Homogeneous low melting temperatures brazing filler metal for joining ferrous and non-ferrous alloys.

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Homogeneous low melting temperatures brazing filler metal for joining ferrous and non-ferrous alloys.

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DE-A-1 558 467
DE-C- 402 614
DE-C- 660 679
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JP-A- 165 590
JP-A- 165 591
US-A-4 182 628
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Description

1. Field of invention

This invention relates to copper-base alloys and, more particularly, to homogeneous, ductile brazing filler metal alloys useful for joining steels, cemented carbides to steels, copper to steels, copper to copper and copper alloys, and composite materials to steels and copper.

2. Description of prior art

Three basic types of filler metals are conventionally used to join ferrous and non-ferrous alloys. According to specifications for brazing filler metals published in 1976 by the American Welding Society, these three major groups are classified as follows:

1. BAg classifications—Filler metals having this classification are used mainly for brazing carbon and low alloyed steel. These alloys have good wetting characteristics and braze steels well at relatively low temperatures, thereby minimizing grain growth in steel during brazing. These alloys do not contain phosphorous and, therefore, brazed joints exhibit good ductility because of the absence of brittle phosphides. However, serious disadvantages exist in the applications; namely, they usually contain substantial amounts of toxic cadmium and precious silver.

2. BC classifications—Filler metals having this classification are used mainly in furnace brazing in controlled atmospheres at temperatures exceeding 1000°C (1850°F). This group consists of alloys which have compositions with copper concentration exceeding 99%. Obviously these alloys cannot be used at low temperatures or under open atmospheric conditions.

3. RBCuZn classifications—Filler metals having this classification are used primarily at brazing temperatures exceeding 925 to 950°C (1700 to 1740°F). In ferrous brazing applications the major disadvantage of the last two classifications is a high brazing temperature. It is well known that such high temperature exposure causes austenite grain growth leading to the appearance of retained austenite which, in turn, results in increased warpage and other deleterious effects. Attempts have been made to develop new alloy alternatives to the BA9 alloys. These new alloy alternatives are based on a copper-manganese system which has a few low melting eutectic compositions. Modified copper-manganese alloys contain small amounts of various elements used as melting temperature depressants and/or strengthening agents.

British Pat. No. 996,177 published on June 23, 1965, describes a nickel-copper-manganese alloy containing small amounts of boron and germanium as temperature depressants in addition to iron and silicon. All alloys disclosed therein have melting temperatures well above 875°C (1575°F).

U.S. Pat. No. 4,071,538 describes a copper base brazing alloy containing manganese, nickel, tin and indium. The brazing temperature for this alloy is in the range of 1000—1050°C (1836—1923°F) which is much higher than temperatures acceptable for ferrous and copper brazing.

U.S. Pat. No. 4,357,299 describes a copper-base brazing alloy containing substantial amounts of manganese with small additions of nickel, iron, indium and tin which is suitable for brazing cemented carbide to steel. All of the alloys disclosed therein, have melting temperatures higher than 820°C. No mention is made therein concerning brazing of materials other than SAE 4340 steel-cemented carbide.

Japanese Kokai Patent Publications No. 165590 and No. 165591 describe copper-manganese-base alloys used as brazing filler materials at brazing temperature well above 900°C. Those alloys, in addition to copper and manganese, contain at least one of zinc, nickel, iron and cobalt, together with silver, aluminum, indium and rare earth elements. No data concerning mechanical properties of joints brazed with these materials is disclosed therein and the alloys are claimed to have utility in joining cemented carbide tool tips to their steel holders.

The GB—A—746 451, the DE—C—402 614 and the US—A—1 840 921 disclose copper-base alloys which contain manganese and silicon. The alloys according to the DE—C—402 614 and the US—A—1 840 921 are used as welding rods.

Each of the aforementioned patents teaches fabrication of the brazing filler metal by conventional processes which comprise the steps of melting, ingot casting and subsequent multiple stage deformation. The microstructures of these alloys are heterogeneous, resulting in relatively coarse joint microstructure.

Summary and objects of the invention

The present invention provides a low melting temperature copper based alloy composition adapted for brazing steels, cemented carbides to steels, copper and copper alloys to steels, copper to copper and copper alloys, and composite materials to steels and copper. Generally stated, the alloy is produced by quenching the melt on a chilled surface at a rate of at least 10⁶°C/sec and has a composition which consists of 4 to 16 atomic percent manganese, 4 to 16 atomic percent silicon, 0 to 16 atomic percent tin, 0 to 20 atomic percent zinc, 0 to 10 atomic percent silver and 0 to 10 atomic percent indium the balance being copper and incidental impurities. Preferably, the alloy has a metastable structure. A metastable structure refers to a state of pseudoequilibrium that has a higher free energy than the true equilibrium state. The
pseudo-equilibrium structure usually transforms to the equilibrium state by thermally activated processes. In the present case, the as-quenched rapidly solidified alloys have a crystal structure of β-bronze which exists at high temperatures in many copper base alloys. The β-bronze structure transforms into the stable structure consisting of a copper base γ-matrix containing manganese silicide precipitates and other minor phases. The major advantage of the metastable state is the compositional homogeneity of this copper matrix with larger amounts of dissolved alloying elements like manganese, silicon, tin, silver, indium and the like. This chemical homogeneity, in turn, imparts uniform melting during brazing and results in a finer microstructure of this brazed joint. A finer microstructure offers superior joint properties.

In addition, the invention provides a homogeneous, ductile brazing foil having a composition and produced as above. Preferably, the brazing foil of this invention is at least partially metastable and consists of 10 to 12 atomic percent manganese, 10 to 12 atomic percent silicon, 3 to 5 atomic percent tin, 4 to 10 atomic percent zinc, 2 to 5 atomic percent silver, 1 to 5 atomic percent indium and 70 to 51 atomic percent copper.

It has been found that the addition of tin, indium and silver to the copper, manganese and silicon admixture markedly decreases melting temperature of alloys. As a result, alloys produced in accordance with the present invention have melting points as low as 640°C.

It has also been found that the addition of tin, indium, silver and zinc enhances wetting and flowability of the alloys on copper and iron base materials.

The homogeneous brazing foil of the invention is fabricated by a process which comprises the steps of forming a melt of the composition and rapidly solidifying the melt on a rotating quench wheel at a rate of at least 10^6 °C/sec.

The filler metal foil is easy to manufacture by this process as homogeneous, ductile ribbon, which is useful for brazing as cast. The metal foil based on the compositions of this invention can be stamped into complex shapes to furnish base preforms. Advantageously, the homogeneous, ductile brazing foil of the invention can be placed inside the joint prior to the brazing operation. The use of the homogeneous, ductile foil provided by the invention also permits production of joints having uniform fine microstructure, thereby achieving good joint mechanical properties. Further, the use of homogeneous, ductile foil in preform shape permits brazing to be accomplished by processes such as dip brazing in molten salts, which are not readily accomplished with powder or rod-type fillers. In addition to foil form, these alloys can also be produced in powder form by grinding the rapidly solidified foil. Powder, produced by rapid solidification, has a similar compositional homogeneity and lower oxide content.

Detailed description of the invention

The homogeneous metastable alloys of the invention are formed by cooling a melt of the desired composition at a rate of at least 10^6 °C/sec. A variety of rapid quenching techniques, well known to the amorphous metal alloy art, are available for producing homogenized metastable metal powders, wires, ribbons and sheets. Typically, a particular composition is selected, powders or granules of the required elements in the desired proportions are melted and homogenized, and the molten alloy is rapidly quenched on a rapidly rotating cylinder.

Copper based brazing alloys have been fabricated by processes such as those described above. Following are criteria which the brazing filler metal must satisfy.

Melting temperature should be as low as possible. At the same time, the filler metal must wet and braze base materials well. The filler metal must provide sufficient strength to the joint to meet service requirements of the brazed unit. Essentially, the filler metal composition must contain elements which are compatible with the materials of the brazed parts. That is, there will be no excessive erosion or dissolution of the base materials during brazing, no formation of brittle phases upon solidification and an absence of preferable corrosion in the brazed joint during service. To provide better joint mechanical properties the brazing foil should be homogeneous and should contain no binder or other materials that would otherwise form voids or contaminating residues during brazing. It is also desirable that the brazing material must be in ductile foil form to permit stamping of complex shapes therefrom.

Alloys with the compositions according to the invention are compatible with ferrous and copper base alloys as well as cemented carbides and composite materials containing free graphite.

By homogeneous is meant that the foil, as produced, is of substantially uniform composition in all dimensions. By ductile is meant that foil may be bent to a round radius as small as ten times the foil thickness without fracture.

Examples of brazing alloy compositions within the scope of the invention are given in Table I.
### TABLE I
Nominal composition, atomic %

<table>
<thead>
<tr>
<th>#</th>
<th>Alloy</th>
<th>Cu</th>
<th>Ag</th>
<th>In</th>
<th>Mn</th>
<th>Si</th>
<th>Zn</th>
<th>Sn</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>1C</td>
<td>69.8</td>
<td>—</td>
<td>—</td>
<td>15.1</td>
<td>15.1</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>3</td>
<td>3C-8</td>
<td>59</td>
<td>—</td>
<td>—</td>
<td>14.5</td>
<td>14.5</td>
<td>—</td>
<td>12</td>
</tr>
<tr>
<td>7</td>
<td>3G</td>
<td>59</td>
<td>—</td>
<td>—</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>8</td>
<td>6G</td>
<td>68</td>
<td>—</td>
<td>—</td>
<td>7</td>
<td>12</td>
<td>5</td>
<td>8</td>
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<tr>
<td>2</td>
<td>6H</td>
<td>71</td>
<td>5</td>
<td>—</td>
<td>12</td>
<td>12</td>
<td>—</td>
<td>—</td>
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<tr>
<td>4</td>
<td>1H</td>
<td>60</td>
<td>—</td>
<td>—</td>
<td>12</td>
<td>12</td>
<td>—</td>
<td>16</td>
</tr>
<tr>
<td>5</td>
<td>10H</td>
<td>59</td>
<td>5</td>
<td>—</td>
<td>12</td>
<td>12</td>
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<td>12</td>
</tr>
<tr>
<td>6</td>
<td>9H</td>
<td>56</td>
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<td>—</td>
<td>12</td>
<td>12</td>
<td>15</td>
<td>—</td>
</tr>
<tr>
<td>9</td>
<td>20H</td>
<td>63</td>
<td>5</td>
<td>—</td>
<td>10</td>
<td>10</td>
<td>—</td>
<td>12</td>
</tr>
<tr>
<td>10</td>
<td>2H</td>
<td>58</td>
<td>2</td>
<td>—</td>
<td>12</td>
<td>12</td>
<td>8</td>
<td>8</td>
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<tr>
<td>11</td>
<td>8G (7H)</td>
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<td>5</td>
<td>—</td>
<td>12</td>
<td>12</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>12</td>
<td>4H</td>
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<td>—</td>
<td>16</td>
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<td>4</td>
<td>4</td>
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<td>14</td>
<td>H12</td>
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<td>4</td>
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<tr>
<td>16</td>
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<td>17</td>
<td>8G-14</td>
<td>64</td>
<td>3</td>
<td>1</td>
<td>12</td>
<td>12</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>18</td>
<td>8G-27</td>
<td>63</td>
<td>—</td>
<td>5</td>
<td>12</td>
<td>12</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

### TABLE I (continued)
Nominal composition, atomic %

<table>
<thead>
<tr>
<th>#</th>
<th>Solidus °C</th>
<th>Liquidus °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>754</td>
<td>803</td>
</tr>
<tr>
<td>3</td>
<td>660</td>
<td>700</td>
</tr>
<tr>
<td>7</td>
<td>670</td>
<td>720</td>
</tr>
<tr>
<td>8</td>
<td>665</td>
<td>720</td>
</tr>
<tr>
<td>2</td>
<td>678</td>
<td>786</td>
</tr>
<tr>
<td>4</td>
<td>585</td>
<td>732</td>
</tr>
<tr>
<td>5</td>
<td>531</td>
<td>855</td>
</tr>
<tr>
<td>6</td>
<td>642</td>
<td>784</td>
</tr>
<tr>
<td>9</td>
<td>550</td>
<td>675</td>
</tr>
<tr>
<td>10</td>
<td>626</td>
<td>709</td>
</tr>
<tr>
<td>11</td>
<td>625</td>
<td>725</td>
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<tr>
<td>12</td>
<td>625</td>
<td>725</td>
</tr>
<tr>
<td>14</td>
<td>626</td>
<td>709</td>
</tr>
<tr>
<td>15</td>
<td>625</td>
<td>705</td>
</tr>
<tr>
<td>13</td>
<td>625</td>
<td>701</td>
</tr>
<tr>
<td>14</td>
<td>700</td>
<td>918</td>
</tr>
<tr>
<td>15</td>
<td>697</td>
<td>755</td>
</tr>
<tr>
<td>16</td>
<td>600</td>
<td>778</td>
</tr>
<tr>
<td>17</td>
<td>619</td>
<td>747</td>
</tr>
<tr>
<td>18</td>
<td>600</td>
<td>710</td>
</tr>
</tbody>
</table>

Within the broad composition range disclosed above, there is a preferred composition range that is
compatible with and permits brazing of steels, copper and copper alloys to steels, copper to copper and
copper alloys, and composite materials to steels and copper. Such preferred compositions are exceedingly
ductile, have good wettability, produce strong joints and consist essentially of 10 to 12 atomic percent
manganese, 10 to 12 atomic percent silicon, 3 to 5 atomic percent tin, 4 to 10 atomic percent zinc, 2 to 5
atomic percent silver, 1 to 5 atomic percent indium and 51 to 70 atomic percent copper.

Three specially preferred alloys of the present invention have the following compositions: (1) about 5
atomic percent silver, about 12 atomic percent manganese, about 12 atomic percent silicon, about 4 atomic
percent zinc, about 4 atomic percent tin, the balance being copper and incidental impurities. (2) about 3
atomic percent silver, about 1 atomic percent indium, about 12 atomic percent manganese, about 12
atomic percent silicon, about 4 atomic percent zinc, about 4 atomic percent tin the balance being copper
and incidental impurities; and (3) about 5 atomic percent of indium, about 12 atomic percent manganese,
about 12 atomic percent silicon, about 4 atomic percent zinc, about 4 atomic percent tin, the balance being copper and incidental impurities. The brazing foils of this invention are prepared from the melt in the same manner as glassy metal foils. Under these conditions, a metastable, homogeneous, microcrystalline ductile material having a grain size smaller than 0.5 micrometer is obtained.

Foils as produced by the process described above are 30–200 μm thick. Foils thicker than 200 μm can also be fabricated by lamination and other compaction techniques.

Example I

Ribbons 5 to 25.5 mm wide and about 30 to 200 μm thick were formed by squirting a melt of the particular composition by over-pressure of argon onto a rapidly rotating copper chill wheel (surface speed 914 to 1829 m/min). Metastable homogeneous alloy ribbons were produced and the compositions of the ribbons are shown in Table I. In Table I are shown the liquidus and solidus temperatures, \( T_L \) and \( T_S \) of the alloys which were determined by Differential Thermal Analysis (DTA) technique.

Example II

Lap shear test specimens were prepared according to the AWS C3.2 "Standard Method for Evaluating the Strength of Brazed Joints". Low carbon 1030SAE steel plates, 3.175 mm thick were used as the base metal. Ribbons of the selected compositions (atom fraction)

\[
\begin{align*}
Cu_{63}Ag_{05}Mn_{12}Si_{12}Zn_{04}Sn_{04} \\
Cu_{64}Ag_{02}Mn_{01}Mn_{12}Si_{12}Zn_{04}Sn_{04} \\
Cu_{62}Ag_{06}Mn_{12}Si_{12}Zn_{04}Sn_{04}
\end{align*}
\]

having dimensions of about 100 μm thick and about 12.5 mm wide were used as the filler metals. Plates of the base metal and filler ribbons were degreased and rinsed according to conventional procedures. The mating surfaces of the plates and brazing ribbons were coated by a standard flux produced by Handy and Harman. Lap joints, with the overlap dimension of about 6.25 mm containing the selected brazing ribbons of the invention were then assembled in a special way with ribs covering the entire area of the overlap. Specimens were then clamped and torch brazed using oxyacetylene flame. Similar samples were also induction brazed. Brazed samples were then air cooled to room temperature and the flux residue was removed by boiling samples in water. Afterward the tensile specimens were milled out of brazed plates.

For comparative purposes identical joints were produced under identical conditions using standard 75 μm (0.005 μm) BAg-1 ribbon. The nominal composition (atomic percent) of BAg-1 alloy according certificate of its producer, Handy and Harman Co. is Ag-37.53, Cu-21.24, Zn-22.02 and Cd-19.21. Afterwards the mechanical tests were done on both types of brazed samples. Mechanical properties of brazed joints are shown in Table II.

<table>
<thead>
<tr>
<th>Filler alloy</th>
<th>Filler alloy composition (atom %)</th>
<th>Shear strength (MPa psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8G</td>
<td>Cu_{63}Ag_{05}Mn_{12}Si_{12}Zn_{04}Sn_{04}</td>
<td>124 (17,980)</td>
</tr>
<tr>
<td>8G-2</td>
<td>Cu_{65}Ag_{05}Mn_{12}Si_{12}Zn_{04}Sn_{04}</td>
<td>115 (16,675)</td>
</tr>
<tr>
<td>8G-14</td>
<td>Cu_{64}Ag_{02}Mn_{12}Si_{12}Zn_{04}Sn_{04}</td>
<td>121 (17,545)</td>
</tr>
<tr>
<td>BAg-1</td>
<td>Cu_{21.8}Ag_{037.5}Zn_{18.9}Cd_{18.9}</td>
<td>135 (19,975)</td>
</tr>
</tbody>
</table>

Example III

Shear test samples were prepared by brazing a low carbon 1010SAE steel plate with a high friction material. This high friction material, comprised of (wt. %) about 15 percent graphite, about 20 percent copper, about 5 percent tin, the balance being iron, is made by means of powder metallurgy and is used as pads for heavy duty truck brakes. Plates of the base metal, filler ribbons and pads were degreased and rinsed according to conventional procedures. The mating surfaces of the plates, brazing ribbon were coated by standard B-1 or H.F. fluxes produced by Handy and Harman. A pad having a 3×2 inches mating surface was positioned on a larger plate with brazing ribbon covering the entire area of contact. Samples were then brazed using induction heating provided by a flat inductor. Three materials, namely

8G-14 (Cu_{64}Ag_{02}Mn_{12}Si_{12}Zn_{04}Sn_{04})
8G (Cu_{63}Ag_{06}Mn_{12}Si_{12}Zn_{04}Sn_{04})
8G-2 (Cu_{66}Ag_{06}Mn_{12}Si_{12}Zn_{04}Sn_{04})

were used as brazing filler metals in the cast ribbon shape of about 1.5 mils (37 μm) thickness. Two ribbons
were replaced in the brazing gap forming about 3 mils filler. For comparative purposes identical joints were produced under identical conditions using standard 125 μm (5 mils) Easy Flo 45 brazing filler alloy which contains 45 wt. % of silver, only one ribbon was placed in the brazing gap. After brazing, the brazements were cleaned up and the shear strength of joints was determined.

Table III shows peak load before joint fracture and the place where the failure occurred.

<table>
<thead>
<tr>
<th>Filler alloy</th>
<th>Filler alloy composition (at. %)</th>
<th>Peak load, lbs.</th>
<th>Failure location</th>
</tr>
</thead>
<tbody>
<tr>
<td>8G-14</td>
<td>Cu₄₆Ag₃In₉Mn₁₂Si₁₂Zn₁₂Sn₄</td>
<td>12,000</td>
<td>Friction material</td>
</tr>
<tr>
<td>8G</td>
<td>Cu₄₆Ag₃In₉Mn₁₂Si₁₂Zn₁₂Sn₄</td>
<td>11,000</td>
<td>Friction material</td>
</tr>
<tr>
<td>8G-2</td>
<td>Cu₄₆Ag₃In₉Mn₁₂Si₁₂Zn₁₂Sn₄</td>
<td>9,600</td>
<td>Friction material</td>
</tr>
<tr>
<td>Easy Flo 45</td>
<td>Cu₂₅Ag₃₇Zn₂₁Cd₁₈₉</td>
<td>8,200</td>
<td>Friction material</td>
</tr>
</tbody>
</table>

Example IV

Lap shear test specimens were prepared according to the AWS C3.2 “Standard Method for Evaluating the Strength of Brazed Joints”. Low carbon 1030 SAE steel and tough pitch copper plates, 3.175 mm (0.125”) thick were used as metals subjected to brazing. Ribbons of the selected compositions (atom fraction)

\[
\begin{align*}
\text{Cu}_{46}\text{Ag}_{3}\text{In}_{9}\text{Mn}_{12}\text{Si}_{12}\text{Zn}_{12}\text{Sn}_{4} \quad (#8G-2), \\
\text{Cu}_{46}\text{Ag}_{3}\text{In}_{9}\text{Mn}_{12}\text{Si}_{12}\text{Zn}_{12}\text{Sn}_{4} \quad (#8G-14) \quad \text{and} \\
\text{Cu}_{46}\text{Ag}_{3}\text{In}_{9}\text{Mn}_{12}\text{Si}_{12}\text{Zn}_{12}\text{Sn}_{4} \quad (#8G)
\end{align*}
\]

having dimensions about 75 μm (3 mils) thick and about 12.5 mm wide were used as the filler metals. Plates of the base metals and filler ribbons were degreased and rinsed according to conventional procedures. The mating surfaces of the plates and brazing ribbons of the invention were then assembled in a special way with ribbons covering the entire area of the overlap. Specimens were then clamped and torch brazed using oxyacetylene flame. Brazed samples were then air cooled to room temperature and the flux residue was removed by boiling samples in water. Afterwards the tensile samples were milled out of brazed plates.

For comparative purposes identical joints were produced under identical conditions using standard 75 μm (3 mils) BAg-1 ribbons. The nominal compositions (atomic percent) of BAg-1 alloy according certificate of its producer, Handy and Harman Co. is Ag-37.53, Cu-21.24, Zn-22.02 and Cd-19.01. Mechanical properties of brazed joints are shown in Table IV.

Table IV

Shear strength of torch flux brazed joints comprised of 1030 SAE/copper plates (Standard AWS C3.2 test procedure)

<table>
<thead>
<tr>
<th>Filler alloy</th>
<th>Filler alloy composition (at. %)</th>
<th>Shear strength MPa (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8G</td>
<td>Cu₄₆Ag₃In₉Mn₁₂Si₁₂Zn₁₂Sn₄</td>
<td>98 (14,210)</td>
</tr>
<tr>
<td>8G-2</td>
<td>Cu₄₆Ag₃In₉Mn₁₂Si₁₂Zn₁₂Sn₄</td>
<td>88 (12,760)</td>
</tr>
<tr>
<td>8G-14</td>
<td>Cu₄₆Ag₃In₉Mn₁₂Si₁₂Zn₁₂Sn₄</td>
<td>92 (13,340)</td>
</tr>
<tr>
<td>BAg-1</td>
<td>Cu₂₅Ag₃₇Zn₂₁Cd₁₈₉</td>
<td>106 (15,370)</td>
</tr>
</tbody>
</table>

Claims

1. A metal alloy produced by quenching the melt on a chilled surface at a rate of at least 10⁶ °C/sec and having a composition consisting of 4 to 16 atom percent manganese, 4 to 16 atom percent silicon, 0 to 16 atom percent tin, 0 to 20 atom percent zinc, 0 to 10 atom percent silver and 0 to 10 atom percent indium, the balance being copper and incidental impurities.
2. A metal alloy composition as recited in Claim 1, wherein said composition is in the form of a foil.
3. A metal alloy composition as recited in Claim 2, wherein said foil is ductile.
4. A metal alloy composition as recited in Claim 2, wherein said foil has a metastable structure.
5. A metal alloy composition as recited in Claim 4, wherein said structure is homogeneous.
6. A metal alloy composition as recited in Claim 1, wherein said composition is in the form of a powder.
7. A metal alloy composition as recited in Claim 1, having a composition consisting of 10 to 12 atom
percent manganese, 10 to 12 atom percent silicon, 3 to 5 atom percent tin, 4 to 10 atom percent zinc, 2 to 5 atom percent silver, 1 to 5 atom percent indium, 51 to 70 atom percent copper and incidental impurities.

A homogeneous, ductile brazing foils produced by quenching the melt on a chilled surface at a rate of at least 10⁻⁹ °C/sec and having a composition consisting of 4 to 16 atom percent manganese, 4 to 16 atom percent silicon, 0 to 16 atom percent tin, 0 to 20 atom percent zinc, 0 to 10 atom percent silver and 0 to 10 atom percent indium, the balance being copper and incidental impurities.

A process for fabricating homogeneous ductile foils having a composition consisting of 4 to 16 atom percent manganese, 4 to 16 atom percent silicon, 0 to 16 atom percent tin, 0 to 20 atom percent zinc, 0 to 10 atom percent silver and 0 to 10 atom percent indium, the balance being copper and incidental impurities, which process comprises forming a melt of the composition and quenching the melt on a rotating chill block at a rate of at least about 10³ °C/sec.

A process for joining together two or more metal parts which comprises:

a) interposing a filler metal between the metal parts to form an assembly, the filler metal having a melting point less than that of any of the parts;

b) heating the assembly to at least the melting temperature of the filler metal; and

c) cooling the assembly; wherein the improvement comprises employing, as the filler metal, a homogeneous, ductile copper based foil according to Claim 8.

Patentansprüche

1. Metallierung, die durch Abschrecken der Schmelze auf einer gekühlten Oberfläche mit einer Geschwindigkeit von wenigstens 10⁻⁹ °C/sec hergestellt wurde und eine Zusammensetzung hat, die aus 4 bis 16 Atom-% Mangan, 4 bis 16 Atom-% Silicium, 0 bis 16 Atom-% Zinn, 0 bis 20 Atom-% Zink, 0 bis 10 Atom-% Silber und 0 bis 10 Atom-% Indium besteht, wobei der Rest aus Kupfer und gelegentlichen Verunreinigungen besteht.

2. Metallierungszusammensetzung nach Anspruch 1, bei der die Zusammensetzung in der Form einer Folie vorliegt.

3. Metallierungszusammensetzung nach Anspruch 2, bei der die Folie duktil ist.

4. Metallierungszusammensetzung nach Anspruch 2, bei der die Folie eine metastabile Struktur hat.

5. Metallierungszusammensetzung nach Anspruch 4, bei der die Struktur homogen ist.

6. Metallierungszusammensetzung nach Anspruch 1, bei der die Zusammensetzung in der Form eines Pulvers vorliegt.

7. Metallierungszusammensetzung nach Anspruch 1 mit einer Zusammensetzung, die aus 10 bis 12 Atom-% Mangan, 10 bis 12 Atom-% Silicium, 3 bis 5 Atom-% Zinn, 4 bis 10 Atom-% Zink, 2 bis 5 Atom-% Silber, 1 bis 5 Atom-% Indium, 51 bis 70 Atom-% Kupfer und gelegentlichen Verunreinigungen besteht.

8. Homogene, duktile Lötfolie, die durch Abschrecken der Schmelze auf einer gekühlten Oberfläche mit einer Geschwindigkeit von wenigstens 10⁻³ °C/sec hergestellt wurde und eine Zusammensetzung hat, die aus 4 bis 16 Atom-% Mangan, 4 bis 16 Atom-% Silicium, 0 bis 16 Atom-% Zinn, 0 bis 20 Atom-% Zink, 0 bis 10 Atom-% Silber und 0 bis 10 Atom-% Indium besteht, wobei der Rest aus Kupfer und gelegentlichen Verunreinigungen besteht.

9. Verfahren zur Herstellung einer homogenen duktilen Folie mit einer Zusammensetzung, die aus 4 bis 16 Atom-% Mangan, 4 bis 16 Atom-% Silicium, 0 bis 16 Atom-% Zinn, 0 bis 20 Atom-% Zink, 0 bis 10 Atom-% Silber und 0 bis 10 Atom-% Indium besteht, indem man einen Schmelze der Zusammensetzung bildet und die Schmelze auf einem rotierenden Kühlblock mit einer Geschwindigkeit von wenigstens etwa 10⁻³ °C/sec abschreckt.

10. Verfahren zum Verbinden zweier oder mehrerer Metallteile miteinander, bei dem man

a) einen Zusatzmetall zwischen den Metallteilen unter Bildung eines Zusammenschaltbaues anordnet, wobei das Zusatzmetall einen geringeren Schmelzpunkt als jenen eines der Teile besitzt,

b) den Zusammenschaltbaue wenigstens auf die Schmelztemperatur des Zusatzmetalles erhitzt und
c) den Zusammenbau kühlt, wobei die Verbesserung in einer Verwendung einer homogenen duktilen Folie auf Kupferbasis nach Anspruch 8 als das Zusatzmetall besteht.

Revidenations

1. Alliage métallique produit par trempe de la masse fonduée sur une surface refroidie à une vitesse d'au moins 10⁻⁶ °C/s et composé de 4 à 16% en masse atomique de manganèse, 4 à 16% en masse atomique de silicium, 0 à 16% en masse atomique d'étain, 0 à 20% en masse atomique de zinc, 0 à 10% en masse atomique d'argent et 0 à 10% en masse atomique d'indium, le reste étant de cuivre et d'éventuelles impuretés.

2. Composition d'alliage métallique selon la revendication 1, caractérisée en ce que ladite composition est sous la forme d'une feuille.

3. Composition d'alliage métallique selon la revendication 2, caractérisée en ce que cette feuille est ductile.

4. Composition d'alliage métallique selon la revendication 2, caractérisée en ce que cette feuille présente une structure métastable.
5. Composition d’alliage métallique selon la revendication 4, caractérisée en ce que ladite structure est homogène.

6. Composition d’alliage métallique selon la revendication 1, caractérisée en ce que ladite composition est sous la forme d’une poudre.

7. Composition d’alliage métallique selon la revendication 1, caractérisée en ce qu’elle est composée de 10 à 12% en masse atomique de manganèse, de 10 à 12% en masse atomique de silicium, de 3 à 5% en masse atomique d’étain, de 4 à 10% en masse atomique de zinc, de 2 à 5% en masse atomique d’argent, de 1 à 5% en masse atomique d’indium, de 51 à 70% en masse atomique de cuivre et d’éventuelles impuretés.

8. Feuille de brasure homogène et ductile produite par trempe de la masse fondu d’une surface refroidie à une vitesse d’au moins 10⁵ °C/s et composée de 4 à 16% en masse atomique de manganèse, de 4 à 16% en masse atomique de silicium, de 0 à 10% en masse atomique d’étain, de 0 à 20% en masse atomique de zinc, de 0 à 10% en masse atomique d’argent et de 0 à 10% en masse atomique d’indium, le complément étant constitué par du cuivre et d’éventuelles impuretés.

9. Procédé de fabrication d’une feuille homogène et ductile constituée de 4 à 16% en masse atomique de manganèse, de 4 à 16% en masse atomique de silicium, de 0 à 16% en masse atomique d’étain, de 0 à 20% en masse atomique de zinc, de 0 à 10% en masse atomique d’argent et de 0 à 10% en masse atomique d’indium, le reste étant constitué par du cuivre et d’éventuelles impuretés, ce procédé comprenant la formation d’une masse fondu de cette composition et la trempe de la masse fondu sur un bloc refroidi en rotation à une vitesse d’au moins environ 10⁵ °C/s.

10. Procédé pour lier l’une à l’autre deux pièces métalliques ou davantage, comprenant:
   a) l’interposition d’un métal d’apport entre les pièces métalliques pour former un assemblage, le métal d’apport ayant un point de fusion inférieur à celui de l’une quelconque des pièces;
   b) le chauffage de l’assemblage à une température au moins égale à la température de fusion du métal d’apport; et
   c) le refroidissement de l’assemblage; caractérisé par l’amélioration consistant à utiliser en tant que métal d’apport, une feuille de cuivre homogène et ductile, à base de cuivre, selon la revendication 8.