Courtesy of Busby Metals, Inc. - www.busbymetals.com

ToughMet™ Alloys

Advancing Bearing Technology

Mobile Equipment

Pumps

Trucks, Automobiles & Motorcycles

Drilling & Mining Equipment

Aircraft

Metal Working

BRUSHWELLMAN
ENGINEERED MATERIALS

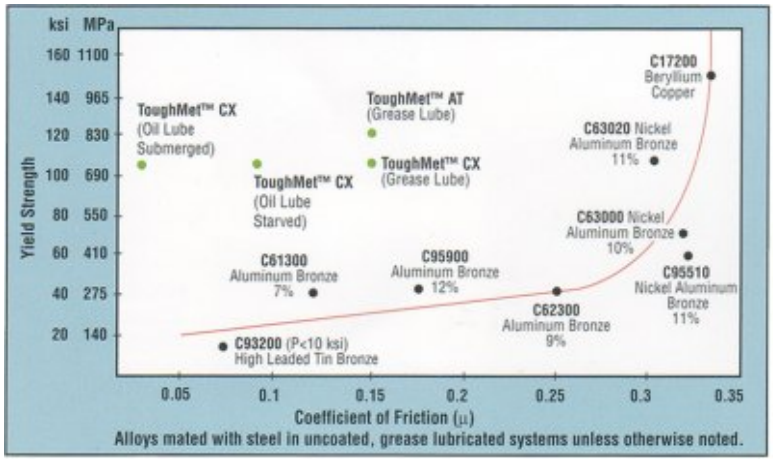
Toughmet™ Performance

Courtesy of Busby Metals, Inc. - www.busbymetals.com

Mechanical properties - ToughMet™3 vs. other bearing alloys

Material	UNS Number	Chemical Composition %	Yield Strength (ksi)	Yield Strength (MPa)	Tensile Strength (ksi)	Tensile Strength (MPa)	Elongation (%)	Hardness	Modulus of Elasticity (10^3 ksi)	Modulus of Elasticity (10^3 MPa)	Fatigue Strength (10^8 cycles) (ksi)	Fatigue Strength (10^8 cycles) (MPa)
ToughMet™ 3	C 96900 C 72900	15 Ni, 8 Sn, Balance Cu	90-150	620-1030	120-160	825-1100	15-2	HRC 26-36	18.5	128	40-60	275-415
Manganese Bronze	C86300	22-28 Zn, 2-4 Fe, 5-8 Al, 2.5-5 Mn, 1 Ni, 60-66 Cu	60	415	110	760	12	HRB 90	14.2	98	25	170
Aluminum Bronze	C95400	3-5 Fe, 10-11.5 Al, 1.5 Ni, .5 Mn, 83 Min Cu	30	205	75	515	12	BHN 150	15.5	105	28	195
Leaded Tin Bronze	C93200	6.3-7.5 Sn, 6-8 Pb, 1-4 Zn, 81-85 Cu	14	95	30	205	10	BHN 65	14.5	100	10	70

Strength and frictional comparison of copper-based bearing alloys



ToughMet™ Alloy System property ranges

Property	ToughMet™
Yield Strength at Room Temp - ksi (MPa)	35-150 (240-1030)
Yield Strength at 600 °F (315 °C) - ksi (MPa)	30-100 (205-690)
Tensile Strength - ksi (MPa)	65-160 (450-1100)
Elongation (%)	45-2
Young's Modulus - 10^3 ksi (10^3 MPa)	17-18.5 (117-128)
Hardness (HRC)	20-36
Electrical Conductivity (% IACS)	9-17
Thermal Conductivity - Btu/ft•hr•°F (W/m•°K)	22-40 (39-72)
Magnetic Permeability	< 1.001
Thermal Expansion - ppm/°F (ppm/°C)	8.9-9.1 (16-16.4)
CVN Toughness - ft-lbs (joules)	200-6 (271-8)
Fatigue Strength -10^8 Cycles, R= -1 - ksi (MPa)	25-60 (172-415)

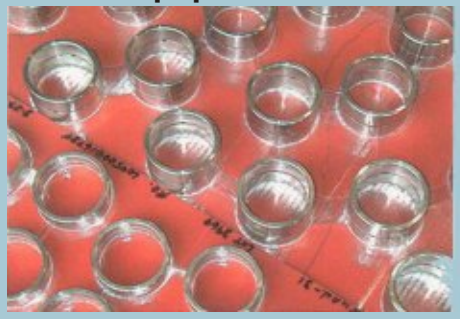
Exact property combinations are developed by varying the spinodal heat treatment and depend on temper and size. The mill will temper material to meet customer specifications. Brush Wellman will also help write the needed specifications for your application.

Brush Wellman is proud to announce the development of ToughMet™, a new line of spinodal alloys for bearings. ToughMet™ is the result of work with leading OEM's, bearing manufacturers, and lubricant & additive producers to create a material to meet a variety of performance demands and to operate in harsh environments. Already proven capable of performing with a variety of shafting materials and lubricants under the widest known range of bearing stresses and speeds, ToughMet™ has advanced bearing technology for today's high performance machines.

ToughMet™ anti-galling alloys are lead and beryllium free, and perform under high loading at low or high speeds with excellent bearing behavior. Combined with the patented EquaCast™ process, Brush Wellman's spinodal heat treatment creates a fine homogeneous microstructure. This creates ultra-microscopic strengthening which is key to the advanced bearing technology.

Applications

Mobile Equipment



Linkage Bushings • Thrust Washers • Wheel Bearings

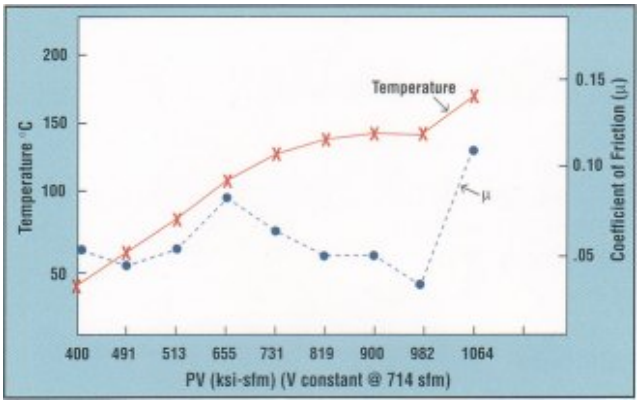
Pumps

Cylinder Barrels • Wear Plates• Slippers• Shaft Bushings • Seals • Slators • Rotors • Fasteners

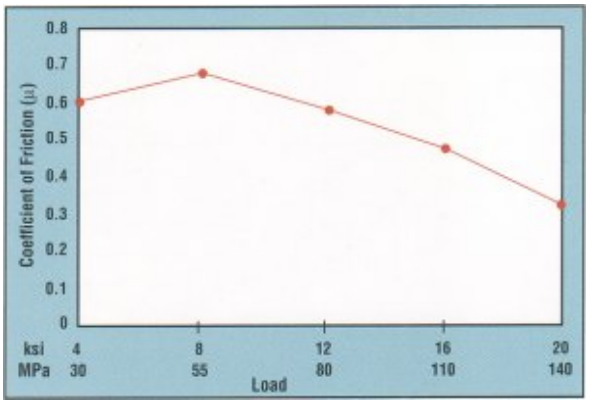
Trucks, Automobiles, & Motorcycles

Wrist Pin Bushings • Thrust Washers • Valve Guides • Roller Bearing Cages • Cam Roller Plns

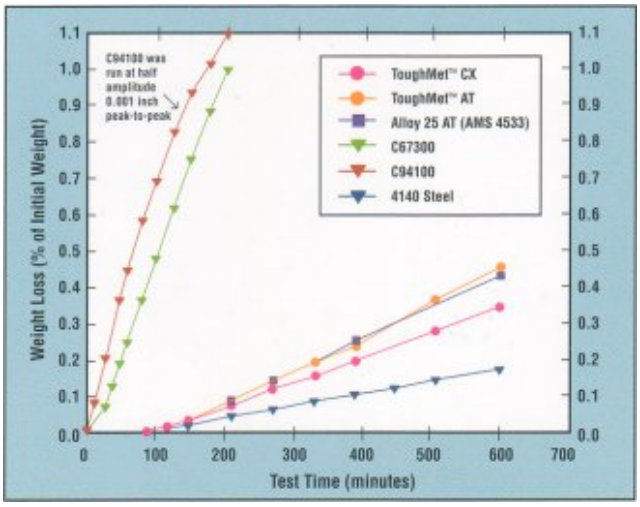
Performance of ToughMet™ running with 52100 steel shaft under starved lubrication conditions



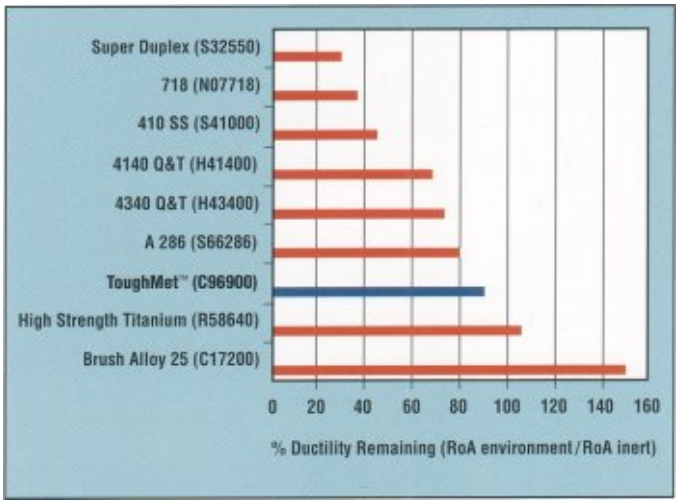
Performance of heavily loaded ToughMet™ running with unlubricated (dry) chrome plated 4340 steel



Cavitation erosion resistance



Slow strain rate tensile testing under 8-day cathodic protection in aerated seawater



It enables ToughMet™ to deliver tough performance in tough environments, assuring reliability and extended life. These attributes are critical to the success of important tribological systems.

Using ToughMet™ will provide:

- More Up-Time
- Greater Reliability
- Better Design Flexibility

PRODUCT AVAILABILITY

ToughMet™ alloys are available in two compositions. ToughMet™ 2 contains 9% nickel, 6% tin, balance is copper. ToughMet™ 3 contains 15% nickel, 8% tin, balance is copper. ToughMet™ alloys are available in wrought form (AT Temper) and continuous cast form (CX Temper).

Rod, bar, hollow bar, plate, and shapes are available in a variety of sizes. Brush Wellman has the capability to provide up to 24" diameter by long mill lengths. For special shapes, consult your Brush Wellman Representative

Advance your bearing technology by designing in Brush Wellman's new ToughMet™ spinodal performance alloys..

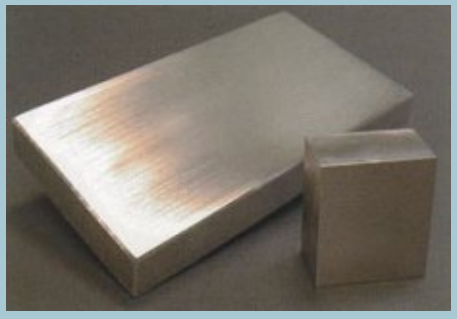
Drilling & Mining Equipment

Centralizers • Rifle Nuts • Piston Rings • Guide Bushings • Spindle Bearings

Aircraft

Landing Gear Bearings • Guide Plates • Shaft Bearings • Spherical Bearings

Metal Working



Wear Plates • Forming Rolls/Punches • Die Inserts • Guides/Slides • Post Bushings