# Bismuth, commercial purity

## General information

### Designation

Bismuth Metal (as sold on world commodity markets)

### Typical uses

Alloying element; Pharmaceuticals; Electronics; Catalysts; Cosmetics; Pigments; Medicines; Thermocouples; Carrier for Uranium fuel in nuclear reactors; Fire sensing equipment;

## Composition overview

### Compositional summary

Bi100

| | |
|---|---|
| Material family | Metal (other) |
| Base material | Bi (Bismuth) |

## Composition detail (metals, ceramics and glasses)

| | | | |
|---|---|---|---|
| Bi (bismuth) | 100 | | % |

## Price

| | | | | | |
|---|---|---|---|---|---|
| Price | * | 7.8 | - | 9.39 | USD/lb |
| Price per unit volume | * | 4.76e3 | - | 5.75e3 | USD/ft^3 |

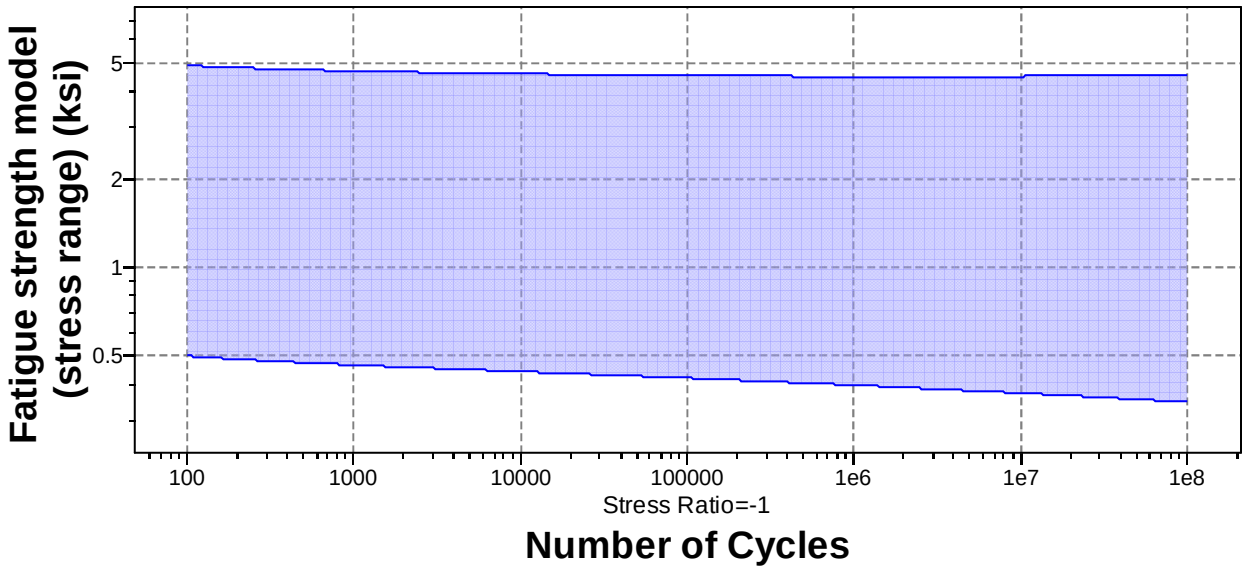
## Physical properties

| | | | | | |
|---|---|---|---|---|---|
| Density | | 0.352 | - | 0.354 | lb/in^3 |

## Mechanical properties

| | | | | | |
|---|---|---|---|---|---|
| Young's modulus | | 4.79 | - | 5.08 | 10^6 psi |
| Yield strength (elastic limit) | * | 0.29 | - | 2.03 | ksi |
| Tensile strength | | 0.58 | - | 2.9 | ksi |
| Elongation | * | 20 | - | 30 | % strain |
| 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 |
| Fatigue strength at 10^7 cycles | * | 1.16 | - | 1.45 | ksi |
| Fatigue strength model (stress range) | * | 0.433 | - | 4.56 | ksi |

Parameters: Stress Ratio = -1, Number of Cycles = 2.5e4cycles




| | | | | | |
|---|---|---|---|---|---|
| Mechanical loss coefficient (tan delta) | * | 0.02 | - | 0.2 | |

## Impact & fracture properties

| | | | | | |
|---|---|---|---|---|---|
| Fracture toughness | * | 4.55 | - | 18.2 | ksi.in^0.5 |

## 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.ft/hr.ft^2.°F |
| Specific heat capacity | | 0.0275 | - | 0.031 | BTU/lb.°F |
| Thermal expansion coefficient | | 7.22 | - | 7.56 | µstrain/°F |
| Latent heat of fusion | | 20.6 | - | 24.1 | BTU/lb |

## Electrical properties

| | | | | | |
|---|---|---|---|---|---|
| Electrical resistivity | | 41.3 | - | 42.9 | µohm.in |
| Galvanic potential | * | -0.25 | - | -0.17 | V |

## Magnetic properties

| | |
|---|---|
| Magnetic type | Non-magnetic |

## Optical properties

| | |
|---|---|
| Transparency | Opaque |

## Critical materials risk

| | |
|---|---|
| Contains >5wt% critical elements? | Yes |

## 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 |
| Note | Rated in chloride; May be susceptible in halide, ammonia, nitrogen, acidic, caustic, carbonate environments |

## Primary production energy, CO2 and water

| | | | | |
|---|---|---|---|---|
| Embodied energy, primary production | * 5.93e4 | - | 6.53e4 | BTU/lb |
| CO2 footprint, primary production | * 8.63 | - | 9.51 | 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 |
| Rough rolling, forging energy | * 137 | - | 152 | BTU/lb |
| Rough rolling, forging CO2 | * 0.0239 | - | 0.0265 | lb/lb |
| Rough rolling, 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 | * 1.99 | - | 2.2 | lb/lb |
| Recycle fraction in current supply | 9.59 | - | 10.6 | % |
| Downcycle | ✓ | | | |
| Combust for energy recovery | ✗ | | | |
| Landfill | ✗ | | | |
| Biodegrade | ✗ | | | |

## 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

ProcessUniverse

Producers

Reference

Shape