



TECH NOTES

LAIRD TECHNOLOGIES



#125

METALLURGY OF BERYLLIUM COPPER IN LAYMAN'S TERMS

By: W. Drew Peregrin

Beryllium copper is an alloy of copper with a small amount of beryllium (up to 2.0% by weight) dissolved in it. The only additions besides beryllium are cobalt, nickel, and iron, which together do not exceed 0.6%. As a result, the alloy remains rich in copper and so retains most of the valuable properties of copper: high electrical and thermal conductivity, and very good cold working properties.

The addition of the small amount of beryllium has a dramatic effect on one physical property in particular, and that is its strength. Beryllium copper alloy CDA17200 has a tensile strength as high as 210 ksi in the hard rolled and heat treated condition. Because of its high strength and electrical conductivity, beryllium copper is an ideal material for use in conductive springs.

The secret to beryllium copper's strength lies in the thermal treatment of the material. The material is first cast and then rolled to size at the mill, then is brought up to about 1600°F for a short period, then quickly cooled. This heat treatment is called solution annealing, which dissolves the beryllium completely into the copper, much like salt dissolves in warm water. The rapid cooling traps the beryllium atoms in solution so that they are evenly spaced and separated. With the beryllium atoms separated, they have very little effect on the mechanical properties of the metal, and the beryllium copper in the solution annealed state retains formability very much like other copper alloys.

At this point the material is cleaned and rolled down to the final size. This final rolling increases the strength in the same way that it does for cold rolled steel. The greater the reduction the stronger and less formable the material becomes. This is usually the condition the product is in when it is received by Instrument Specialties, and it will have designations of ADS (annealed dead soft –

minimum cold work) A (Annealed), 1/4 H (1/4 Hard), 1/2 H (Hard), and H (full Hard-heavily cold worked).

At Laird Technologies the strip metal is then stamped to its final form, and then precipitation hardened. Precipitation hardening is the final thermal treatment which gives the material its strength. Precipitation hardening is a low temperature (450 to 900°F) heat treatment which allows the beryllium atoms, dissolved in the beryllium copper, to migrate and form a structure or pattern. When the optimum pattern is obtained, the material has maximum strength. If the heat treatment is continued (the parts are left in the oven too long), the beryllium atoms will continue to migrate beyond the optimum pattern, and the strength will decrease.

The low temperature of this final heat treatment removes only a portion of the cold work put into the material by the mill, and therefore adds to the final strength of the heat treated part. If the beryllium copper is precipitation heat treated at standard time and temperature, it is given the designation T behind the rolled temper designation. For example, 1/4H after standard precipitation heat treatment (2 hours @ 600°F) would be designated 1/4HT.

After heat treatment, the beryllium copper is as strong as most cold rolled steels, while still maintaining many of the desirable properties of copper. Its mechanical properties at different temperatures mimic other copper alloys. At cryogenic temperatures beryllium copper maintains most of its ductility, but like other copper alloys it is subject to stress relaxation at higher temperatures. Beryllium copper's high strength in part makes up for this relaxation, and beryllium copper is often successfully substituted for other copper alloys, such as phosphor bronze in high temperature (200 to 300°F) applications.