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COPPER-LEAD ALLOY

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ABSTRACT OF THE DISCLOSURE

A method of making a homogenous copper-lead alloy, and the alloy and its uses, wherein the method comprises adding an effective amount of a homogeneity promoter to a mixture of molten lead and copper. The promoter consists essentially of elemental carbon and an alkali metal compound capable of reacting to form a gas. An example of the alkali metal compound is sodium carbonate. Uses for the alloy include bearings, lubricants and as an additive to petroleum and vegetable based lubricating compounds.

This invention relates to alloys and in particular to copper-lead alloys and methods of making them and different uses thereof.

Attempts to produce substantially pure and uniformly homogenous copper-lead alloys have been made in order to provide such alloys which have high thermal conductivity, low electrical resistivity and a lower coefficient of friction. These properties are highly desirable for metals used to make bearings or as a bearing material and as a dry lubricant or as an additive to liquid or viscous lubricants made of petroleum or vegetable bases. However, many problems have not been solved by the prior art in attempting to make substantially pure and uniformly homogenous copper-lead alloys. A basic previously unsolved problem is the prevention of segregation of the copper and lead during the initial and subsequent remelts without the addition of ternary elements. This tendency to segregate has been a particularly difficult problem as the lead content rises about 30% of the total weight of the copper-lead alloy. Another problem associated with the use of prior alloys is that even if there is initial homogeneity, under high stress and temperature conditions, the lead has a tendency to segregate from the copper. A further problem associated with copper-lead alloys in the prior art is that the lead tends to segregate from the copper when it is being remelted and recast into other shapes and forms.

In the prior art, ternary materials have been added to the alloy to prevent segregation. Tin, antimony, aluminum, zinc, nickel and other materials have been added to the basic copper-lead alloys. Although these additives have been somewhat effective in solving the homogeneity problem, they have also added qualities which make them less desirable as antifriction bearing materials or as lubricants. For instance, by the additioin of ternary materials, the coefficient of friction is increased, thermal conductivity decreased and electrical resistivity increased.

It is therefore an object of the present invention to provide an improved copper-lead alloy which is substantially pure, but in which extremely fine traces of homogeneity promoting elements remain in suspension.

Another object of the present invention is to provide a uniformly homogeneous copper-lead alloy in which segregation of lead from copper is reduced on successive remelts even though the lead content is greater than 30% of the total weight of the alloy.

Yet another object of the present invention is to provide a homogenous copper-lead alloy which is useful for production of bearings and a bearing material, and for utilization as a dry lubricant or as an additive to petroleum and vegetable based lubricants.

Still another object of the present invention is to provide a substantially pure copper-lead alloy having a lower coefficient of friction, a higher thermal conductivity and a lower electrical resistivity than previously known alloys of this type.

An additional object of the present invention is to provide a copper-lead alloy in which impurities and additives are minimized.

A further object of the present invention is to provide a copper-lead alloy in which losses due to oxidation are minimized during the process.

Yet another object of the present invention is to provide a process for making the copper-lead alloy of the present invention which has the aforementioned properties.

These and other objects will be apparent from a reading of the specification and claims of this application.

Briefly, in accordance with the present invention, the foregoing and other objects are accomplished by adding effective amounts of a homogeneity promoter to a melt of copper and lead. The promoter consists essentially of elemental carbon and an alkali metal compound which reacts under the molten conditions present during the alloying and casting of the copper and lead to form a gas. An example of such an alkali metal compound is sodium carbonate.

Copper-lead alloys are produced according to the present invention in varying proportions of copper and lead. The proportions may be varied as desired and as the specific application dictates. It has been found that alloys of most utility are preferably those which contain 20% to 48% lead and the remainder copper. If the lubricating qualities of the alloy are to be increased, the proportion of lead should be increased. If it is desirable to increase the strength of the material, a lesser proportion of lead should be utilized.

In one method of making the alloy of the present invention, copper of the desired quantity is placed in a graphite crucible and brought to a temperature of 1250°–1350° C. using an induction heater. When the copper is melted and has attained the appropriate temperature, as for example about 1275° C., the lead and the homogeneity promoter are added to the melt. Thereupon violent agitation of the liquid mixture ensues with the formation of gas. The temperature of the mixture is maintained for at least 1 minute and preferably 3 minutes for best results. The melt is then allowed to cool through its solidification temperature during which time the agitation continues. After solidification, the temperature of the alloy is permitted to drop to ambient levels. Surprisingly, in spite of the gas evolved during the solidification of the melt, the resulting solid structure of the ingot is free of porosity.

As to the homogeneity promoter of this invention, it has been found that the elemental carbon component is perferably finely powdered graphite. Although coarser carbon may be used, the larger particles tend to decrease the efficiency of the process, presumably due to reduced surface area to volume ratio. Other forms of carbon include bone-black, carbon-black, charcoal and the like.

The alkali metal component compound may be either potassium or sodium combined as a carbonate. The amount of homogeneity promoter used must be at least that amount which ensures formation of a uniformly dispersed mixture of lead and copper which does not segre-

gate on solidification. It has been found that the minimum weight proportion of the promoter which is required to provide the novel alloys of this invention is about 3 grams of each component for each pound of alloy. Below this proportion, segregation in the alloy is pronounced. The maximum proportion of the promoter is determined by characteristic requirements of the alloy, since excessive proportions of the component materials may tend to adversely affect the alloy. An effective range of the proportions has been found to be about 4–10 grams of carbon or graphite powder and about 4–26 grams of alkali metal compound for each pound of alloy. Approximately 5–7 grams of carbon or graphite powder and about 18–24 grams of alkali metal compound per pound of mixture provide a preferred alloy.

Although the exact mechanism is not understood, and patentability is not dependent thereupon, it is believed that the alkali compound is decomposed to form the gaseous alkali metal and a gas such as carbon monoxide. The carbonate melts well below the reaction temperature range and decomposes at the higher temperatures into carbon monoxide gas and the alkali metal oxide. The oxide in turn is reduced by the carbon to form additional carbon monoxide and alkali metal. The alkali metal is also above its boiling point and is released in gaseous form. The combined action of the carbon monoxide and alkali metal gases cause the vigorous stirring action. Agitation continues through the cooling step and it is in this stage when the agitation is believed to be most effective. The agitation prevents gross separation of the lead and the copper phases and further provides many more nucleation sites for the solid, copper-rich dendrites to form from the liquid. The additional nucleation sites cause the final solidified structure to be fine-grained and further allows more efficient and homogeneous entrapment and entrainment of the lead phase in the copper matrix. The combined action promotes a random, fine-grained dispersion of lead in copper which is mandatory for the optimum characteristics and requirements of a bearing alloy. An additional benefit of the emission of carbon monoxide is to produce a reducing atmosphere over the alloy during the liquification and solidification which almost completely prevents oxidation of the alloy from the air. Thus, it is not necessary to employ artificial protective atmospheres to reduce severe metal loss due to oxidation. However, if desired, inert atmospheres may be used in addition to blanket the system.

Another advantage of this process is the multiple remelt capability of the copper-lead alloy without resulting segregation. This effect is desirable particularly if the material is produced as solid billets for use in subsequent castings into desired forms. The remelt capability without accompanying segregation, it is believed is attributed to remnants of the homogeneity promoter remaining in the alloy. The nonsegregative feature of this process has been observed to exist for successive remelts.

The alloy of the present invention is noncorrosive and can easily be stored.

The novel alloys of copper-lead prepared by the foregoing method have the structural characteristics required to produce optimum antifrictional qualities. The purity is high since the alloy has been thoroughly deoxidized. Also the elements of impurity are almost undetectable with emission spectroscopy. The lead phase is finely and randomly dispersed throughout the copper matrix. These factors contribute to a low coefficient of friction in the lifetime of the bearing alloy. They also have a high thermal conductivity and low electrical resistivity. In addition, they are easily sintered, drawn, extruded, rolled and machined without losing their superior antifriction qualities.

One application that the alloy of the present invention is particularly suited for is as a coating for small arms ammunition and as a rotating band for ammunition such as 20 mm. and larger. The rotating bands are fitted onto the circumference of the projectile and are thus in contact with the inside of the barrel when the projectile is fired.

Due to the lubricating qualities of the alloy, barrel friction is reduced. This in turn provides a longer barrel life and an increased impact velocity for the projectile.

In addition, the copper-lead alloy coats the inside surface of the barrel of the gun, and particularly the lands thereof. Because of the high thermal conductivity of the alloy, hot spots on the barrel are virtually eliminated, cook-offs are reduced and the overall barrel temperature is reduced during firing as heat is dissipated faster. This in turn allows the fire power of the weapon, in terms of rounds per minute, to be increased. In small arms ammunition, a steel or other bullet is coated with the alloy and this in turn coats the barrel of the weapon providing the same features as with larger caliber weapons previously described.

In another application, the alloy of the present invention is used as a bearing surface. It is especially suited for use when high or extremely low temperatures and high stresses are present. It maintains its excellent lubricating qualities in a temperature range from minus 450° F. to over 1500° F. This quality is derived from its excellent anti-frictional qualities. Most standard methods for making bearings and bearing surfaces may be employed. As an example, in bonding the alloy of the present invention to steel, the alloy can be powdered utilizing the atomization method to as fine as 1 micron. The steel is heated, until it turns blue (approximately 600° F.) and the powder made from the alloy is then sprayed onto the steel surface. The heat from the surface of the steel bonds the copper-lead alloy to the steel on contact. The bond is strong enough to resist high stresses that result from bearing forces while providing excellent bearing properties. For example, instead of forming rotating bands for ammunition from the alloy in their entirety, such rotating bands may be made by bonding the alloy to the surface of a steel core in the manner set forth above.

Still further use of the alloy of the present invention is as an additive to lubricants. The alloy is combined in powdered form with other lubricants such as greases and oils in quantities ranging preferably from a trace to 4 ounces per pound of the grease or oil. The resulting combination is a superior lubricant which fully coats moving parts thereby increasing the life of these parts. Maintenance requirements are also reduced. The alloy is of particular value when the lubricant combination is used in sealed units where frequent changes of lubricant are uneconomical. In this application, the improved results are obtained over a longer period of time when higher percentages of lead are used in the alloy.

In the following examples, the alloys contained copper to lead in weight proportion of 60 to 40. The copper was heated to about 1275° C. in a crucible in an induction oven. At this temperature, the balance of the lead was added to the copper together with the components shown in the table below. The proportion of components added are listed in grams for each pound of copper and lead. Results are tabulated as percent segregation in the alloy metals.

TABLE

Run	$NaCO_3$	Graphite powder	Percent segregation
1(control)			100
2	22.5		5
3	22.5	6.8	0
4	4.5	4.5	0
5		13.5	25
6	2.3	4.5	20

The Abstract of the Disclosure is included herein solely for the purposes of Rule 72(b) of the Rules of Practice. While a new alloy, methods of making same and different uses have been disclosed, and examples provided, it is obvious that various modifications can be made without departing from the spirit and scope of the invention.

What is claimed is:

1. The method of making a homogeneous copper-lead

alloy comprising the step of adding an effective amount of a homogeneity promoter to a mixture of molten lead and copper, said promoter consisting essentially of elemental carbon and an alkali metal compound capable of reacting to form gas.

2. A method according to claim 1 wherein the temperature of said molten lead and copper is maintained in the range of between about 1250°–1350° C. for at least 1 minute subsequent to said adding step and thereafter including the step of cooling said molten alloy.

3. A method according to claim 1 wherein said alloy is made in a nonoxidizing environment.

4. A method according to claim 3 wherein said environment is inert gas.

5. A method according to claim 2 wherein said promotor is finely powdered graphite and sodium carbonate.

6. A method according to claim 5 wherein the proportions of said graphite is at least 3 grams, and said sodium carbonate is at least 3 grams, respectively, for each pound of copper and lead in the alloy.

7. The method of claim 1 wherein said elemental carbon is finely powdered graphite and said alkali metal compound is selected from the group consisting of sodium carbonate and potassium carbonate and wherein 4–10 grams of graphite and 4–26 grams of alkali metal compound are added for each pound of alloy.

8. The method of claim 1 wherein said alloy comprises from 20 to 48 percent lead.

9. The method of claim 6 wherein said alloy comprises from 20 to 48 percent lead.

10. A homogeneous alloy consisting essentially of copper and lead, and the reaction product of elemental carbon with an alkali metal compound selected from the group consisting of sodium carbonate and potassium carbonate in molten copper and lead.

11. The alloy of claim 10 wherein said alloy comprises from 20 to 48 percent lead.

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