75e4	-	8.55e4	in^3/lb

Processing energy, CO2 footprint & water

Casting energy	* 2.27e3	-	2.5e3	BTU/lb
Casting CO2	* 0.395	-	0.437	lb/lb
Casting water	* 276	-	414	in^3/lb
Roll forming, forging energy	* 137	-	152	BTU/lb
Roll forming, forging CO2	* 0.0239	-	0.0265	lb/lb
Roll forming, forging water	* 46.8	-	70	in^3/lb
Extrusion, foil rolling energy	* 152	-	168	BTU/lb
Extrusion, foil rolling CO2	* 0.0265	-	0.0293	lb/lb
Extrusion, foil rolling water	* 47.1	-	70.6	in^3/lb
Wire drawing energy	* 233	-	258	BTU/lb
Wire drawing CO2	* 0.0407	-	0.045	lb/lb
Wire drawing water	* 5.54	-	8.58	in^3/lb
Metal powder forming energy	* 1.79e3	-	1.99e3	BTU/lb
Metal powder forming CO2	* 0.334	-	0.37	lb/lb
Metal powder forming water	* 126	-	189	in^3/lb
Vaporization energy	* 8.89e5	-	9.83e5	BTU/lb
Vaporization CO2	* 155	-	171	lb/lb
Vaporization water	* 2.39e4	-	3.58e4	in^3/lb

Coarse machining energy (per unit wt removed)	* 206	-	228	BTU/lb
Coarse machining CO2 (per unit wt removed)	* 0.036	-	0.0398	lb/lb
Fine machining energy (per unit wt removed)	* 226	-	250	BTU/lb
Fine machining CO2 (per unit wt removed)	* 0.0395	-	0.0436	lb/lb
Grinding energy (per unit wt removed)	* 248	-	275	BTU/lb
Grinding CO2 (per unit wt removed)	* 0.0433	-	0.0479	lb/lb
Non-conventional machining energy (per unit wt removed)	* 8.89e3	-	9.83e3	BTU/lb
Non-conventional machining CO2 (per unit wt removed)	* 1.55	-	1.71	lb/lb

Recycling and end of life

Recycle	✓			
Embodied energy, recycling	1.09e4	-	1.2e4	BTU/lb
CO2 footprint, recycling	2	-	2.2	lb/lb
Recycle fraction in current supply	9.59	-	10.6	%
Downcycle	✓			
Combust for energy recovery	✗			
Landfill	✗			
Biodegrade	✗			

Possible substitutes for principal component

Antibiotics, magnesia, and alumina can replace bismuth in pharmaceutical applications. Titanium dioxide-coated mica flakes and fish scale extracts are substitutes in pigment uses. Indium can replace bismuth in low-temperature solders. Resins can replace bismuth alloy jigs used for holding metal shapes during machining. Glycerine-filled glass bulbs can replace bismuth alloys as a triggering device for fire sprinklers. Selenium, tellurium, and lead could replace bismuth in free-machining alloys.

Geo-economic data for principal component

Principal component	Bismuth			
Typical exploited ore grade	0.404	-	0.446	%
Minimum economic ore grade	0.05	-	0.8	%
Abundance in Earth's crust	0.008	-	0.18	ppm
Abundance in seawater	2e-5	-	4e-4	ppm
Annual world production, principal component	1.89e4			ton/yr

Main mining or production areas

China, 76%
Laos, 14%
Republic of Korea, 4%
Japan, 3%
Mexico, 1%
Kazakhstan, 1%

Notes

Warning

Excess bismuth can cause mild kidney damage to humans;

Other notes

Bismuth is one of the less toxic heavy metals. It has a silver luster with a pink tinge.

Links

Elements in this material

JAHM Curve data

ProcessUniverse

Producers

Reference

Shape
