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3,544,313

DISPERSION HARDENED HIGH STRENGTH BRASS ALLOY

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4 Claims

ABSTRACT OF THE DISCLOSURE

An intermetallic compound or compounds formed by aluminum on one part and titanium or zirconium of Group IVa or chromium or molybdenum of Group VIa of the periodic table on the other part, is or are added to a wrought high strength brass alloy having a structure of $\alpha+\beta$ solid solution or a β solid solution containing no iron; and is or are dispersed therein so as to strengthen the matrix of said brass alloy. Said brass alloy so produced, which is to be used for constituent parts of various machinery, has a greater strength, a greater resistance to wear and a better refractory property, and can be produced at a lower cost of production.

In order to obtain the greater strength of a high

strength brass alloy, it is found out that the alloy is prepared by the following method: From 0.05% to 10% by weight of an intermetallic compound or compounds, that is, one or more of titanium aluminide, zirconium aluminide, chromium aluminide or molybdenum aluminide is or are added to a $\alpha+\beta$ solid solution or a β solid solution base alloy consisting by weight of from 54% to 68% copper, from 3% to 7% aluminum, from 2.0% to 5.0% manganese, max. 1% nickel, up to 0.02% tin, max. 0.5% lead, zinc constituting the remaining part, and containing no iron.

Titanium, zirconium, chromium or molybdenum produces an aluminide with the aluminum in the base alloy and form with it a minute intermetallic compound which disperses in the matrix of the base alloy and checks the movability of dislocation 1, the plastic deformation, and which strengthens the strength of the high strength brass alloy.

An addition of each intermetallic compound among a group of titanium aluminide, zirconium aluminide, chromium aluminide and molybdenum aluminide may be performed either in a form of each intermetallic compound or in a form of a single substance of each element or in a form of mother alloy when the high strength brass alloy of the base is melted. In the latter two cases, such a single substance or mother alloy forms an intermetallic compound with the aluminum in the base alloy. In all the cases, the intermetallic compound will disperse in the matrix of the base alloy after the base alloy has been solidified.

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Example 1 shows the chemical compositions by weight of ASTM B138 Copper Alloy No. 670 and of some alloys prepared in accordance with the present invention.

EXAMPLE I

Chemical composition, weight percent	ASTM B 138 Copper alloy No. 670	Alloy			
		A	B	C	D
Copper.....	63.0-68.0	62.4	64.6	58.3	63.5
Aluminum.....	3.0-6.0	4.1	4.8	3.3	3.9
Manganese.....	2.5-5.0	3.0	2.9	1.6	1.2
Iron.....	2.0-4.0	nil	nil	nil	nil
Tin.....	0.5 ¹	nil	nil	0.01	nil
Lead.....	0.2 ¹	0.02	0.3	nil	nil
Nickel.....	0.6	0.6	0.3	0.3	0.4
Titanium.....	1.3	0.7	1.5	0.5	0.6
Zirconium.....	0.7	0.6	0.7	0.7	0.7
Chromium.....	0.6	0.6	0.7	0.7	0.7
Molybdenum.....	(²)	(²)	(²)	(²)	(²)
Zinc.....	(²)	(²)	(²)	(²)	(²)

¹ Maximum. ² Balance.

Table 1 shows the various comparisons of the average mechanical properties of the alloys mentioned in Example I.

TABLE I

Mechanical properties as extruded	ASTM B 138 Copper Alloy No. 670	Alloy			
		A	B	C	D
Tensile strength p.s.i.....	92,000	113,000	110,000	121,000	104,000
Yield strength p.s.i.....	56,000	78,000	75,000	80,000	72,000
Percent elongation 2".....	21	14	18	10	15

The above table shows clearly that the dispersion of intermetallic compounds improves the mechanical properties of the alloys to a marked degree.

The conventional high strength brass alloy as, for example, ASTM B 138 Copper Alloy No. 670, ASTM B 147 8B, or the alloy described in the specification of U.S. Patent 3,097,093, has as its main constituents copper, aluminum, manganese, iron and zinc, and also contains minute quantities of tin and lead. In our studies of improving a resistance to wear of the high strength brass alloy, however, it has been found out that the presence of iron has an ill effect on the alloy. There is no iron, therefore, in the base alloy of the high strength brass alloy developed in accordance with the present invention. An increase in the strength of the high strength brass alloy by means of iron can be sufficiently made up for by an addition of an intermetallic compound or compounds prepared in accordance with the present invention.

Table II shows comparative wear test results between ASTM B 138 Copper Alloy No. 670 and one of the alloys prepared in accordance with the present invention. It is clear that the alloy containing no iron has a greater resistance to wear.

TABLE II.—WEAR TEST (AVERAGE)

Alloy:	Amount of wear, g./cm. ² /km.
ASTM B 138 Copper Alloy No. 670 as extruded	0.26
Alloy A as extruded	0.09

Load 40 kg./cm.², sliding speed 1 m./sec.

As a dispersed intermetallic compound does not dissolve in the matrix at a high temperature, the alloy does not decrease much in its strength even at the high temperature.

Table III shows the hardness of the alloy after it has been heated with a high temperature.

TABLE III.—ALLOY A AS EXTRUDED

Reduce hardness of Diamond pyramid hardness at high Temperature

As extruded	180
300° C.	182
400° C.	184
500° C.	182
600° C.	181
700° C.	177
800° C.	174

After having been heated, the alloy was cooled at the room temperature and measured.

In the specification of U.S. Patent 3,097,093 (1st column, line 33 and the following), it is described to the effect that the presence of lead decreases the impact strength of an alloy, and consequently the content of lead is limited up to 0.2%. In our studies, however, lead can be added up to 0.5% to the alloy in accordance with our invention without an appreciable ill effect. On the contrary, such a presence of lead increases the machinability.

Example 2 and Table IV show the comparisons of the alloy containing lead with the alloy containing no lead, both alloys being prepared in accordance with our invention. Table IV shows clearly that the addition of lead does not decrease the impact strength of the alloy.

EXAMPLE II

Chemical composition, weight percent	Alloy E	Alloy F
Copper	64.7	64.5
Aluminum	4.2	4.1
Manganese	2.0	1.9
Nickel	0.3	0.3
Chromium	0.3	0.3
Molybdenum	0.1	0.1
Lead	nil	0.4
Zinc	(¹)	(¹)

¹ Balance.

TABLE IV.—AS EXTRUDED (DIAMETER 2")

Impact strength Charpy V-notch,
kgm./cm.² at room temperature

Alloy E	4.7
Alloy F	4.8

We claim as our invention:

1. A $\alpha+\beta$ solid solution dispersion hardened high strength brass alloy consisting essentially of, by weight, from 54% to 68% copper, from 3.0% to 7.0% aluminum, from 2.0% to 5.0% manganese, from 0 to 1% nickel, from 0 to 0.02% tin, from 0 to 0.5% lead, and from 0.05% to 10% of an intermetallic compound selected from titanium aluminide, zirconium aluminide, chromium aluminide, molybdenum aluminide and balance zinc, said alloy being characterized in that it has high strength and has excellent resistance to wear, and good refractory properties, and that it contains no iron at all.

2. The $\alpha+\beta$ solid solution dispersion hardened strength brass alloy of claim 1 wherein said intermetallic compound is a plurality of intermetallic compounds.

3. A β solid solution dispersion hardened high strength brass alloy consisting essentially of, by weight, from 54% to 68% copper, from 3.0% to 7.0% aluminum, from 2.0% to 5.0% manganese, from 0 to 1.0% nickel, from 0 to 0.02% tin, from 0 to 0.5% lead, and from 0.05% to 10% of an intermetallic compound selected from titanium aluminide, zirconium aluminide, chromium aluminide, molybdenum aluminide and balance zinc, said alloy being characterized in that it has high strength and has excellent resistance to wear, and good refractory properties, and that it contains no iron at all.

4. The β solid solution dispersion hardened high strength brass alloy of claim 3 wherein said intermetallic compound is a plurality of intermetallic compounds.

References Cited

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