

The universal lead-free soldering material of the present invention thus manufactured not only has a melting temperature suitable for wiring general electronic components, but also has a narrow solidification range so as to be advantageous for stepwise automatic soldering. Further, it has improved mechanical strengths compared with the conventional Sn-Pb soldering material.

Now the present invention will be described based on actual examples, but the scope of the present invention will not be limited by the specific examples.

~~Example 1~~

~~<Inventive example 1>~~

~~The metallic ingredients Sn, Ag and Bi were weighed to the composition shown in Table 1 below. The casting was carried out by melting the composition in a vacuum of over 10^{-3} torr by using a vacuum induction furnace. For the alloy thus manufactured, the solidus line temperature and the liquidus line temperature of the solidification procedure were measured, and the measured results are shown in Table 1 below.~~

~~<Table 1>~~

Sn	Ag	Bi	Solidus line temp.	Liquidus line temp.
90%	3.9%	6.1%	200°C	220°C

~~As shown in Table 1, for the inventive material 1, the liquidus line temperature was 220°C, and the solidus line temperature was 200°C, while the solidification range was 20°C. Thus it is apparent that the material is suitable as a universal lead free soldering material.~~

~~<Inventive example 2>~~

~~The raw metallic materials having a composition as shown in Table 2 below were melted in the air by using a induction furnace, and casting was carried out. For the cast alloy after the casting, the solidus line temperature, the liquidus line temperature and the solidification temperature range were measured, and the measured results are shown in Table 2 below.~~

~~<Table 2>~~

Sn	Ag	Bi	Solidus line temp.	Liquidus line temp.
90%	3.1%	6.9%	195°C	218°C

~~As shown in Table 2 above, The inventive material 2 had characteristics such that the liquidus line temperature was 218°C, the solidus line temperature was 195°C, and the solidification temperature range was 23°C. Therefore, the material was very much suitable as a universal lead-free soldering material.~~

~~<Inventive example 3>~~

~~A lead free soldering material having a composition as shown in Table 3 below was melted in an inert gas (N₂) atmosphere by using a vacuum induction furnace, the pressure of the inert gas atmosphere being maintained at 250-300 m bar. Then casting was carried out, and for the cast alloy, the solidus line temperature and the liquidus line temperature were measured, and the measured results are shown in Table 3 below.~~

~~<Table 3>~~

Sn	Ag	Bi	Solidus line temp.	Liquidus line temp.
81.7%	3.3%	15%	180°C	206°C

~~As shown in Table 3 above, the inventive material 3 had characteristics such that the liquidus line temperature was 206°C, the solidus line temperature was 180°C, and the solidification temperature range was 26°C. Therefore, it was apparent that the material can be used as a universal lead-free soldering material.~~

~~<Inventive example 4>~~

~~A lead-free soldering material having a composition as shown in Table 4 below was manufactured in the same method as that of the inventive example 3, and the solidification temperature was measured for the manufactured material. The results of the measured solidification temperature are shown in Table 4 below.~~

~~<Table 4>~~

Sn	Ag	Bi	Solidus line temp.	Liquidus line temp.
63.2%	6.8%	30%	138°C	144°C

~~As shown in Table 4 above, the inventive material 4 had characteristics such that the liquidus line temperature was 144°C, the solidus line temperature was 138°C, and the solidification temperature range was 6°C. Therefore, it was apparent that the material can be used as a universal lead free soldering material.~~

~~<Comparative example 1>~~

~~A conventional lead free soldering material having a composition as shown in Table 5 below was manufactured, and then, the solidification temperature for the manufactured alloy was measured. The measured results are shown in Table 5 below.~~

~~<Table 5>~~

Sn	Ag	Bi	Solidus line temp.	Liquidus line temp.
94.5%	3.5%	2%	215°C	220°C

~~As shown in Table 5 above, the soldering material having a composition as shown in Table 5 had characteristics such that the liquidus line temperature was 220°C, the solidus line temperature was 215°C, and the solidification temperature range was 5°C. Therefore, this material was a high melting temperature lead free soldering material.~~

~~<Comparative example 2>~~

~~A lead-free soldering material having a composition as shown in Table 6 below was manufactured in the same method as that of the comparative example 1, and the measured values are shown in Table 6 below.~~

~~<Table 6>~~

Sn	Ag	Bi	Solidus line temp.	Liquidus line temp.
93-93.5%	1.5-2%	5%	211°C	223-236°C

~~As shown in Table 6 above, the soldering material having a composition as shown in Table 6 had characteristics such that the liquidus line temperature was 223-236°C, the solidus line temperature was 211°C, and the solidification temperature range was 12-25°C. Therefore, this material was a high melting temperature lead-free soldering material.~~

~~Example 2~~

~~The inventive material 2 which was composed of Sn-3.1%Ag-6.9%Bi, and the comparative material 3 which was composed of Sn-3.5%Ag-4.5%Bi, were melted in the air by using a induction furnace, and then, casting was carried out. For the cast alloys, the wetability was measured, and the measured results are shown in FIG. 1.~~

~~As shown in FIG. 1, the inventive material 2 was superior in the wetability over the comparative material 3, thereby showing a superior solderability.~~

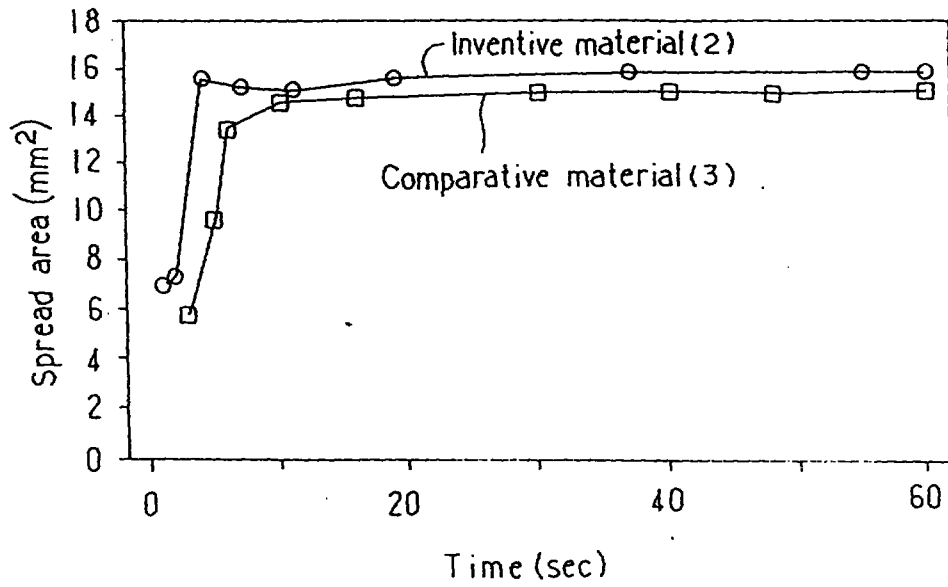
~~In order to see the mechanical properties for the conventional soldering material and the lead free soldering material according to the present invention, a conventional soldering material composed of Sn-40Pb and the inventive material 2 were measured as to their mechanical properties. The measured results are shown in FIG. 2.~~

~~As shown in FIG. 2, the inventive material 2 was extremely superior in the tensile strength over the~~

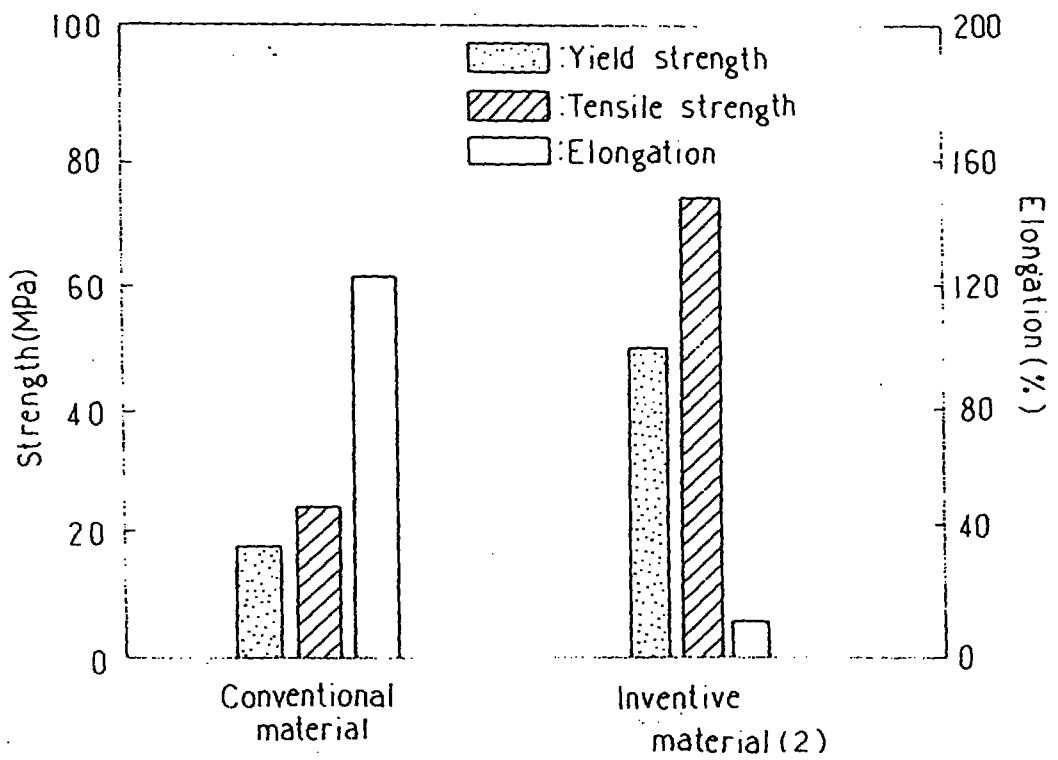
~~conventional material. This suggests that the final joining strength of the lead-free soldering material of the present invention is superior.~~

~~As can be seen in the above described examples, the lead free soldering material according to the present invention is superior in the mechanical properties over the conventional Sn Pb soldering material, with the result that the lead-free soldering material of the present invention is superior in the final joining strength. Further, since there is contained no lead, the working environment is improved. Further, the melting temperature is low, and the solidification temperature range is narrow. Therefore, the lead free soldering material according to the present invention is more suitable for soldering general electronic components compared with the conventional Sn-Ag-Bi high melting temperature lead free soldering materials.~~

DRAWINGS



~~FIG.1~~



~~FIG.2~~

UNIVERSAL LEAD-FREE SOLDERING MATERIAL
ABSTRACT OF THE DISCLOSURE

~~A universal lead free soldering material for use in soldering general electronic components is disclosed. The universal lead-free soldering material has a composition including: 3.1-7% of Ag, 6-30% of Bi and a balance of Sn (as illustrated in Fig.1 of the Drawings).~~