US 20100226815A1

(19) **United States**

(12) **Patent Application Publication**

Lazarus

(10) **Pub. No.: US 2010/0226815 A1**

(43) **Pub. Date: Sep. 9, 2010**

(54) **LEAD-FREE BRASS ALLOY**

(76) Inventor: **Norman M. Lazarus**, Houston, TX (US)

Correspondence Address:
FULBRIGHT & JAWORSKI, LLP
1301 MCKINNEY, SUITE 5100
HOUSTON, TX 77010-3095 (US)

(21) Appl. No.: **12/400,283**

(22) Filed: **Mar. 9, 2009**

Publication Classification

(51) **Int. Cl.**
C22C 9/04 (2006.01)

(52) **U.S. Cl.** **420/477**

(57) **ABSTRACT**

The invention relates to brass alloys that are substantially lead-free. In the alloys of the invention, lead is replaced with tellurium resulting in alloys that exhibit excellent machinability and conductivity.

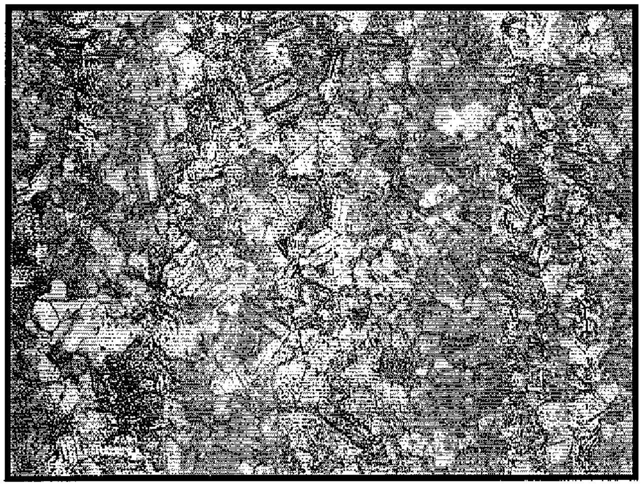

Figure 1: 25.4mm dia – 0.045mm grain size

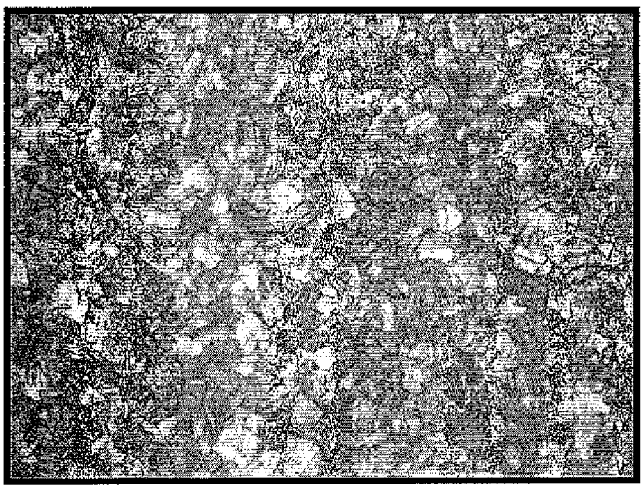

Figure 2: 50.8mm dia – 0.035mm grain size

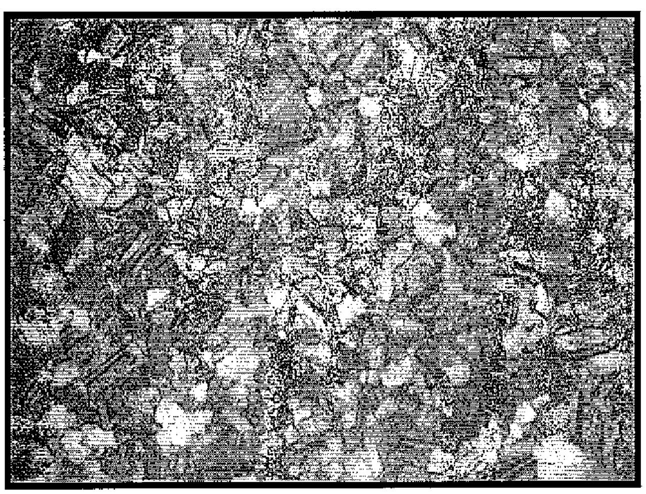

Figure 3: 22.23mm A/F – 0.035mm grain size

LEAD-FREE BRASS ALLOY

TECHNICAL FIELD

[0001] The present invention relates to brass compositions with extremely low to no lead content. The compositions exhibit good machinability and strength similar to that of conventional leaded brass alloy free machining brass.

BACKGROUND OF THE INVENTION

[0002] It has been common practice to add up to 4.5% lead to brass compositions to improve the machinability of the resulting product. Lead, however, is a toxic substance and its use in the production of alloys is surrounded by legislation and expensive control procedures. For example, California adopted legislation which limits the amount of lead in plumbing fixtures to 0.25% or less beginning in 2010.

[0003] Furthermore, the lead phase in copper lead alloys can be affected by corrosive attacks with hot organic or mineral oil. For example, when temperature of such an alloy rises, it has been known that the oil can break down to form peroxides and organic gases which effect a degree of leaching on the lead phase within the alloy. If this leaching progresses to any appreciable extent, the component, if it is a bearing or structural component, may eventually malfunction or fail.

[0004] There is, therefore, considerable advantage in reducing, or if possible, eliminating the contents of lead within powder metallurgy compositions. Various proposals have been put forward for doing this. The considerable proportions of lead incorporated in powder metallurgy materials in the past has resulted in ease of machinability and durability of the resulting product component. Replacement of part of the lead by bismuth has been proposed in International Application published under No. WO91/14012. This results in successful replacement of part of the lead without significant reduction in the machinability. It is, however, accompanied by some reduction of transverse strength of the material. For many purposes this reduction in transverse strength is not a significant problem.

[0005] Another approach has been described in U.S. Pat. No. 5,445,665. In this product 0.1 to 1.5% graphite is added to the alloy allowing for reduction of lead to 2% of the alloy or less.

[0006] While the alloys described above yield substantially lead-free alloys, they do not possess the same machinability as the lead containing alloys. This results in the need for substantial retooling of the equipment used to produce end product, such as plumbing equipment and the like. In addition, the scrap produced during the manufacturing of the lead products often cannot be readily recycled by the end product manufacturer. Recycling typically can only be done by the manufacturer of the alloys. The cost of shipping the scrap back to the initial foundry increases the overall product cost of the end product.

[0007] Thus, there remains a need for a lead-free brass alloy which exhibits machinability similar to that of lead containing products and that can be recycled by the customer.

BRIEF SUMMARY OF THE INVENTION

[0008] The present invention comprises a brass alloy containing from about 0.20% to 1.5% tellurium as a substitute for lead, typically added to the brass composition. In one series of embodiments the tellurium ranges from about 0.4% to about 1.0%. The resulting alloy typically has a lead content of from less than about 0.025% to less than about 0.001% which is considered "lead-free."

[0009] Brass alloys of the invention typically have a copper content of from about 98% to about 57%, a zinc content of from about 43% to about 2%, a tellurium content of from about 1.0% to about 0.02%, a lead content of from about 0.025% to about 0.001%, and a maximum phosphorous content of about 0.05%.

[0010] The resulting alloys exhibit excellent machinability and conductivity. Depending on the composition of the alloy, the tensile strength will vary between 240 MPa and 530 MPa and yield strength will vary from about 200 to about 450 MPa. Conductivity will range from about 28% to about 49% IACS. The machinability of the novel alloys of the invention is similar to that for lead containing compositions. This eliminates or reduces the amount of retooling needed to use the novel alloys to produce finished products such as plumbing fixtures.

[0011] The composition of the novel alloys also allows the end product manufacturers to recycle the scrap from the manufacturing process itself. This eliminates the need to return the scrap to the alloy manufacturer for recycling. Yet another key feature of the present invention is that the alloys containing less than about 15% zinc exhibit excellent dezincification resistance.

[0012] The foregoing has outlined rather broadly the features and technical advantages of the present invention in order that the detailed description of the invention that follows may be better understood. Additional features and advantages of the invention will be described hereinafter which form the subject of the claims of the invention. It should be appreciated by those skilled in the art that the conception and specific embodiment disclosed may be readily utilized as a basis for modifying or designing other structures for carrying out the same purposes of the present invention. It should also be realized by those skilled in the art that such equivalent constructions do not depart from the spirit and scope of the invention as set forth in the appended claims. The novel features which are believed to be characteristic of the invention, both as to its organization and method of operation, together with further objects and advantages will be better understood from the following description when considered in connection with the accompanying figures. It is to be expressly understood, however, that each of the figures is provided for the purpose of illustration and description only and is not intended as a definition of the limits of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. **1** is a photomicrograph of the alloy used in Sample C1 after draw.

[0014] FIG. **2** is a photomicrograph of the alloy used in Sample C2 after draw.

[0015] FIG. **3** is a photomicrograph of the alloy used in Sample C3 after draw.

DETAILED DESCRIPTION OF THE INVENTION

[0016] The brass alloys of the present invention are prepared by first melting copper at a temperature of about 1050° C. Zinc and tellurium are then added to the molten copper. Brass alloy is then cast into billets utilizing horizontal or vertical casting methods.

[0017] The copper used to make the alloys is typically copper cathode or high grade uncontaminated and pure copper scrap comprising 99.95% minimum copper and to 0.05% impurities. Lead is a typical impurity, comprising less than 0.025% of the copper used. In the formation of the alloys of the invention, copper comprises from about 57.00 to about 98.00% of the alloy.

[0018] Zinc is the next major component comprising from about 2.00% to about 43.00% of the alloy.

[0019] Tellurium is used as a replacement for lead. Like lead, tellurium is added to improve machinability of the alloy without the negative contribution of lead. Tellurium is added in an amount ranging from about 0.20% to about 1.5% of the alloy. In one series of embodiments, the tellurium ranges from about 0.4 to about 1.0%. In one embodiment, tellurium comprises about 0.5% of the alloy. The amount of tellurium used will depend, in part, on the amount of copper used in the alloy, as copper levels increase the amount of tellurium used with decrease. Like lead, the addition of tellurium to the alloy creates discontinuities in the copper and zinc phases of the alloy like those shown in FIGS. **1**-**3**. The good dispersion of these discontinuities leads to the improved machinability of the alloys.

[0020] One advantage of the present invention is that the alloys exhibit machinability similar to that of lead containing alloys while using significantly lower amounts of tellurium.

[0021] Other materials which may be added to the brass alloys include arsenic, nickel manganese, silicon, and phosphorous. When phosphorous is used, the amount present will typically be less than 0.05% of the alloy.

[0022] The resulting alloys will generally exhibit excellent machinability and conductivity as indicated by Ultimate Tensile Strength (UTS) ranging from about 240 to about 530 MPa and a yield strength of from about 200 MPa to about 450 MPa as determined using ASTM method B**140**. The actual Tensile strength and Yield strength will depend, in part, on the actual composition of the alloy. Conductivity of the alloys will range from about 28 to about 45% IACS.

EXAMPLES

[0023] A series of brass alloys were prepared where the added lead (typically about 2%) was replaced with approximately 0.5% tellurium. The composition of each alloy is shown in Table 1.

TABLE 1

Sample	Cu	Pb	Zn	Te	P	Sn
A	Balance	<0.01	5.10	0.5	0.011	—
B	Balance	0.00	8.82	0.57	.001	—
C	83.03	0.06	Balance	.052	0.05	0.11
D	59.41	0.02	Balance	0.17	0.05	—

[0024] The billets were then changed into an extrusion press at a temperature ranging from about 780° C. to about 860° C. The billets were then hot extruded through a variety of dies and at different pressures to produce numerous sizes. Each shot was lubricated prior to extrusion and the extrusion dies were preheated. The results are shown in Table 2.

TABLE 2

Sample	Final Draw Size	Shot Temp	Pressure	Length
A1	31.75 mm	808° C.	234 MPa	12 m
A2	75.40 mm	822° C.	268 MPa	18.5 m
A3	19.05 mm	803° C.	305 MPa	34 m
B1	31.75 mm	794° C.	267 MPa	12 m
B2	25.40 mm	800° C.	289 MPa	18.5 m
B3	19.05 mm	806° C.	304 MPa	34 m
B4	12.70 mm	870° C.	265 MPa	67 m
C1a	25.40 mm	830° C.	298 MPa	18.4 m
C1b	25.40 mm	867° C.	280 MPa	18.4 m
C2a	50.80 mm	750° C.	230 MPa	21.5 m
C3a	22.23 mm AF Hex	830° C.	312 MPa	21.5 m
C3b	22.23 mm AF Hex	837° C.	324 MPa	21.5 m
D1a	50.8 mm	640° C.	128 MPa	4.6 m
D1b	50.80 mm	637° C.	142 MPa	4.6 m
D2a	25.4 mm	650° C.	234 MPa	18.4 m
D2b	25.4 mm	660° C.	214 MPa	18.4 m
D3a	22.23 mm AF Hex	648° C.	235 MPa	21.5 m
D3b	22.23 mm	621° C.	276 MPa	21.5 m

[0025] The bars were then passed through a bath of sulfuric pickling acid and then cold drawn so as to induce the correct mechanical properties and grain size requirements. Also this process ensures that the correct size tolerances are met. The cold drawing operation was accomplished effortlessly. The products were then tested for tensile strength, hardness, conductivity, and machinability. The results are shown in Table 3.

TABLE 3

Sample	Reduction in Area (%)	Ultimate Tensile Strength (MPa)	Yield Strength (MPa)	ELONGATION	HARDNESS (Rb)
A1	11.24	267.9	210.3	30%	56
A2	12.8	296.5	341.3	24%	57
A3	1__.71	322	279.2	16%	60
B1	11.24	302.7	241.3	26%	59
B2	12.8	322	259.2	24%	63
B3	17.71	322.7	268.9	21%	64
B4	28.32	393.7	393	12%	69
C1	12.8	350.2	291.9	20%	51
C2	11.13	354.9	295.8	20%	52
C3	13	358.8	294.1	22%	53
D1	14.10	487.8	378.2	29%	75
D2	14.10	531.6	443	20%	78
D3	14.44	485.3	407.8	19%	76

[0026] Conductivity tests were then conducted on various samples. Conductivity diminishes as the ratio of zinc content increases. The results ranged from at least about 28% to about 49% maximum.

[0027] Photomicrographs of Samples C1, C2 and C3 were taken after draw and are shown in FIGS. **1**-**3**. The micro structure in the alloys were uniform indicating good dispersion of the tellurium throughout the alloy.

[0028] Although the present invention and its advantages have been described in detail, it should be understood that various changes, substitutions and alterations can be made herein without departing from the spirit and scope of the invention as defined by the appended claims. Moreover, the scope of the present application is not intended to be limited to the particular embodiments of the process, machine, manufacture, composition of matter, means, methods and steps described in the specification. As one of ordinary skill in the art will readily appreciate from the disclosure of the present invention, processes, machines, manufacture, compositions of matter, means, methods, or steps, presently existing or later to be developed that perform substantially the same function or achieve substantially the same result as the corresponding embodiments described herein may be utilized according to the present invention. Accordingly, the appended claims are intended to include within their scope such processes, machines, manufacture, compositions of matter, means, methods, or steps.

1. A brass alloy comprising:

Copper;

Zinc;

Tellurium; and

Lead

wherein lead comprises less than 0.25% of the alloy and the tellurium comprises from about 0.025% to about 1% of the alloy, and

wherein the alloy has a tensile strength of from about 240 MPa to about 530 MPa, and

wherein the alloy is silicon free.

2. The alloy of claim **1** wherein the copper comprises from about 57% to about 98% of the alloy.

3. The alloy of claim **1** wherein the zinc comprises from about 2.0% to about 43% of the alloy.

4. The alloy of claim **1** further comprising less than about 0.02% phosphorous.

5. A brass alloy comprising:

about 57% to about 98% copper;

about 2% to about 43% zinc; and

about 0.025% to about 1.0% tellurium

wherein the alloy has a tensile strength of from about 240 MPa to about 530 MPa, and

wherein the alloy is silicon free.

6. The alloy of claim **5** further comprising less than about 0.025% lead.

7. (canceled)

8. The alloy of claim **1** having a yield strength of from about 200 MPa to about 450 MPa.

9. The alloy of claim **1** having a conductivity of from about 28% to about 49% IACS.

10. The alloy of claim **1** wherein the zinc comprises about 5% of the alloy.

11. The alloy of claim **1** wherein the zinc comprises about 10% of the alloy.

12. The alloy of claim **1** wherein the zinc comprises about 15% of the alloy.

13. The alloy of claim **1** when the zinc comprises about 40% of the alloy.

14. (canceled)

15. The alloy of claim **5** having a lead content of less than about 0.5%.

16. The alloy of claim **5** having a lead content of less than about 0.01%.

17. The alloy of claim **5** having a tensile strength of from about 240 MPa to about 530 MPa.

18. The alloy of claim **5** having a yield strength of from about 200 MPa to about 450 MPa.

19. The alloy of claim **5** having a conductivity of from about 28% to about 49% IACS.

* * * * *