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(54) **Low-lead brass alloy**

(57) The invention relates to a low-lead brass alloy, comprising: by the total weight of the brass alloy, 62.5-63 wt% copper, 0.16-0.24 wt% lead, 0-0.02 wt% antimony, 0-0.01 wt% magnesium, 0-0.2 wt% tin, 0.0005-0.0009

wt% boron, 0.55-0.7 wt% aluminum, 0.05-0.15 wt% iron, 0-0.15 wt% nickel, 0.09-0.12 wt% arsenic, 0-0.005 wt% zirconium, 0-0.01 wt% impurities, and a balance of zinc.

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DescriptionFIELD OF INVENTION

[0001] The invention relates to a low-lead brass alloy.

BACKGROUND OF INVENTION

[0002] Copper has excellent electrical conductivity and environmental friendliness, and bacteria harmful to the human can't survive on its surface. Other elements are added into copper, so as to improve its performance. For example, the addition of lead into the brass alloy containing copper and zinc significantly improves the cutting performance of the brass. However, lead has a destructive effect on the human health and ecological balance. It is also a trend around the world that there are increasing restrictions on the application of lead-containing alloy.

[0003] In addition, the environmental problem is increasingly outstanding, and the working environment is becoming more serious. As a result, the surface strength of brass products is reduced, and the brass tube may even perforate. This greatly reduces the lifetime of brass products and causes problems in application.

[0004] Therefore, there is a need to provide an alloy formula for solving the above problems, which can replace the brass with a high lead content, is dezincification corrosion resistant, and further has excellent casting performance, forgeability, cutting performance, corrosion resistance and mechanical properties.

SUMMARY OF INVENTION

[0005] It is an object of the invention to provide a brass alloy which exhibits excellent performance like tensile strength, elongation rate, dezincification resistance and cutting performance, which is suitable for cutting processed products that require high strength, wear resistance and waterlogging resistance. The brass alloy of the invention can securely replace the alloy copper with a high lead content, and can completely meet the demands about restrictions on lead-containing products in the development of human society.

[0006] To achieve the above object, the inventors have proposed the following low-lead brass alloy.

[0007] A low-lead brass alloy (hereinafter referred to as the inventive product 1) comprises: by the total weight of the brass alloy, 62.5-63 wt% copper, 0.16-0.24 wt% lead, 0.55-0.7 wt% aluminum, and a balance of zinc.

[0008] In the inventive product 1, the content of lead is reduced to 0.24 wt% or less, the content of copper is maintained at 62.5-63 wt%, and a trace amount of aluminum is added to increase cutting performance of the brass alloy. Meanwhile, since aluminum has a higher tendency to be ionized on the surface of the alloy than zinc, and preferentially reacts with oxygen in a corrosive gas or solution to develop a dense protection film of aluminum oxide on the surface of the alloy, thus increasing corrosion resistance and dezincification resistance of the brass alloy in the severe environment. Besides, aluminum can increase cast flowability of the alloy, so that the alloy exhibits a significant improvement in strength and hardness. In order to make a better use of the above effects, the content of aluminum is 0.55-0.7 wt% by the total weight of the brass alloy.

[0009] Preferably, the inventive product 1 further comprises: one or more elements selected from the group consisting of 0-0.02 wt% antimony, 0-0.2 wt% tin, 0-0.01 wt% magnesium, and 0.09-0.12 wt% arsenic by the total weight of the brass alloy. All of these elements can to a certain degree increase cutting performance of the brass alloy. The addition of antimony and tin can significantly increase strength of the alloy, and improve its plasticity and corrosion resistance. A trace amount of arsenic can increase dezincification resistance of the alloy. However, a high content of arsenic is not favorable, since it will decrease the thermal forgeability and squeezing performance of the alloy.

[0010] More preferably, the above-mentioned inventive product further comprises one or more elements selected from the group consisting of 0.0005-0.0009 wt% boron, 0.05-0.15 wt% iron, 0-0.15 wt% nickel, and 0-0.005 wt% zirconium by the total weight of the brass alloy. Boron can increase corrosion resistance of the brass alloy, and can also prevent dezincification. Iron can enhance toughness of the brass alloy. Nickel can not only prevent the brass alloy from rusting, but also can form intermetallic compounds among metals in the alloy, which uniformly precipitate in the matrix, thus increasing wear resistance and strength of the alloy. Zirconium can help to refine grains, thus increasing casting performance of the brass alloy.

[0011] A low-lead brass alloy (hereinafter referred to as the inventive product 2) comprises: by the total weight of the brass alloy, 62.5-63 wt% copper, 0.16-0.24 wt% lead, two or more elements selected from the group consisting of 0.55-0.7 wt% aluminum, 0-0.02 wt% antimony, 0-0.2 wt% tin, and 0-0.01 wt% magnesium by the total weight of the brass alloy, and a balance of zinc. Aluminum, antimony, tin, and magnesium are added on basis of the same reasons as the inventive product 1, and are added according to actual needs.

[0012] Preferably, the inventive product 2 further comprises two or more elements selected from the group consisting of 0.09-0.12 wt% arsenic, 0.0005-0.0009 wt% boron, 0.05-0.15 wt% iron, 0-0.15 wt% nickel, and 0-0.005 wt% zirconium

by the total weight of the brass alloy. Arsenic, boron, iron, nickel, and zirconium are added on basis of the same reasons as the inventive product 1, and are added according to actual needs.

[0013] A low-lead brass alloy (hereinafter referred to as the inventive product 3) comprises: by the total weight of the brass alloy, 62.5-63 wt% copper, 0.16-0.24 wt% lead, 0-0.02 wt% antimony, 0-0.01 wt% magnesium, 0-0.2 wt% tin, 0.0005-0.0009 wt% boron, 0.55-0.7 wt% aluminum, 0.05-0.15 wt% iron, 0-0.15 wt% nickel, 0.09-0.12 wt% arsenic, 0-0.005 wt% zirconium, 0-0.01 wt% impurities, and a balance of zinc. Antimony, magnesium, tin, boron, aluminum, iron, nickel, arsenic, and zirconium are added on basis of the same reasons as the inventive product 1. In the inventive product 3, these elements are added simultaneously for the purpose of meeting needs for specific product performance.

DETAILED DESCRIPTION

[0014] The technical solutions of the invention will be described expressly by referring to embodiments thereof.

[0015] It is not intended to limit the scope of the invention to the described exemplary embodiments. The modifications and alterations to features of the invention as described herein, as well as other applications of the concept of the invention (which will occur to the skilled in the art, upon reading the present disclosure) still fall within the scope of the invention.

[0016] In the invention, the wording "or more", "or less" in the expression for describing values indicates that the expression comprises the relevant values.

[0017] The dezincification corrosion resistant performance measurement, as used herein, is performed according to AS-2345-2006 specification in the cast state, in which 12.8 g copper chloride is added into 1000C.C deionized water, and the object to be measured is placed in the resulting solution for 24 hr to measure a dezincification depth.

[0018] ⊙ indicates a dezincification depth of less than 300 μm; ○ indicates a dezincification depth between 300 μm and 400 μm; and × indicates a dezincification depth larger than 400 μm

[0019] The cutting performance measurement, as used herein, is performed in the cast state, in which the same cutting tool is adopted with the same cutting speed and feed amount. The cutting speed is 25 m/min (meter per minute), the feed amount is 0.2 mm/r (millimeter per number of cutting edge), the cutting depth is 0.5 mm, the measurement rod has a diameter of 20 mm, and C36000 alloy is taken as a reference. The relative cutting rate is derived by measuring the cutting resistance.

[0020] The relative cutting rate = cutting resistance of C36000 alloy/cutting resistance of the sample.

[0021] ⊙ indicates a relative cutting rate larger than 85%; and ○ indicates a relative cutting rate larger than 70%.

[0022] Both the tensile strength measurement and the elongation rate measurement, as used herein, are performed in the cast state at room temperature as an elongation measurement. The elongation rate refers to a ratio between the total deformation of gauge section after elongation ΔL and the initial gauge length L of the sample in percentage: $\delta = \Delta L / L \times 100\%$. The reference sample is a lead-containing brass with the same state and specification, i.e., C36000 alloy.

[0023] As used herein, the performance for elements in alloy to dissolve in water is tested in accordance with GB/T5750-2006 "Standard examination methods for drinking water" and is judged in accordance with GB5749-2006 "Standards for drinking water quality".

[0024] According to measurement, the proportions for constituents of C36000 alloy mentioned above are listed as follow, in the unit of weight percentage (wt%):

Material No.	copper (Cu)	zinc (Zn)	bismuth (Bi)	antimony (Sb)	manganese (Mn)	aluminum (Al)	tin (Sn)	lead (Pb)	iron (Fe)
C36000 alloy	60.53	36.26	0	0	0	0	0.12	2.97	0.12

Embodiment

[0025] Table 1 lists 15 different constituents for the low-lead brass alloy, each constituent being in the unit of weight percentage (wt%).

Table 1

No.	copper (Cu)	zinc (Zn)	lead (Pb)	magnesium (Mg)	aluminum (Al)	antimony (Sb)	tin (Sn)	boron (B)	iron (Fe)	nickel (Ni)	arsenic (As)	zirconium (Zr)
1	63.000	36.233	0.215	--	0.550	--	--	--	--	--	--	--
2	62.542	36.578	0.240	--	0.638	--	--	--	--	--	--	--
3	62.500	36.638	0.160	--	0.700	--	--	--	--	--	--	--
4	62.511	36.648	0.168	0.010	0.551	0.020	--	--	--	--	0.090	--
5	62.780	36.136	0.179	0.009	0.589	--	0.200	--	--	--	0.105	--
6	62.993	35.967	0.200	--	0.688	--	0.150	--	--	--	--	--
7	62.567	36.541	0.161	--	0.560	--	--	0.0005	0.050	--	0.120	--
8	62.874	36.123	0.187	0.007	0.653	--	--	--	--	0.150	--	0.004
9	63.000	36.116	0.192	--	0.670	0.015	--	--	--	--	--	0.005
10	62.510	36.416	0.167	--	0.689	0.018	0.198	--	--	--	--	--
11	62.913	36.860	0.198	0.008	--	0.019	--	--	--	--	--	--
12	62.780	36.250	0.201	0.009	0.580	--	0.178	--	--	--	--	--
13	62.500	36.541	0.200	--	0.663	0.017	--	0.0007	0.076	--	--	--
14	62.831	35.987	0.212	0.010	0.578	--	0.132	--	--	0.132	0.112	0.004
15	62.670	35.845	0.198	0.008	0.674	0.017	0.188	0.0009	0.150	0.143	0.101	0.003

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[0026] Measurements about cutting performance, dezincification corrosion resistant performance, tensile strength, and elongation rate are performed on alloys with the above constituents in the cast state at room temperature, and the reference sample is a lead-containing brass with the same state and specification, i.e., C36000 alloy.

[0027] Results of the measurements about tensile strength, elongation rate, cutting performance, and dezincification corrosion resistant performance are listed as follow:

No.	TENSILE STRENGTH (N/mm ²)	ELONGATION RATE (%)	DEZINCIFICATION LAYER	RELATIVE CUTTING RATE
1	298	10	⊙	○
2	301	10	⊙	⊙
3	308	10	⊙	⊙
4	305	11	⊙	⊙
5	310	11	⊙	⊙
6	315	12	⊙	⊙
7	311	12	⊙	⊙
8	317	12	⊙	⊙
9	320	11	⊙	⊙
10	310	11	⊙	⊙
11	300	10	⊙	⊙
12	307	11	⊙	⊙
13	317	12	⊙	⊙
14	335	13	⊙	⊙
15	326	13	⊙	⊙
C36000 alloy	394	9	×	⊙

[0028] The performance for constituents in alloy to dissolve in water is tested, and the measurement results are listed as follow (in the unit of mg/L):

No.	copper (Cu)	zinc (Zn)	lead (Pb)	aluminum (Al)	antimony (Sb)	boron (B)	iron (Fe)	nickel (Ni)	arsenic (As)
1	<1.0	<1.0	<0.01	<0.2	<0.005	<0.5	<0.3	<0.02	<0.01
2	<1.0	<1.0	<0.01	<0.2	<0.005	<0.5	<0.3	<0.02	<0.01
3	<1.0	<1.0	<0.01	<0.2	<0.005	<0.5	<0.3	<0.02	<0.01
4	<1.0	<1.0	<0.01	<0.2	<0.005	<0.5	<0.3	<0.02	<0.01
5	<1.0	<1.0	<0.01	<0.2	<0.005	<0.5	<0.3	<0.02	<0.01
6	<1.0	<1.0	<0.01	<0.2	<0.005	<0.5	<0.3	<0.02	<0.01
7	<1.0	<1.0	<0.01	<0.2	<0.005	<0.5	<0.3	<0.02	<0.01
8	<1.0	<1.0	<0.01	<0.2	<0.005	<0.5	<0.3	<0.02	<0.01
9	<1.0	<1.0	<0.01	<0.2	<0.005	<0.5	<0.3	<0.02	<0.01
10	<1.0	<1.0	<0.01	<0.2	<0.005	<0.5	<0.3	<0.02	<0.01
11	<1.0	<1.0	<0.01	<0.2	<0.005	<0.5	<0.3	<0.02	<0.01
12	<1.0	<1.0	<0.01	<0.2	<0.005	<0.5	<0.3	<0.02	<0.01
13	<1.0	<1.0	<0.01	<0.2	<0.005	<0.5	<0.3	<0.02	<0.01

(continued)

No.	copper (Cu)	zinc (Zn)	lead (Pb)	aluminum (Al)	antimony (Sb)	boron (B)	iron (Fe)	nickel (Ni)	arsenic (As)
14	<1.0	<1.0	<0.01	<0.2	<0.005	<0.5	<0.3	<0.02	<0.01
15	<1.0	<1.0	<0.01	<0.2	<0.005	<0.5	<0.3	<0.02	<0.01

[0029] Although the invention has been described with respect to embodiments thereof, these embodiments do not intend to limit the invention. The ordinary skilled in the art can made modifications and changes to the invention without departing from the spirit and scope of the invention. Thus, the protection of the invention is defined by the appended claims.

Claims

1. A low-lead brass alloy, **characterized by** comprising: by the total weight of the brass alloy, 62.5-63 wt% copper, 0.16-0.24 wt% lead, 0.55-0.7 wt% aluminum, and a balance of zinc.
2. A low-lead brass alloy of claim 1, **characterized by** further comprising: one or more elements selected from the group consisting of 0-0.02 wt% antimony, 0-0.2 wt% tin, 0-0.01 wt% magnesium, and 0.09-0.12 wt% arsenic by the total weight of the brass alloy.
3. A low-lead brass alloy of claim 2, **characterized by** further comprising: one or more elements selected from the group consisting of 0.0005-0.0009 wt% boron, 0.05-0.15 wt% iron, 0-0.15 wt% nickel, and 0-0.005 wt% zirconium by the total weight of the brass alloy.
4. A low-lead brass alloy, **characterized by** comprising: by the total weight of the brass alloy, 62.5-63 wt% copper, 0.16-0.24 wt% lead, two or more elements selected from the group consisting of 0.55-0.7 wt% aluminum, 0-0.02 wt% antimony, 0-0.2 wt% tin, and 0-0.01 wt% magnesium by the total weight of the brass alloy, and a balance of zinc.
5. A low-lead brass alloy of claim 4, **characterized by** further comprising: two or more elements selected from the group consisting of 0.09-0.12 wt% arsenic, 0.0005-0.0009 wt% boron, 0.05-0.15 wt% iron, 0-0.15 wt% nickel, and 0-0.005 wt% zirconium by the total weight of the brass alloy.
6. A low-lead brass alloy, **characterized by** comprising: by the total weight of the brass alloy, 62.5-63 wt% copper, 0.16-0.24 wt% lead, 0-0.02 wt% antimony, 0-0.01 wt% magnesium, 0-0.2 wt% tin, 0.0005-0.0009 wt% boron, 0.55-0.7 wt% aluminum, 0.05-0.15 wt% iron, 0-0.15 wt% nickel, 0.09-0.12 wt% arsenic, 0-0.005 wt% zirconium, 0-0.01 wt% impurities, and a balance of zinc.



EUROPEAN SEARCH REPORT

Application Number
EP 14 17 6783

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	CN 101 988 164 A (MODERN ISLAND CO LTD) 23 March 2011 (2011-03-23)	1-5	INV. C22C9/04
A	* example 3; tables 1-2 * -----	6	
A	CN 101 440 445 A (LUDA XIAMEN INDUSTRY CO LTD [CN]) 27 May 2009 (2009-05-27) * tables 1-5 *	1-6	
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The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
			C22C
Place of search		Date of completion of the search	Examiner
Munich		24 November 2015	Liu, Yonghe
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

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24-11-2015

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