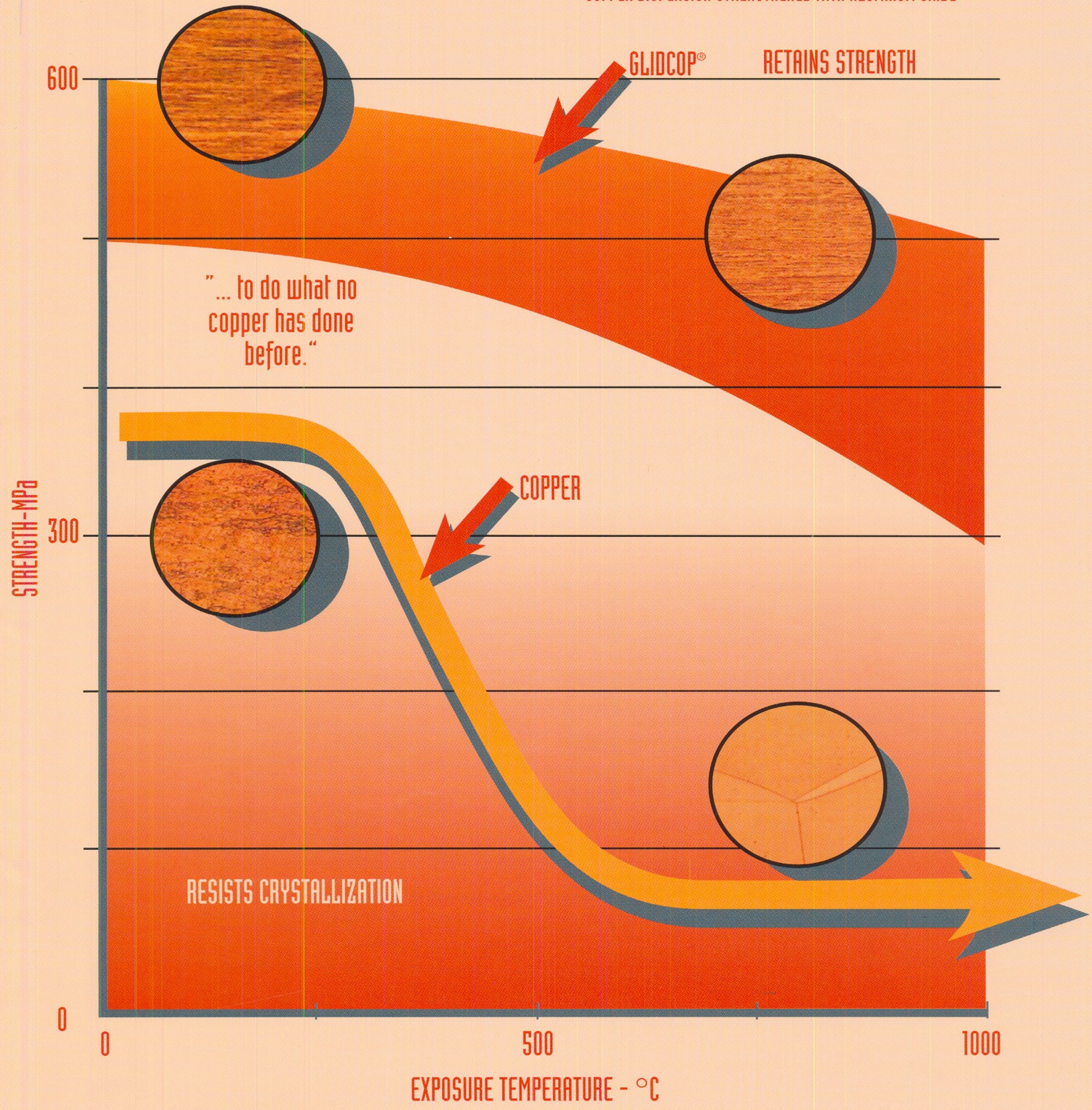
GLIDCOP®

COPPER DISPERSION STRENGTHENED WITH ALUMINUM OXIDE



SCM METAL PRODUCTS, INC.

GLIDCOP®

GlidCop® will continue to meet the increasing demands for technologically sophisticated materials well into the next century. It is truly a unique, high performance material system which offers outstanding opportunities to the designer and user, including:

- GlidCop®'s high strength combined with high electrical and thermal conductivities,
- GlidCop®'s exceptional resistance to thermal softening,
- GlidCop®'s high elevated temperature strength and creep resistance,
- GlidCop®'s resistance to radiation damage, and
- GlidCop®'s anti-stick characteristics when welding coated steels

GlidCop® offers the design engineer or scientist the option of using a copper base material in components where copper has previously not been used or considered, or where the copper alloy being used does not meet the desired or required performance objectives for the component or system design.

Copper in its pure state is a well-known material that is widely used in industrial applications mainly because of its high electrical and thermal conductivities. It also has excellent corrosion resistance and is easy to fabricate. However, the major drawback of pure copper is its low tensile and yield strengths at room temperature as well as at elevated temperatures.

Copper can be strengthened substantially by alloying it with other elements; but alloying causes a significant loss in conductivity. Copper can also be strengthened by incorporating fine particles of a second phase in its matrix, causing only a relatively small loss in conductivity. The second phase can be a metal or an intermetallic compound precipitated from a solid solution by an aging treatment, or it can be nonmetallic particles, such as a stable oxide, added to or formed within the copper matrix. Several commercial alloys are available using the second phase precipitation mode of strengthening. While they offer good strength and conductivity at room temperature in the hardened condition, prolonged heating to temperatures above the initial aging temperature (typically 752-932°F/400-500°C) causes the precipitate particles to grow and eventually to go into solution. On the other hand, copper systems strengthened with stable oxide particles (commonly referred to as Dispersion Strengthened Copper or "DSC") do not experience oxide particle growth nor dissolution of the oxide particles into the copper matrix, and therefore their strength is not significantly affected by exposure to elevated temperatures. The effectiveness of these oxide particles as strengtheners depends upon particle size (finer is better), particle distribution (well dispersed is better), particle density (more per unit volume is better), and particle spacing (closer is better).

There are several ways to incorporate the oxide particles in a copper matrix. Conventional melting and casting techniques do not work well because wide differences in the densities of copper and the oxide phase lead to segregation in the melt. The only current practical methods, therefore, involve powder metallurgy. These methods range from simple mechanical mixing of the constituents to complex methods, such as internal oxidation. Internal oxidation produces a superior product because it develops the finest oxide particle size, smallest interparticle spacing, and most uniformly spaced particles required for optimum properties.

GlidCop® is made by the internal oxidation technique. The patented process begins by melting copper and aluminum to make a dilute molten alloy which is then atomized to produce a fine copper plus aluminum alloy powder. The powder is then processed under oxidizing conditions whereby the aluminum is selectively oxidized in-situ (within the copper matrix). The powder is then consolidated into fully dense shapes using conventional metal working processes (normally extrusion). The consolidated shapes can be further reduced in section size by cold drawing, rolling, etc., to produce wire, rod, strip, tube or plate products.

Grades Available

The properties of GlidCop® are primarily dependent upon aluminum oxide content. Thermomechanical processing history of the consolidated form will also influence properties, and will be discussed later in this brochure.

Figure 1 shows how room temperature tensile strength, yield strength, and percent elongation are affected by varying the aluminum oxide content. Three commercial grades of GlidCop® have been established, with GlidCop® AL-15 having the lowest amount of aluminum oxide, thus lowest strength, and GlidCop® AL-60 having the highest aluminum oxide content, thus highest strength. The chemical compositions of the three grades are shown in Table 1. Both the Unified Numbering System for Metals and Alloys (UNS) coding numbers and the SCM Metal Products, Inc., grade designations are shown for cross referencing.

Since GlidCop® contains only a small quantity of aluminum oxide within a pure copper matrix, its room temperature physical properties closely resemble those of pure copper. Table 2 shows the physical properties of the three grades of GlidCop® compared to Oxygen Free (OF) copper. The melting point, density, and coefficient of thermal expansion are very similar to those of pure copper, while the modulus of elasticity is somewhat higher. Electrical conductivities for GlidCop® range from 78 to 92% of that of pure copper, while thermal conductivity values range from 82 to 93% of that of pure copper.

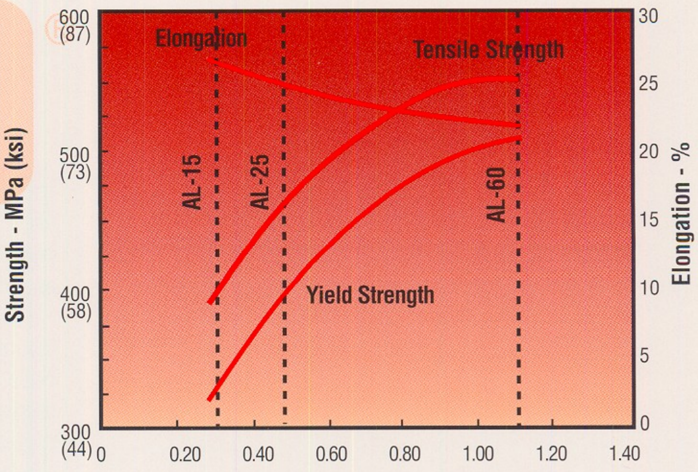


Figure 1
Room temperature mechanical properties versus aluminum oxide content.

Table 1		
Chemical Composition of GlidCop® Grades		
GlidCop® Grade	Aluminum Oxide Content	UNS Alloy Number
GlidCop® AL-15	0.3 wt. %	UNS-C15715
GlidCop® AL-25	0.5 wt. %	UNS-C15725
GlidCop® AL-60	1.1 wt. %	UNS-C15760

Cladding

GlidCop® powder is normally consolidated into full dense shapes using an extrusion process. In this process, loose GlidCop® powder is placed in a high purity copper vessel (called a billet), the billet is sealed, and then the powder filled billet is extruded. In this process, the copper vessel becomes part of the extruded GlidCop® cross-section as the billet is forced through the extrusion die. Figures 2a and 2b show a cross-section of an extruded GlidCop® bar with typical copper cladding. Some applications require that this copper cladding be removed in order to obtain the maximum strength per cross-sectional area, or to facilitate other design and/or processing factors. In this case, cladding removal (DECLAD) can be accomplished by conventional machining or grinding techniques.

"LOX" Grades

GlidCop® normally contains some free or reducible oxygen in the range of .02-.05 wt%. This is typical of the oxygen contained in most wrought copper products, and thus regular GlidCop® may experience hydrogen embrittlement at high temperatures. For applications that require lower free oxygen contents, such as applications in which the material will be exposed to a reducing atmosphere or vacuum at elevated temperatures, special Low Oxygen ("LOX") grades are available which effectively eliminate the free or reducible oxygen through a patented deoxidation process. This proprietary process includes a small addition of boron to the GlidCop® system which acts as a getter in tying-up the free oxygen. The "LOX" process has virtually no effect on the physical or mechanical properties of GlidCop®.

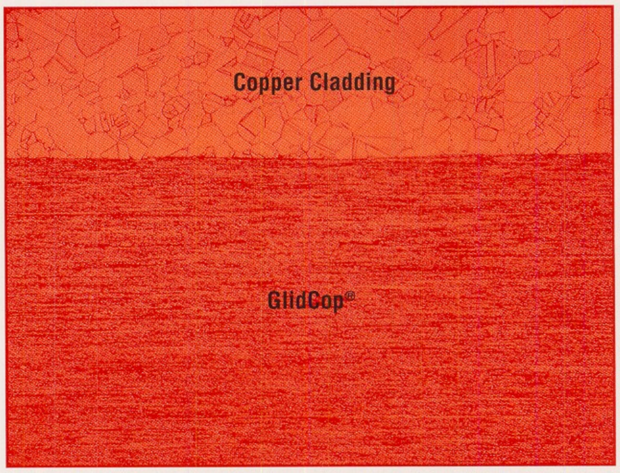


Figure 2a
Copper cladding typical of extruded GlidCop® products.
(magnification 33x; longitudinal)

Property	GlidCop® AL-15 UNS-C15715	GlidCop® AL-25 UNS-C15725	GlidCop® AL-60 UNS-C15760	OF Cu
Melting Point				
°C	1083	1083	1083	1083
°F	1981	1981	1981	1981
Density				
g/cm³	8.90	8.86	8.81	8.94
lb/in³	0.321	0.320	0.318	0.323
Electrical Conductivity				
Meg S/m	54	50	45	58
% IACS	92	87	78	101
Thermal Conductivity				
watt/m/°K	365	344	322	391
BTU/ft/hr/°F	211	199	186	226
Coefficient of Thermal Expansion				
micrometer/m/°C	16.6	16.6	16.6	17.7
microinch/in/°F	9.2	9.2	9.2	9.8
(range 20-150°C, 68-300°F)				
Modulus of Elasticity				
GPa	130	130	130	115
Mpsi	19	19	19	17

Table 2

Physical Properties of GlidCop® and OF Copper

•Note: All properties shown are at room temperature unless otherwise indicated.

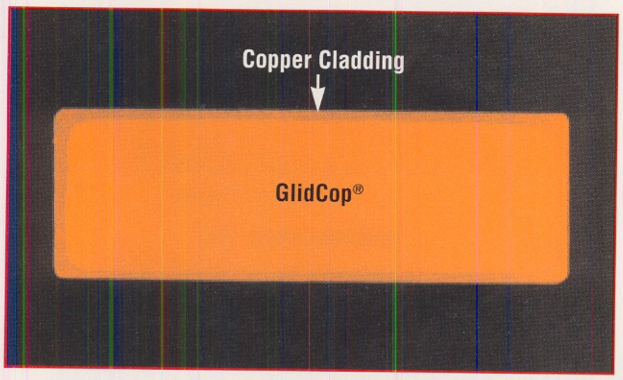


Figure 2b
Copper cladding typical of extruded GlidCop® products.
(magnification 8x; transverse)

Forms Available

GlidCop® is available in a wide variety of standard extruded round, square, and rectangular shapes. Product can be supplied as standard mill lengths from 6-12 feet long (2-4 meters), or as coils depending on cross-sectional area. Extruded cross-sections from .2 to 50 in² (1.3 to 320 cm²) are available. A limited range of extruded tube sizes are also available. Extruded forms are normally supplied with the copper cladding on the outer periphery of the cross-section.

GlidCop® has excellent cold workability, and is thus also available as fine drawn wire and as thin rolled strip and plate.

GlidCop® is available on a limited basis as hot isostatically pressed (HIP) sections in grades AL-15 and AL-25. This product is normally supplied DECLAD.

Joining Methods

Normally, it is recommended that GlidCop® be brazed when joining is required. GlidCop®, with its fine dispersion of stable aluminum oxide particles, is very difficult to fusion weld. When conventional welding methods are employed, the aluminum oxide particles tend to separate from the molten copper matrix and segregate to the resolidification grain boundaries as the molten area cools. This creates an embrittled weld joint, with a weakened, aluminum oxide depleted solidification zone. Some high heat flux, rapid quench welding methods, such as laser and electron beam, have had limited success in fusion welding GlidCop® with minimal loss in properties.

Brazing techniques such as vacuum brazing, torch brazing, and furnace brazing have been successfully employed. With good brazing practice, it is possible to achieve joint strengths comparable to the bulk strength of the GlidCop® component. Unlike conventional copper alloys, which soften during brazing, the elevated temperatures associated with brazing have minimal influence on the mechanical properties of the GlidCop® components.

SCM Metal Products, Inc. has extensive experience in the brazing of GlidCop® to a variety of materials including austenitic grades of stainless steel, plain carbon steel, and copper-chromium composites. The unique fine grain microstructure of GlidCop®, however, requires that brazing procedures designed specifically for GlidCop® be employed to provide the highest possible joint integrity. In many applications, gold based alloys are recommended over the lower melting point silver based alloys to simplify preparation of the components prior to brazing. The diffusion of silver in the fine grain matrix often requires that an electroplated barrier layer be included in the pre-braze preparation to minimize loss of the brazing alloy to the GlidCop® matrix where long brazing times must be used.

Vacuum brazing and furnace brazing in reducing atmospheres are frequently recommended for component joining, and it is necessary to specify the Low Oxygen ("LOX") grades of GlidCop® to prevent the development of porosity in the microstructure.

Specific brazing applications often require specialized procedures, and SCM Metal Products has developed recommended practices for pre-braze surface preparation, optimum time at temperature for common braze alloys, and recommendations for braze alloy selection.

ROOM TEMPERATURE PROPERTIES

Table 3 shows typical room temperature mechanical properties that can be expected from the three GlidCop® grades for extruded or HIPed shapes and section sizes available. These products cover a broad range in strength, (some comparable to steel), with conductivities comparable to copper. Note that these values for the extruded products are for the longitudinal direction; transverse properties may be 2-10% lower based on section size.

Effect of Cold Working

GlidCop® has excellent cold workability, and can be cold worked by drawing, rolling, cold heading, or cold forming. These processes increase GlidCop®'s strength level significantly. Figure 3 shows the influence of cold work, expressed as percent reduction in cross-sectional area, for a GlidCop® AL-15 extruded bar that was progressively drawn to a 94% reduction. As is typical of cold worked GlidCop®, strength increases dramatically, while ductility (percent elongation) is significantly reduced.

Effect of High Temperature Exposure

GlidCop® has excellent resistance to softening even after exposure to temperatures close to the melting point of copper. This is possible because the aluminum oxide particles are stable at these temperatures and retain their original size and spacing. These particles block dislocation and grain boundary motion, and thus prevent recrystallization which leads to softening.

Figure 4 compares the softening behavior of GlidCop® AL-15 and AL-60 with OF copper and copper-zirconium alloy after being annealed for one hour over the range of temperatures shown. At common brazing and glass to metal sealing temperatures (above 1112°F/600°C), GlidCop® retains much of its strength while OF copper and copper-zirconium alloy lose most of their strength.

Table 3
Typical GlidCop® Mechanical Properties

Section Size	Ultimate Tensile Strength ksi/MPa	.2% Yield Strength ksi/MPa	Elongation % in 1.0 inch	Hardness Rockwell B
	GlidCop® AL-15 Products			
As-Extruded, up to 3 in²	57-64 / 393-441	45-52 / 310-358	22-27	65-70
As-Extruded, over 3 in²	53-60 / 365-413	39-46 / 269-317	20-25	62-67
As-HIPed, all sizes	50-55 / 345-379	33-38 / 227-262	16-21	55-60
	GlidCop® AL-25 Products			
As-Extruded, up to 3 in²	64-71 / 441-489	53-60 / 365-413	18-23	69-74
As-Extruded, over 3 in²	57-64 / 393-441	45-52 / 310-358	16-21	66-71
As-HIPed, all sizes	54-59 / 372-407	38-43 / 262-296	12-17	62-67
	GlidCop® AL-60 Products			
As-Extruded, up to 3 in²	71-78 / 489-537	57-64 / 393-441	18-23	75-80
As-Extruded, over 3 in²	65-72 / 448-496	53-60 / 365-413	14-19	72-77

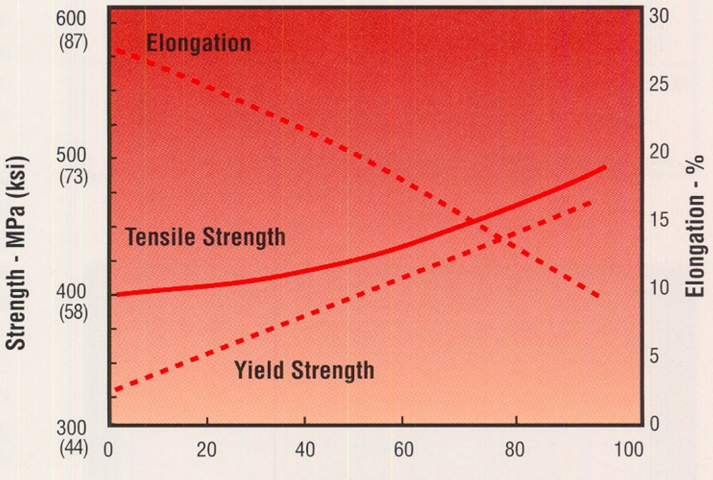


Figure 3
Influence of cold work on GlidCop® AL-15 mechanical properties.

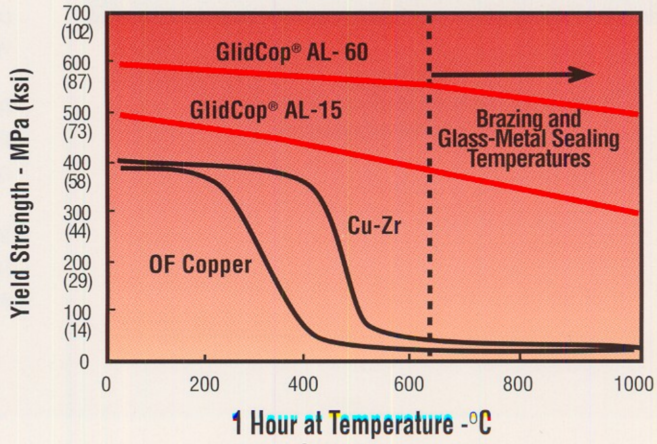


Figure 4
Room temperature yield strength of GlidCop® AL-15 and AL-60, copper, and copper-zirconium after one hour exposure to elevated temperatures.

ELEVATED TEMPERATURE PROPERTIES

Tensile Strength

GlidCop® has exceptionally high strength at elevated temperatures when compared to other high performance, high conductivity copper alloys. This is again due to the thermal stability of the aluminum oxide particles, and their effectiveness in blocking dislocation movement, retarding recrystallization, and preventing grain growth, particularly at high temperatures.

Figure 5 demonstrates this unique feature by showing the high temperature properties for a GlidCop® AL-15 rod that was 75% cold worked prior to testing. At 932°F (500°C), GlidCop® AL-15 has a yield strength of over 29 ksi (200 MPa).

Stress Rupture Strength

Figure 6 further illustrates the high temperature strength characteristics by comparing the elevated temperature 100 hour stress rupture strengths of two grades of GlidCop® with several other high conductivity copper base materials available.

Strength drops dramatically for the other copper alloys as overaging and eventual dissolution of their precipitated strengthening phases occur with increasing temperature. GlidCop® is far superior above 752°F (400°C), with the stability of the aluminum oxide particles clearly evident.

Electrical and Thermal Conductivity

Because only a very small amount of ultra-finely dispersed aluminum oxide is required to produce the high strength, GlidCop® is almost pure copper. Thus, GlidCop®'s conductivity properties closely reflect those of pure copper. Additionally, the aluminum oxide particles remain inert within the copper matrix, and do not "poison" or alloy undesirably with the copper matrix as the second phase precipitate particles do.

Figures 7 and 8 show electrical and thermal conductivities of GlidCop® AL-15 and AL-60 as compared to Oxygen Free Copper over a temperature range of 68-750°F (20-400°C). GlidCop®'s high values parallel those of pure copper over the range of elevated temperatures shown.

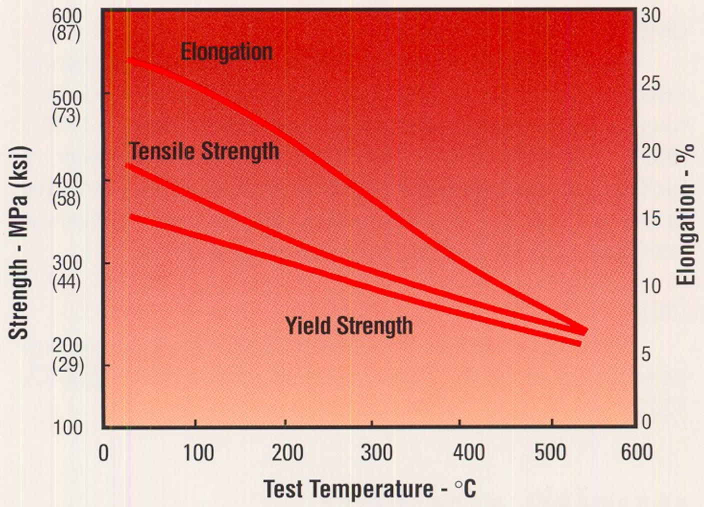


Figure 5
Elevated temperature mechanical properties of GlidCop® AL-15 drawn rod.

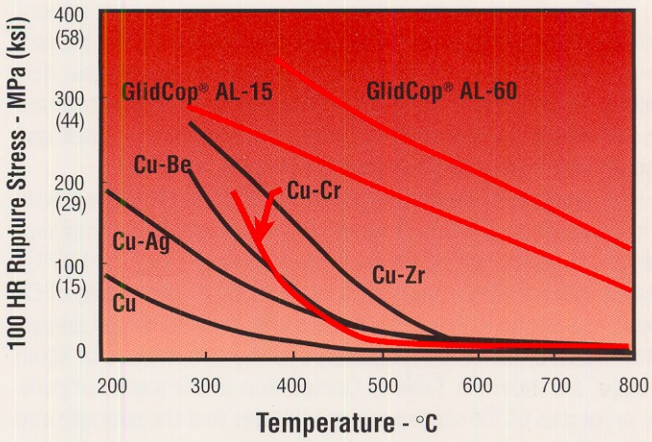


Figure 6
Elevated temperature 100 hour stress rupture strength of GlidCop® AL-15 and AL-60 compared to other high conductivity copper materials.

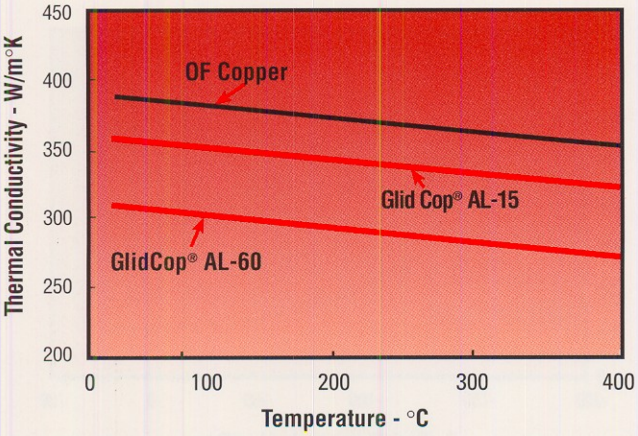


Figure 8
Elevated temperature thermal conductivity of GlidCop® AL-15, AL-60, and oxygen free copper.

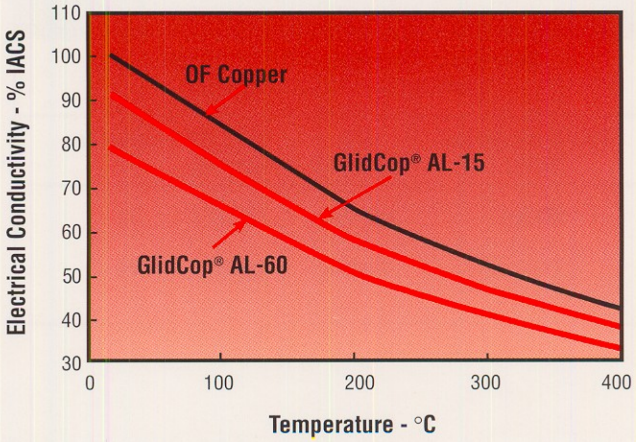


Figure 7
Elevated temperature electrical conductivity of GlidCop® AL-15, AL-60, and oxygen free copper.

ELEVATED TEMPERATURE PROPERTIES

Coefficient of Thermal Expansion

The information shown in Figure 9 illustrates the thermal expansion properties of GlidCop® grades AL-60 and AL-15 measured at temperatures ranging from room temperature to 1742°F (950°C). As noted earlier, the thermal expansion behavior of GlidCop®, as well as the other physical properties, can be attributed to the fact that the aluminum oxide particles have no chemical interaction with the pure copper matrix of GlidCop®.

Creep

The creep properties for extruded GlidCop® AL-15 are illustrated in Figure 10 for three test temperatures: 932°F (500°C), 1202°F (650°C), and 1472°F (800°C).

CRYOGENIC PROPERTIES

Electrical Conductivity

GlidCop® has been successfully evaluated in applications involving extended service at cryogenic temperatures. The properties of GlidCop®, like other metals with face centered cubic (fcc) crystal structure, are not adversely affected by low temperature service conditions. At low temperatures, the properties of GlidCop® are enhanced in a manner similar to other copper alloys.

Measurements have been performed to determine the electrical conductivity of GlidCop® grades AL-60 and AL-15 at temperatures as low as the boiling point of liquid nitrogen (-321°F, -196°C). Data for these grades, compared to the electrical conductivity of OF copper, are shown in Figure 11. Additionally, the mechanical properties of GlidCop® AL-15 wire, measured at the temperature of liquid nitrogen, are shown in Table 4. Comparison to the room temperature properties of the same product indicates that the strength and ductility of the wire are increased at the lower test temperature.

Table 4

Mechanical Properties of 0.144" (3.6mm) GlidCop® AL-15 LOX Drawn Bar

Test Temperature °F(°C)	UTS ksi(MPa)	0.2% YS ksi(MPa)	Elongation %
68(20)	80(551)	71(488)	12
-321(-196)	99(684)	86(593)	19

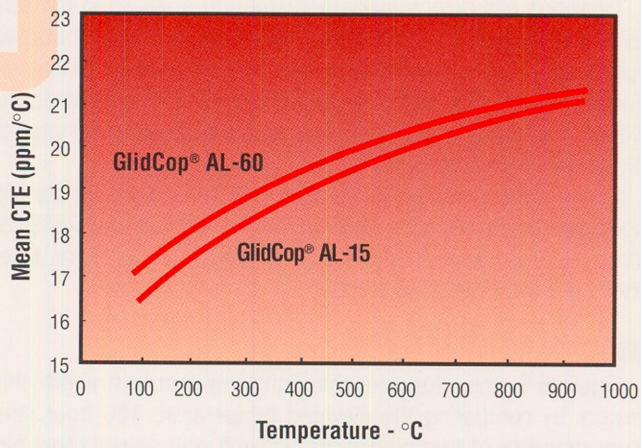


Figure 9
Mean coefficient of thermal expansion for extruded GlidCop® AL-15 and AL-60 measured at elevated temperature.

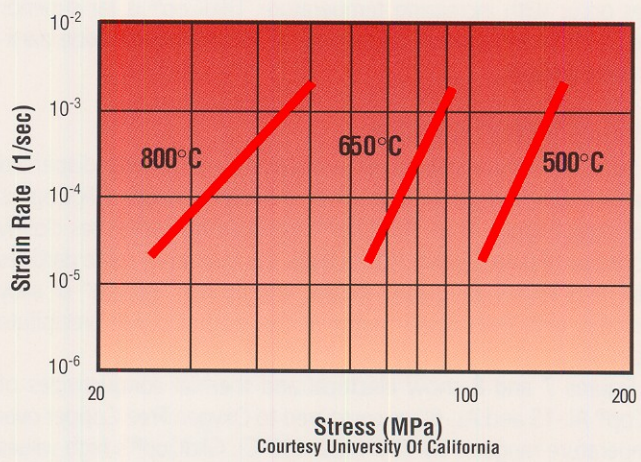


Figure 10
Elevated temperature creep properties for extruded GlidCop® AL-15.

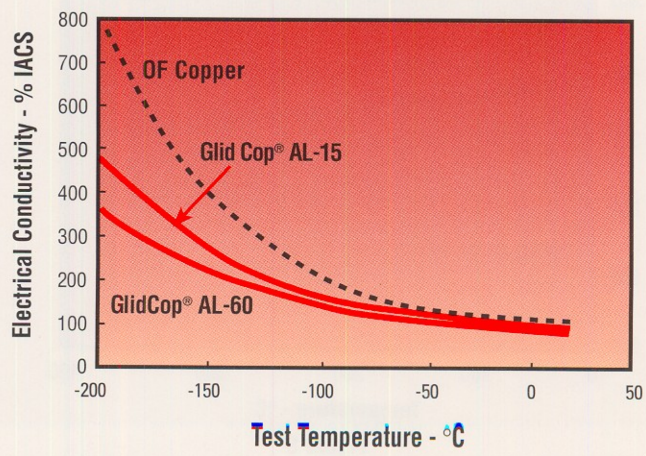


Figure 11
Low temperature electrical conductivity of GlidCop® AL-15 and AL-60 compared to oxygen free copper.

POST NEUTRON IRRADIATED PROPERTIES

Mechanical Properties and Swelling

GlidCop® is highly resistant to degradation of mechanical and electrical properties when exposed to neutron irradiation. Additionally, GlidCop® experiences less swelling than conventional coppers and copper alloys following irradiation.

Figure 12 shows the tensile properties for samples irradiated at 50 to 150 dpa (displacements per atom) at 772°F (411°C). GlidCop® AL-25, cold worked 50%, is compared to marz copper (99.999% copper). Note the consistently high tensile strength for GlidCop® at all dosage levels.

The superior swelling resistance of GlidCop® is illustrated in Figure 13. Note that the marz copper shows a high degree of swelling while the AL-25 remains essentially unaffected at all dosage levels tested.

Figure 14 indicates that while both materials have decreasing electrical conductivity with increasing dosages of radiation, the rate of decrease of the electrical conductivity for AL-25 is significantly less than that observed for the marz copper. The data presented here is provided through the courtesy of Battelle Pacific Northwest Laboratory.

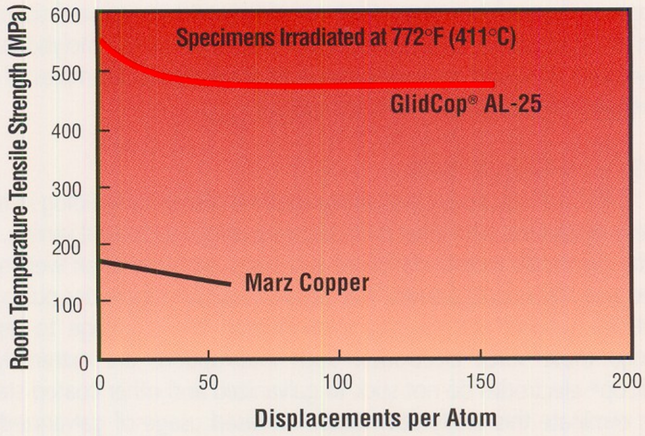


Figure 12
Room temperature tensile strength of GlidCop® AL-25 and marz copper after exposure to neutron irradiation.

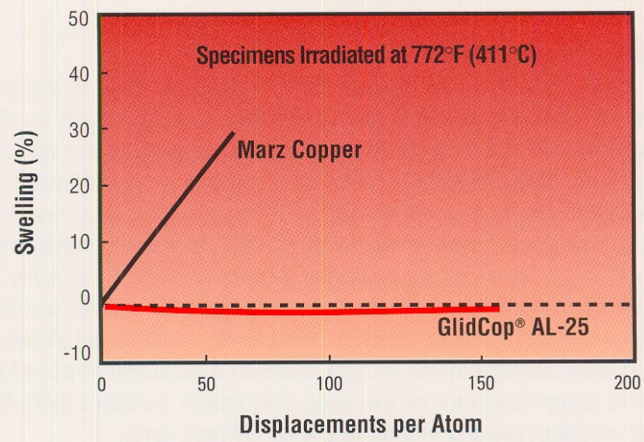


Figure 13
Swelling of GlidCop® AL-25 and marz copper after exposure to neutron irradiation.

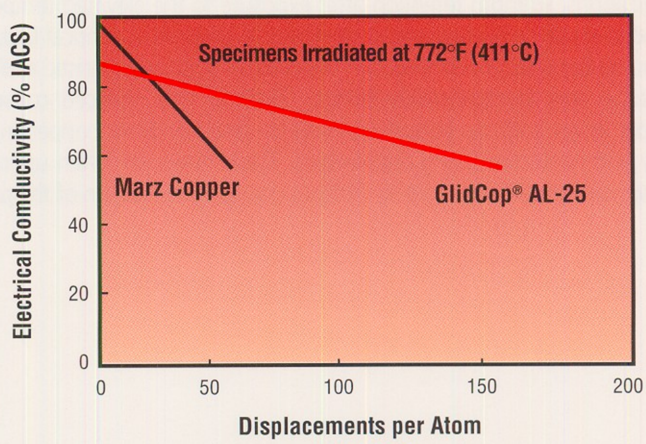
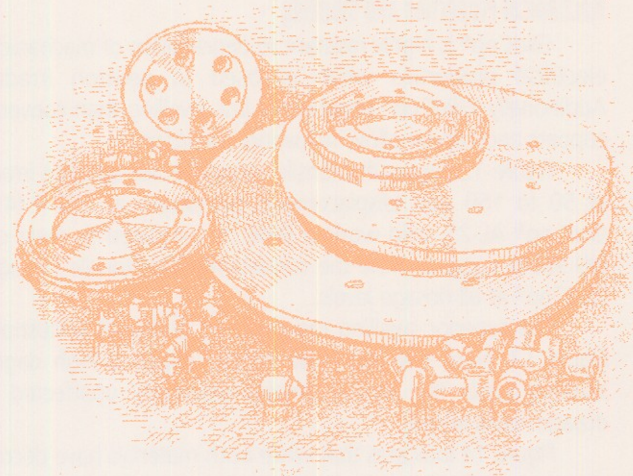


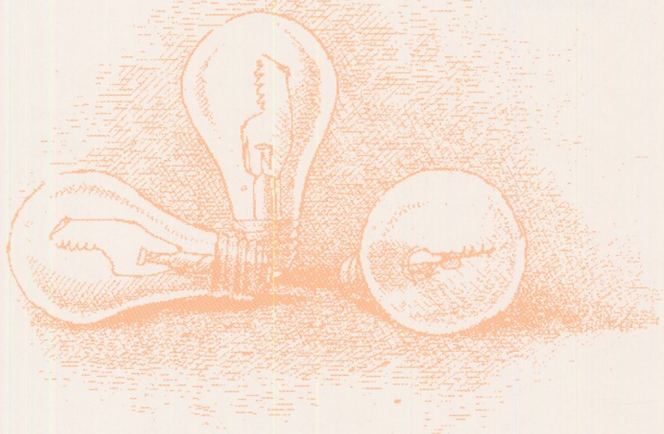
Figure 14
Comparison of the room temperature electrical conductivity of GlidCop® AL-25 and marz copper after exposure to neutron irradiation.

GlidCop® has become the material of choice in several applications due to one or more of its *Unique Features.* GlidCop® has replaced plain copper, high strength copper alloys, stainless steels, carbon steels, molybdenum, and alloys such as Kovar® in a wide range of applications. Examples of applications currently specifying GlidCop® include:



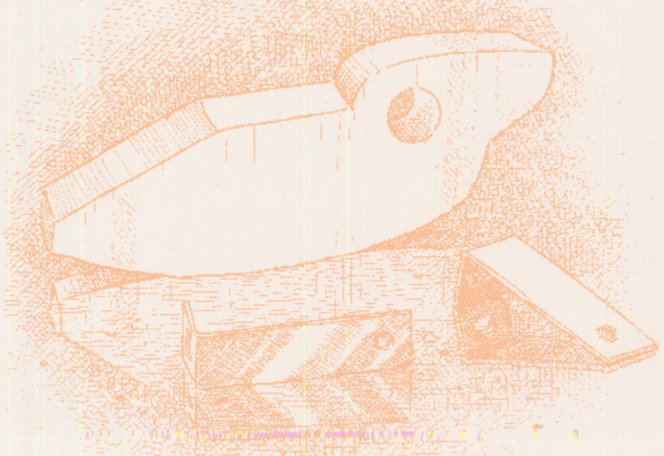
Resistance Welding Electrodes:

GlidCop® electrodes are widely used for resistance welding in the automotive, appliance, and other industries requiring sheet metal joining. Sticking of the electrodes to the workpiece is a major problem when welding galvanized and other coated steels. This usually results in electrodes pulling off the electrode holders and causing a production line stoppage to replace or change these stuck electrodes. Such interruptions are extremely costly. GlidCop® electrodes do not stick to galvanized and other coated steels, and thus eliminate this costly downtime. Increased usage of galvanized steel in the automotive industry has prompted wide use of GlidCop® electrodes. When used properly, electrodes made from GlidCop® consistently outperform Cu-Cr, Cu-Cr-Zr, and Cu-Zr electrodes because of GlidCop®'s superior high temperature softening resistance.



Incandescent Lamp Leads:

GlidCop® wire is used in leads for incandescent lamps. Its ability to resist softening after exposure to high temperature is a key reason for GlidCop® being selected for this application. Its high temperature strength retention capability enables the glass to metal sealing operation in bulb assembly to be performed without causing undue softening of the supportive leads that hold the tungsten filament wire in place. Also, expensive molybdenum lead support wires are eliminated without sacrificing the lead reliability because the GlidCop® leads have the strength to support themselves and the tungsten filament. The superior strength of the GlidCop® lead also allows a reduction in wire diameter which in turn results in a reduction in power loss due to a net lower resistance of the leads. This design produces more light at a lower wattage resulting in a more energy efficient lamp.

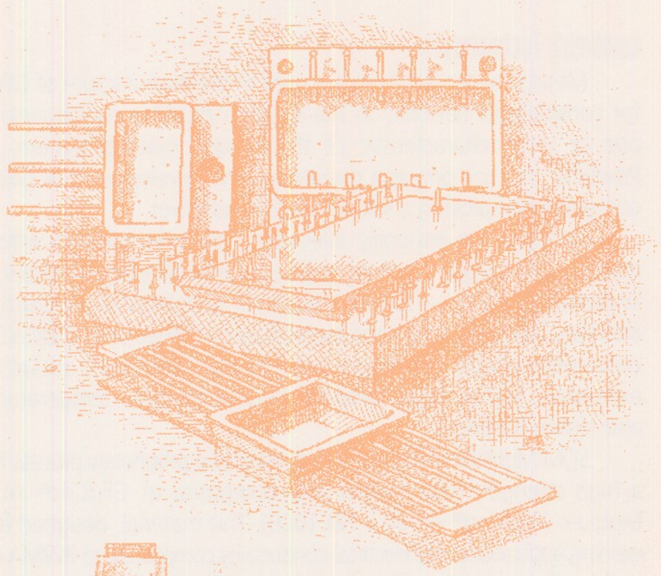


Relay Blades and Contactor Supports:

GlidCop® strip is used in relay blades and contactor supports. In these applications, strength retention after exposure to the elevated temperatures associated with soldering and/or brazing the contacts is a critical feature that warrants the selection of Glidcop®. Because of this characteristic and its high electrical and thermal conductivities, GlidCop® has replaced conventional copper alloys such as phosphorus-bronze and beryllium copper in several relay and contactor spring applications. These relays are often upgraded to higher current carrying capacity without changing the design of the package.

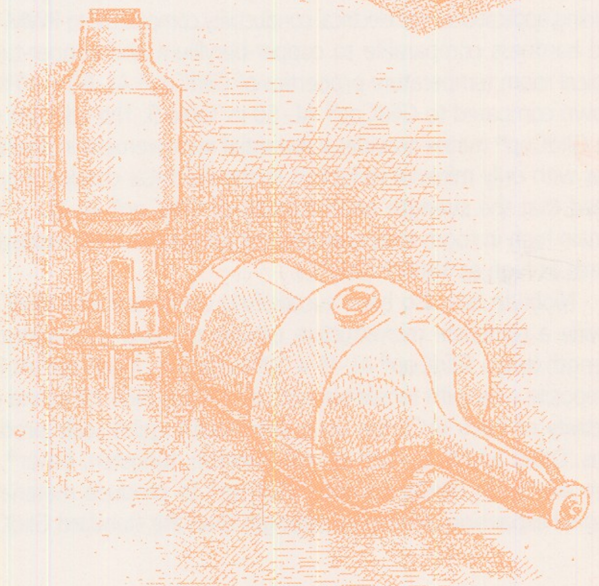
Hybrid Circuit Packages:

GlidCop® strip is used as the base plate for hybrid circuit package cases. Brazing of these bases to stainless steel and/or Kovar® components is a required step in this manufacturing process. GlidCop®'s ability to maintain its strength after this brazing step makes it the material of choice for this application when the package is used in a highly stressed environment. GlidCop® also exceeds the hermeticity requirements for this application. GlidCop® wire is also used as leads for hybrid packages because of its ability to retain its stiffness after high temperature ceramic sealing of the lead into the case.



X-ray Tube Components:

GlidCop® bar products are used in the manufacture of critical X-ray tube components. GlidCop®'s ability to retain its strength after high temperature exposure during the tube components manufacture and assembly process made it an excellent, high thermally conductive replacement for both stainless steel and conventional copper components. GlidCop® exceeds the industry requirements for hermeticity, with over a decade of product in the field without a single reported vacuum breakdown related to GlidCop®.

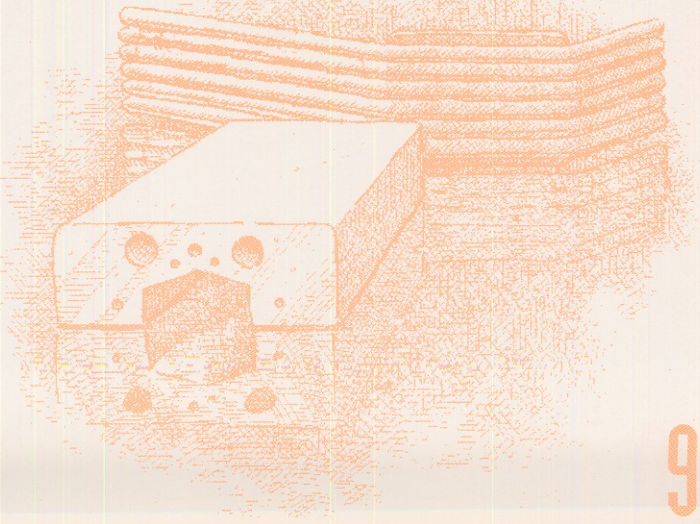


Heat Exchanger Sections for Fusion Power and Synchrotron Units:

GlidCop® plate, tubing, and special sections are used at several renowned research installations around the world that are involved with Fusion Energy research and Synchrotron Particle Accelerator development. GlidCop® is used as heat exchanger components in the form of divertors, absorbers, cooling channels, mirrors, and targets. High thermal conductivity, high strength, creep resistance and vacuum integrity to below 10^{-10} torr make GlidCop® an integral part in materials selection for these cutting edge technologies.

Other Applications:

GlidCop® is also used in many diverse applications due to its *Unique Features*, including High Field Magnet Coils, Sliding Electrical Contacts, Arc Welder Back-up Contact Bars, Anode Stems in Chlorine Cells, EDM Electrodes, Electronic Leadframes, MIG Contact Tips, Commutators, High Speed Motor and Generator Components, and Microwave Power Tube Components.



GLIDCOP®

Combining Technologies

Metal powder technologies used in the manufacture of GlidCop® allow for considerable flexibility in the addition of other constituents to enhance one or more characteristic of this unique material system. SCM Metal Products, Inc. has ongoing research in the development of GlidCop® based composites employing a wide variety of additives.

Additives are generally selected to minimize alloying with the copper matrix of GlidCop® because solid solution alloying produces a generally undesirable effect — reduced electrical and thermal conductivities. Many additives, however, have been successfully combined with GlidCop® to produce composites which, when compared to pure GlidCop®, exhibit low thermal expansion, higher room temperature and elevated temperature strengths, and higher hardness.

SCM Metal Products, Inc. has developed a proprietary process for producing a high strength, high conductivity composite of GlidCop® AL-60 + 10% Niobium (GlidCop® AL-60 + NB 1000). This material, designed for resistance welding applications, has electrical conductivity comparable to RWMA Class 2 alloy, and hardness comparable to copper-beryllium and copper-tungsten alloys. Typical room temperature properties of GlidCop® AL-60 + 10% Niobium are shown compared to GlidCop® AL-60 in Table 5. The addition of niobium to the GlidCop® matrix provides substantial improvement in strength and hardness with only minimal reduction in the electrical conductivity. Further, it is noted that the strength and hardness of GlidCop® AL-60 + 10% Niobium remain high in room temperature tests performed after exposure to temperatures as high as 1800°F (982°C).

Niobium has also been successfully combined with GlidCop® AL-15 to provide a composite microstructure capable of being cold worked to very high strength levels. GlidCop® AL-15 + 10% Niobium (GlidCop® AL15 + NB 1000) composite wire with tensile strength of 140 ksi (965 MPa) and electrical conductivity of 68% IACS has been produced in pilot scale production conditions. Other additives, such as molybdenum, tungsten, Kovar®, and Alloy 42 have also been combined with GlidCop® to produce materials with lower thermal expansion and higher strength than the standard GlidCop® product.

Table 5

Room Temperature Properties of GlidCop® AL-60 + 10% Niobium Compared to GlidCop® AL-60

	GlidCop® AL-60 + 10% Nb		GlidCop® AL-60
	As Extruded	Heat Treated 1800°F(982°C) 1hour/Argon	As Extruded
UTS ksi(MPa)	110(758)	91(627)	80(551)
0.2%YS ksi(MPa)	80(551)	67(462)	75(517)
Elongation %	10	16	22
Hardness HRB	95	90	80
Elect.Cond. %IACS	67	72	78

Recent developments in powder metal consolidation technology, developed and patented by SCM Metal Products, Inc., have resulted in the ability to now make near-net-shape structural parts using GlidCop® powder. This has opened the possibility to make GlidCop® full dense components that were previously impractical or cost prohibitive due to wrought form limitations or availability. All the economic advantages of near-net-shape manufacturing technology associated with P/M parts manufacturing can now be applied to GlidCop®.

Properties for GlidCop® near-net-shape parts are very similar to those of HIPed sections, which were presented earlier in this brochure.

GlidCop®

GlidCop® Dispersion Strengthened Copper is patented and exclusively produced by SCM Metal Products, Inc. GlidCop® is sold throughout the world by a network of agents and direct sales offices.

SCM Metal Products, Inc., with over 60 years of experience, is the world's largest manufacturer of non-ferrous metal powders and metal brazing pastes. Products include copper, bronze, brass, tin, iron, stainless steel, tool steel, lead and nickel base alloy powders; Cubond® Brazing Pastes; Microbond Solder Creams; and, of course, GlidCop®.

Our products are used in the following applications:

- Stainless Steel P/M compacting powders for automotive and appliance parts.
- Bronze, Brass, and Copper powders used in the production of oiless bearings and bushings, structural components and carbon brushes.
- Pre-alloy Bronze powders for the production of microbearings used in fractional horsepower motors.
- GlidCop® rod, bar, and strip products used as resistance welding electrodes, high performance electrical and electronic components, current carrying springs, and anneal resistant high conductivity components.
- Friction grade powders for aircraft braking systems, commercial transportation clutch facings and off highway heavy equipment clutch facings and transmission components.
- Cubond®, a copper brazing paste used to furnace braze steel components used in the automotive industries.
- Microbond Solder Creams used in consumer electronics SMT, electronic component assembly, semiconductor packaging, military and specialty applications, and telecommunications SMT.

SCM Metal Products, Inc. is committed to be the market leader in all markets served by providing the best service and quality to our customers worldwide.

For information on GlidCop® or any of the other products supplied by SCM Metal Products, Inc., contact:

UNITED STATES OFFICE:
SCM Metal Products, Inc.
2601 Weck Drive
Box 12166
Research Triangle Park,
North Carolina, USA 27709-2166
Telephone: 919-544-8090
Fax: 919-544-7996
Telex: 196-072(SCM MTL UT)

EUROPEAN OFFICE:
N.V. SCM Europe S.A.
141 rue Saint Lambert
B1200
Brussels, Belgium
Telephone: 32-2-7712110
Fax: 32-2-7714902
Telex: 23997 (SCMEUR B)

SCM METAL PRODUCTS, INC.®

The recommendations and suggestions given in this brochure are made without any representation of warranty, expressed or implied, in law or fact, and upon the condition that the purchasers make their own tests to determine the suitability of such products for their particular purposes. Statements concerning the possible use of