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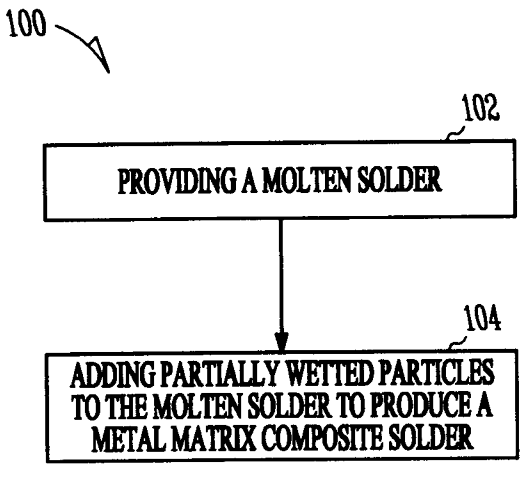

FIG. 1

(57) Abstract: A composite solder is disclosed which comprises a solder combined with particles to form a metal matrix composite (MMC) solder, wherein the particles are partially wetted particles having an average diameter sufficiently large to perform functionally as partially wetted particles when mixed with the solder. In one embodiment, the solder is a solder alloy. The MMC solder has improved wettability, an increased rate of flow upon melting, and higher strength, as compared with traditional solder formulas. In one embodiment, the partially wetted particles are selected from aluminum oxide (Al2O3), silicon carbide (SiC), silicon dioxide (SiO2), stainless steel, silicon nitride (Si3N4), boron nitride (BN), graphite and combinations thereof. Embodiments include methods for making and using the MMC solder.

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METAL MATRIX COMPOSITE SOLDERS

Cross-Reference to Related Application

This application claims the benefit under 35 U.S.C. 119 (e) of U.S. Provisional Application No. 60/949,661 filed on July 13, 2007, which is hereby incorporated by reference in its entirety.

Background

Soldering involves melting a solder material between two metal objects to join the two objects without causing them to melt. Solder is useful for plumbing, electronic circuit boards, solar cells, radiators, tin coating and other known soldering applications.

Summary

The inventors have discovered a need for new types of solders, including solder alloys, with improved physical properties. In one embodiment, a solder is provided which comprises a composite solder combined with particles to form a metal matrix solder composite, wherein the particles are partially wetted particles having an average diameter sufficiently large to perform functionally as partially wetted particles when mixed with the solder. In one embodiment, the partially wetted particles have an average diameter of between about six (6) and 300 microns.

The partially wetted particles may be selected from aluminum oxide (Al_2O_3) particles, silicon carbide (SiC) particles, silicon dioxide (SiO_2) particles, stainless steel particles, silicon nitride (Si_3N_4) particles, boron nitride (BN) particles, graphite particles and combinations thereof.

In one embodiment, the aluminum oxide (Al_2O_3) particles have a size of about 150 to about 240 grit. In one embodiment, the silicon dioxide (SiO_2) particles have a size of about 30 to 300 grit or 60 to 240 grit, such as about 60 grit. In one embodiment, the stainless steel particles have a size of about 60 to about 240 grit.

In one embodiment, the partially wetted particles comprise 0.1 to five (5) wt% of the solder, 0.5 to five (5) wt% of the solder, or one (1) to four (4) wt% of the solder.

In a particular embodiment, the solder comprises about 90 to about 99 wt% Sn and up to about six (6) wt% Cu. Such solder may further comprise about eight (8) to about 12 wt% Zn and about 83 to about 95 wt% Sn. In one embodiment, such solder further comprises about one (1) to about five (5) wt% aluminum oxide having a size of 150 grit.

In one embodiment, a solder is provided which comprises a lead-free solder combined with partially wetted particles to form a lead-free metal matrix solder composite, wherein the partially wetted particles have an average diameter greater than about 60 microns up to about 300 microns.

In one embodiment, a method comprising providing molten solder; and adding partially wetted particles to the molten solder to produce a metal matrix composite solder is provided. In a particular embodiment, the adding step comprises mechanically mixing the partially wetted particles into the molten solder between the liquidus and solidus temperatures of the solder (which includes any type of solder alloy), i.e., in the slushy phase, although the invention is not so limited. In one embodiment, the partially wetted particles are added at or above the solidus temperature of the solder. The method may further comprise adding an inert gas blanket to minimize dross formation in the solder; and removing floating dross from the solder after mixing.

In one embodiment, the method comprises mixing partially wetted particles into flux, the partially wetted particles having an average diameter of a size sufficient to function as partially wetted particles when mixed with solder; and soldering a component with the flux and the solder. The partially wetted particles may additionally be mixed into the solder as described above.

The novel MMC solders described herein provide improved wetting properties, increase the rate at which solder flows upon melting, and create higher strength in the joint as compared with traditional solder formulas. As a result, previously unacceptable formulations known in the art are now possible. Lower temperature solders, as that term is understood in the art, are also possible due to the improved wetting properties of the MMC solders.

Since partially wetted particles tend to cost less than traditional solder materials, lower cost solders having the requisite physical properties can now be produced. As a result, the use of expensive elements, such as indium, silver and gold in solders can now be minimized or eliminated. Furthermore, the use of aluminium, zinc and tin solder alloys can now be expanded due to the improvement in wetting properties, cost, strength and temperature reduction.

In one embodiment, various methods for using MMC solders are provided. In one embodiment, less solder is used to produce an acceptable soldered joint. It is also possible that metals which are known to be difficult to solder (e.g., aluminum) may be soldered with the novel MMC solders disclosed herein.

Brief Description of the Figure

FIG. 1 shows a block flow diagram in one embodiment of the present invention.

Detailed Description

In the following detailed description of embodiments of the invention, embodiments are described in sufficient detail to enable those skilled in the art to practice them, and it is to be understood that other embodiments may be utilized and that chemical and procedural changes may be made without departing from the spirit and scope of the present subject matter. The following detailed description is, therefore, not to be taken in a limiting sense, and the scope of embodiments of the present invention is defined only by the appended claims.

Definitions

The term “wettability,” as used herein refers to the ability of liquids to spread on a surface, e.g., of a particle. Increased wettability is associated with a lower contact angle. Incomplete wettability occurs on surfaces with a contact angle less than 90 degrees.

The term “completely wetted particle” or “completely wetting particle,” as used herein, refers to a particle which dissolves into a molten mass, changing the composition of the molten mass. Copper is one example of a “completely wetted particle.” Copper slowly dissolves into a molten mass, and does not remain as a discrete particle.

The term "partial wetting," as used herein, refers to incomplete wetting.

The term "partially wetted particle" or "partially wetting particle," as used herein, refers to a particle with a surface which does not become completely wet when placed in a liquid or molten mass, i.e., the liquid does not spread completely onto the particle surface. A "partially wetted particle" therefore does not dissolve in a molten mass (e.g., solder), but remains chemically inert. A shearing force is required to mix a "partially wetted particle" into a molten mass. The smaller the particle, the larger the overall surface area. Therefore, smaller particles require a greater shearing force in order to wet the surface and mix the particle into the molten mass. If the particle size becomes too small, a "partially wetted particle" may functionally behave instead as a non-wetted particle (described below).

The term "partially wetted powder" as used herein refers to a plurality of partially wetted particles, as defined herein.

The term "non-wetting," as used herein, refers to a surface property which does not allow a liquid to spread when the measured contact angle is equal to or greater than 90 degrees.

The term "non-wetted particle" or "non-wetting particle," as used herein refers to a particle which is completely immiscible in a molten mass, even when a shearing force is applied. Once the shearing force (i.e., any type of mixing) stops, a non-wetted particle floats back to the surface of the molten mass.

Description of the Embodiments

Traditionally, most solders have been composed primarily of lead and tin. However, new government regulations in many countries are gradually eliminating the use of lead in solders. The industry has therefore moved towards lead free solders. However, many such alternative solders contain silver, which is quite costly. Other formulations not containing silver may not have the requisite physical properties.

In one embodiment, a metal matrix composite (MMC) solder is disclosed. In one embodiment, the metal matrix composite solder comprises a lead-free solder or lead-free solder alloy together with partially-wetted particles of a sufficient average diameter or size. In one embodiment, the novel MMC solder may be a lead-based solder, as demonstrated in Example 7.

In one embodiment, the composite comprises about 90 to about 99 wt% tin (Sn), and up to about six (6) wt% copper (Cu), with partially wetted particles having an average diameter of at least six (6) microns up to about 300 microns, although the invention is not so limited. In other embodiments, the average diameter may be about 14 to about 60 microns. In one embodiment, the average diameter is greater about 60 microns up to about 300 microns.

In one embodiment, the concentration of the partially wetted particles in the composite is at a level to provide the requisite physical properties for a particular application. If the concentration of the partially wetted particles is too high, the ductility of the solder is decreased. Furthermore, particles unable to become wetted would remain floating on the surface after mixing is completed. If the concentration of the partially wetted particles is too low, the improved strength, wetting and flow characteristics are not achieved. In one embodiment, the concentration of the partially wetted particles in the solder is about 0.1 to five (5) wt%. In one embodiment, the concentration is about 0.5 to five (5) wt%. In one embodiment, the concentration of the partially wetted particles is about one (1) to about four (4) wt%.

In one embodiment, the partially-wetted particles are selected from aluminum oxide (Al_2O_3) particles, silicon carbide (SiC) particles, silicon dioxide (SiO_2) particles, stainless steel particles, silicon nitride (Si_3N_4) particles, boron nitride (BN) particles, graphite particles and combinations thereof, with an average diameter of a size sufficient to function as partially wetted particles. The requisite average diameter for a particle to function as a partially wetted particle depends on a number of variables, including, but not limited to, the type of particle, type of molten mass, particular type of joint desired, and so forth. As noted above, particle sizes which are too small will not function as partially wetted particles, but will instead function as non-wetted or insoluble particles.

In one embodiment, the partially wetted particles include, but are not limited to, aluminum oxide (Al_2O_3) particles having a size of about 150 to about 240 grit, silicon dioxide (SiO_2) particles having a size of about 30 to 300 grit or 30 to 240 grit, such as about 50 to 70 grit, stainless steel particles having a size of about 60 to about 240 grit, and silicon carbide (SiC,) particles having an average particle diameter of about 12 to about 300 microns.

In one embodiment, the invention comprises a low cost Zn-Sn solder with partially wetted particles having improved physical properties and containing about eight (8) to about 12 wt% Zn, about 83 to about 95 wt% Sn, and about one (1) to about five (5) wt % aluminum oxide having a size of about 150 grit.

In one embodiment, the novel MMC composite solders do not contain copper. In such embodiments, the solder may comprise up to 100% Sn.

In one embodiment, the copper level is greater than zero (0) wt% up to at least one (1) wt%. In one embodiment, the copper level is greater than one (1) wt% up to at least two (2) wt%. In one embodiment, the copper level is greater than two (2) wt% up to at least three (3) wt%. In one embodiment, the copper level is greater than three (3) wt %, up to about 4 wt%, about 5 wt% or about 6 wt% or higher. If the concentration of copper is too high, the solder would not function properly. However, the novel MMC solders described herein allow higher levels of copper to be used as compared with conventional solders, thus extending the useable range of copper.

In one embodiment, a method for making MMC solders is provided. In the embodiment shown in the Figure, the method 100 includes providing 102 a molten solder and adding 104 partially wetted particles to the molten solder to produce a metal matrix composite solder. In one embodiment, the solder is a solder alloy. In one embodiment, the adding step 104 includes mechanically mixing a plurality of partially wetted particles (i.e., a partially wetted powder) into molten solder between the liquidus and solidus temperatures of the solder (which includes any type of solder alloy), i.e., in the slushy phase, although the invention is not so limited. In one embodiment, the partially wetted particles are added at or above the solidus temperature of the solder, which includes a solder alloy.

Minimization of dross creation during mixing can be achieved with an inert gas blanket of nitrogen or argon. Floating dross on the surface of the molten bath can be removed after mixing. Wettability of the solder is controllable with adjustments to the concentration, type, shape and size of particles used to make the MMC solder.

In one embodiment, the novel partially wetted particles may be added into the flux instead of or in addition to being added into the solder.

The various composites described herein are useful in a variety of soldering applications including, but not limited to, plumbing, printed circuit boards, radiators and heat exchangers, cooling fin solders, wave soldering, and so forth.

For example, with respect to plumbing applications, better wetting properties in the novel MMC solders provided herein reduce failure of joints due to pin hole leaks and weak solder joints. Preventing pin hole leaks and weak spots also reduces future repairs. Additionally, better wetting on a copper pipe allows the solder to flow freely between the joints. As a result, in one embodiment, joint strength is increased due to the increased surface area soldered, thus leading to improved improves pressure tightness. In one embodiment, the strength of the bond is higher with the novel MMC solders described herein, as compared with a conventional solder.

In one embodiment, MMC solders are easier to use than standard lead free solders due to the visual flowing of the material into the joint. In one embodiment, MMC solders work well with brass, which is more difficult to solder than ordinary copper plumbing. In one embodiment, MMC solder can be used to improve the current silver-based lead free plumbing solders, thus making them more reliable and lower in cost, due to the addition of lower cost components.

With respect to circuit boards, in one embodiment, MMC composite solders produce improved toughness and stronger solders due to better wetting and strength, resulting in less cyclical fatigue failure in the boards. The lower temperature helps to reduce the temperature for wave soldering techniques preventing damage to delicate circuit board parts. In one embodiment, improved wetting allows less solder and higher densities of contacts on circuit boards. During the wave soldering of printed circuit boards, copper dissolution from the printed circuit board components increases copper content in the melt. The melt is eventually disposed of or diluted with fresh solder due to reduction in physical properties of the joint. In one embodiment, the improved wetting and strength of the novel MMC composite solders described herein may increase the tolerance of the bath to copper content before physical properties of the joint decrease to below acceptable levels.

With respect to radiators and heat exchangers, Sn 97/Cu 3 solder commonly used for radiator core tubes is limited by contamination of copper into the solder during soldering. In one embodiment, the use of MMC additives reduces this problem because the solder can be used with a higher copper concentration due to improved properties. The cost is lowered due to the reduced cost of the novel additives as compared with the base tin. Use of a lower temperature also results in energy savings. In one embodiment, improved wetting and bond strength allows the soldering process to proceed faster, thus resulting in further savings.

The invention will be further described by reference to the following examples, which are offered to further illustrate various embodiments of the present invention. It should be understood, however, that many variations and modifications may be made while remaining within the scope of the present invention.

EXAMPLE 1

Approximately 0.5 kg of each individual solder alloy was added to a stainless steel cup and heated to approximately 240 °C using a hotplate until it melted to produce a molten solder alloy. The desired amount of partially wetted powders were mixed into the molten solder alloy using simple stir casting mechanical mixing as is well known in the art, using a stainless steel spoon or rotating stainless steel drill bit. Dross was skimmed from the surface after the powder was mixed into the molten solder.

Table 1 shows the various combinations tested.

Table 1. Metal Matrix Composites Tested

Powder	Average Diameter (microns)	Approximate wt%	Solder Base
Aluminium Oxide	54	0.5-5	Sn
Aluminium Oxide	93	0.5-5	Sn
Silicon Carbide	66	0.5-5	Sn

Silicon Carbide	14	0.5-5	Sn
304 Stainless steel	Mix 54-268	0.5-5	Sn
Silicon Dioxide	268	0.5-5	Sn
Aluminium Oxide	54	0.5-5 wt%	Ag 1%/ Cu 3%/ Sn 97%
Aluminium Oxide	93	0.5-5 wt%	Ag 1%/ Cu 3% /Sn 97%
Aluminium Oxide	54	0.5-5 wt%	Cu 3%/ Sn 97%
Aluminium Oxide	193	0.5-5 wt%	Zn9%/ Sn 89%

Strength tests were conducted by butt end soldering two copper plates which were 30.5 cm (one (1) ft) long and 0.32 cm (0.125 in) thick, with a joint which is 1.27 cm (one (1) in) wide. The copper plates had been cleaned with steel wool and standard resin flux. Various solder compositions were used to solder the plates together.

The approximate strength of the joint could easily be determined by twisting the copper plates with vice grips until the joint gave way. Pb 50%/Sn 50% joints broke cleanly in the solder with very little effort. The traditional Ag 1%/Cu 3%/Sn 96% solder broke only with some effort and a very slight distortion of the copper plates. Again, the break was cleanly in the solder, i.e., the solder did not part from the copper.

The Sn 97%/aluminium oxide 3% MMC solder required an extreme effort to break the solder, resulting in major twisting of the copper plates indicative of extreme force being required to break the bond. Again, the break was cleanly in the solder and not between the solder and the copper plate.

From the results of this testing, it appears that the MMC solder has a greater strength and likely greater bond strength with copper.

EXAMPLE 2

Three cold samples of different solder compositions produced in Example 1 were placed on a 2.54 cm x 1.9 cm x 0.3 cm (one (1) in x 0.75 in x 0.125 in) copper plate on top of a steel plate to spread the heat evenly. The samples were then slowly heated up on a hot plate to compare the melting points. The temperature at which they flowed was measured with a laser pointer infrared pyrometer. The temperature was raised slowly and heat applied on and off, so that the temperature of each piece of solder remained within 15 °C (five (5) °F) degrees of each other. The MMC solders with particles in then flowed sooner than comparable solders and flowed sooner and easier on the copper plate as shown in Table 2.

Table 2 Melting Temperatures Comparison

Wave solder	Melting Temp (°C)	New MMC Solder	Flow Temp (°C)
Cu 3%/Sn 97%	227	Cu 3%/Sn9 7%/Al_2O_3 3%	222
Plumbing solders			
Ag,Cu,97%Sn	227	Sn 95%/SiO_2 5%	201
SnSb5	236	Sn97%/$Al_2O_3$3% (14 μ diam)	213
		Sn97% SiC (6 μ diam)	215
		Sn 97% 3% stainless steel	216

EXAMPLE 3

The MMC solders made in Example 1 were poured off into small diameter rods for testing on standard copper plumbing joints. Standard Kester brand resin flux (Ag 1%/ Cu 3%/ Sn 96%) manufactured by Kester, having offices in Itasca, Illinois, was used as flux for all of the copper joints.

All the MMC solders showed dramatically better wetting than standard lead solders and lead free solders. Lead solders entered the joint as expected. Lead free solders tended to stay near the joint, balled up at the surface and were not sucked into the joint. The lead free solder also tended to show pin hole porosity.

The MMC solders were drawn into the joint and thoroughly distributed inside the copper joint. The SiO_2 MMC solders ran through the entire joint.

EXAMPLE 4

Several solder compositions were tested for use in wave soldering. A solder composition of about 97% Sn and three (3)% copper with aluminum oxide particles of about 60 microns in a concentration of about three (3) wt% flowed at 222 °C as compared with 227 °C for a 100% Sn solder.

Other compositions tested had concentrations of copper up to about six (6) wt%. Good wetting properties were observed, even at copper levels of about six (6) wt%, which occurred due to contamination from the standard industrial processes. A composition containing about three (3) % Alumina and about 97% Sn was also tested with good wettablity and bonding strength.

EXAMPLE 5

A 9% Zinc/91% Sn solder was compared to a solder containing about one (1) to about five (5) wt% aluminium oxide 150 added grit. The zinc-tin solder did not solder well when attempting to solder a simple copper tube to a copper straight through plumbing fixture, i.e., the solder did not flow well and there were obvious holes in the joint. With added aluminum oxide, this solder soldered extremely well, i.e., the solder flowed easily into the joint and flowed completely through the joint. In each case the melting point was below 200°C.

EXAMPLE 6

Standard solder paste (Masters soldering Paste imported by G.F. Thompson, New Market, Ontario, Canada and purchased locally, had three (3) to ten (10)% by weight of 240 grit aluminum oxide powder mechanically mixed into it using a spoon. This mixed paste was used under the same conditions as in Example 1 to melt 3% Cu-97% Sn solder obtained from Canada Metals in Toronto, onto a copper plate. A second identical plate was made using the plain paste (Masters) and the same 3% Cu-97% Sn solder. The two samples melted at approximately the same time and temperature. However, the one with the aluminum oxide powder wetted the surface better, i.e., it spread out much more.

In addition, the paste with aluminum oxide powder and without was used with the 3% Cu -97% Sn alloy to solder two sets of copper plates end to end. The one with the aluminum oxide in it produced the stronger bond, as evidenced by simple bend until the joint broke, i.e., much more force was needed to break the joint.

EXAMPLE 7

A three (3) mm Kester solid wire solder obtained from a local retailer. The solid wire solder was comprised of 60% Pb/40% Sn alloy composition had three (3)% by weight of 240 grit aluminum oxide melted into it and mechanically mixed as in Example 1. This mixed solder was compared to the simple three (3) mm Kester solid wire solder (60%Pb/40% Sn) by using a copper plate and using Masters solder paste for the plate and slowly increasing the temperature on a hot plate. The solder with the aluminum oxide in it appeared to flow at a temperature of about two (2)°C lower than the simple Pb/Sn solder. The wetting of the plate was greater as well. A simple break test using small copper plates was used for both of the above samples. The plates jointed by the solder containing aluminum oxide were more difficult to break by hand than the sample without the aluminum oxide added.

Conclusion

Embodiments of the present invention include a variety of metal matrix composite solders containing partially wetted particles dispersed throughout the matrix. The novel MMC composite solders described herein have improved wetting properties, a lower flow temperature, improved ease of use, and improved bonding strength as compared with conventional solders.

In one embodiment, standard tin solder alloys are converted to metal matrix composites (MMC) with addition of partially wetted particles. Such composites can be used as a solder or tinning material. MMC solders can be used for any number of applications, including, but not limited to, plumbing, electronic circuit boards, manufacturing solar modules, radiators, tin coating, brazing and other traditional soldering applications.

Although specific embodiments have been illustrated and described herein, it will be appreciated by those of ordinary skill in the art that any procedure that is calculated to achieve the same purpose may be substituted for the specific embodiments shown. This application is intended to cover any adaptations or variations of the present subject matter. Therefore, it is manifestly intended that embodiments of this invention be limited only by the claims and the equivalents thereof.

IN THE CLAIMS:

1. A composite solder comprising a solder combined with particles to form a metal matrix solder composite, wherein the particles are partially wetted particles having an average diameter sufficiently large to perform functionally as partially wetted particles when mixed with the solder.

2. The composite solder of claim 1 wherein the partially wetted particles have an average diameter of between about six (6) and 300 microns.

3. The composite solder of claim 1 wherein the partially wetted particles are selected from aluminum oxide (Al_2O_3) particles, silicon carbide (SiC) particles, silicon dioxide (SiO_2) particles, stainless steel particles, silicon nitride (Si_3N_4) particles, boron nitride (BN) particles, graphite particles and combinations thereof.

4. The composite solder of claim 3 wherein the aluminum oxide (Al_2O_3) particles have a size of about 150 to about 240 grit.

5. The composite solder of claim 3 wherein silicon dioxide (SiO_2) particles have a size of about 30 to 300 grit.

6. The composite solder of claim 5 wherein the silicon dioxide (SiO_2) particles have a size of about 60 to 240 grit.

7. The composite solder of claim 3 wherein the stainless steel particles have a size of about 60 to about 240 grit.

8. The composite solder of any of claims 1 to 7 wherein the partially wetted particles comprise 0.1 to five (5) wt% of the solder.

9. The composite solder of claim 8 wherein the partially wetted particles comprise one (1) to four (4) wt% of the solder.

10. The composite solder of any of claims 1 to 9 comprising about 90 to about 99 wt% Sn and up to about six (6) wt% Cu.

11. The composite solder of any of claims 1 to 9 comprising about eight (8) to about 12 wt% Zn.

12. The composite solder of any of claims 1 to 9 comprising about 83 to about 95 wt% Sn.

13. A solder comprising a lead-free solder combined with partially wetted particles to form a lead-free metal matrix solder composite, wherein the partially wetted particles have an average diameter greater than about 60 microns up to about 300 microns.

14. The solder of claim 14 wherein the partially wetted particles are aluminum oxide particles added in amount of about 0.5 to five (5) wt%.

15. A method comprising:

providing molten solder; and

adding partially wetted particles to the molten solder to produce a metal matrix composite solder.

16. The method of claim 15 wherein the adding step comprises mechanically mixing the partially wetted particles into the molten solder at a temperature between the liquidus and solidus temperatures of the solder.

17. The method of claim 16 further comprising:

adding an inert gas blanket to minimize dross formation in the solder; and

removing floating dross from the solder after mixing.

18. The method of claim 15 wherein the solder is a solder alloy.

19. A method comprising:

mixing partially wetted particles into flux, the partially wetted particles having an average diameter of a size sufficient to function as partially wetted particles when mixed with solder; and

soldering a component with the flux and the solder.

20. The method of claim 19 further comprising mixing the partially wetted particles into the solder.

21 The method of claim 19 or 20 wherein the partially wetted particles are selected from aluminum oxide (Al_2O_3) particles, silicon carbide (SiC) particles, silicon dioxide (SiO_2) particles, stainless steel particles, silicon nitride (Si_3N_4) particles, boron nitride (BN) particles, graphite particles and combinations thereof.

22. The method of any of claims 19 to 21 wherein the component is a circuit board, a pipe, a radiator, a heat exchanger or a cooling fin.

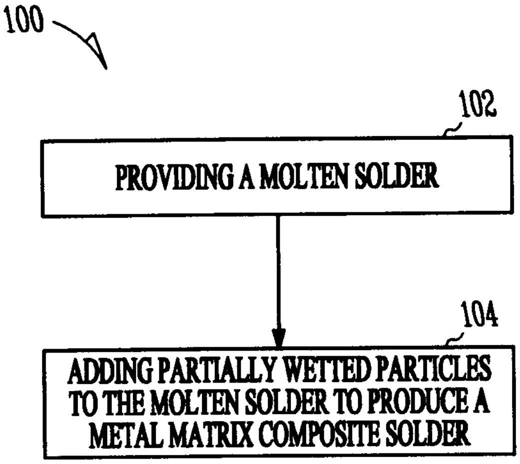
100
102
PROVIDING A MOLTEN SOLDER
104
ADDING PARTIALLY WETTED PARTICLES TO THE MOLTEN SOLDER TO PRODUCE A METAL MATRIX COMPOSITE SOLDER

FIG. 1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2008/001282

A. CLASSIFICATION OF SUBJECT MATTER
IPC: ***B23K 35/22*** (2006.01) , ***B23K 1/00*** (2006.01)
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8): B23K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)
Delphion, CPD, STN*Easy*, esp@cenet
Keywords: solder*, wet*, (aluminium oxide or aluminium oxide or al2o3) or (silica or silicon dioxide or silicon oxide or sio2) or (sic or silicon carbide) or (si3n4 or silicon nitride) or (bn or boron nitride) or (stainless steel)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	**US 5,127,969** (Sekhar) 07 July 1992 (07-07-1992) Abstract; col. 2, line 44-col. 3, line 12; col. 3, line 63-col. 4, line 7; col. 4, lines 37-39, 50-63; col. 6, lines 45-47 & 61-63; claims 1,2 & 5.	1-16 & 18-22 17
X Y	**US 2006/0120911 A1** (Gupta et al.) 08 June 2006 (08-06-2006) Abstract; paras 0013-0017, 0020, 0022, 0023; claims 1, 12-14, 18 & 19.	1-14 & 19-22 15-18
X Y	**Proceedings of the IEEE CPMT Conference on High Density Microsystem Design, Packaging and Failure Analysis (HDP'05), 7th, Shanghai, China, June 27-June 30, 2005 (2005), pp. 187-190**. "*The Evaluation of Sn-58Bi Composite solder Mixed with* Y_2O_3",(Liu et al.) Whole document.	1, 2, 8, 9, 19, 20 & 22 15-18
X Y	**Thin Solid Films, Volume 504, Issue 1-2 (2006), pp. 401-404**, "*Influence of ceramic reinforcements on the wettability and mechanical properties of novel lead-free solder composites*", (Nai et al). Whole document.	1, 2, 8-10, 12, 19, 20 & 22 15-18
Y	**US 6,673,310** (Tadauchi et al.) 06 January 2004 (06-01-2004) Abstarct; col. 1, lines 63-64; col. 4, lines 4-7; col. 5, lines 7-18.	17

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search 22 October 2008 (22-10-2008)	Date of mailing of the international search report 13 November 2008 (13-11-2008)
Name and mailing address of the ISA/CA Canadian Intellectual Property Office Place du Portage I, C114 - 1st Floor, Box PCT 50 Victoria Street Gatineau, Quebec K1A 0C9 Facsimile No.: 001-819-953-2476	Authorized officer Benjamin Chan 819- 934-3593

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	**US 5,405,577** (Seelig et al.) 11 April 1995 (11-04-1995) Whole document.	
A	**CA 2,302,490** (Smith et al.) 18 March 1999 (18-03-1999) Whole document.	
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International application No.
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