The electrode of the electronic parts is normally made of Cu and this Cu electrode is generally coated by electrolessno-electrode Ni plating, electroless Ni/Au plating or electroless Ni/Pd/Au plating. Thus, the electroless plating with noble metal such as Au and a combination of Au and Pd is performed on the Cu electrode. The Au plating suppresses oxidization of undercoated Ni plating and improves wettability to the molten solder. The electroless Ni plating forms Ni plating containing a considerable amount of P derived from a reducing agent (for example, sodium hypophosphite) which is used in the electroless plating. Such Ni plating contains at least some mass percent, for example, 2 through 15 mass% of P.

[0010]

However, although Patent Document 1 discloses that Cu and Ni are added to the Sn-Bi solder alloy to form the intermetallic compounds having hexagonal closest packing structure on the joining interface between the solder alloy and a Cu wiring part derived from the electrode, it does not disclose any alloy components specifically nor disclose any results for establishing an effect of high joining strength. Although the same document discloses a range of contents of Cu and Ni to be added to a component in which Sn is of 57 atm % and Bi is of 43 atm %, it is unknown to improve the joining strength within all this range.

[0011]

Further, although the same document discloses Cu wiring parts of the printing circuit board and wiring parts each containing no Cu as an object to be joined with the solder alloy, it is unknown what kind of configuration the object to be joined has except that the wiring parts are made of Cu. Since the same document does not disclose any alloy components of the solder alloy specifically as stated above, it does not disclose nor support any condition of the joining interface except that the intermetallic compounds are formed on the joining interface between the electrode and the solder alloy. Therefore, when all the solder alloys which meet contents of Bi, Cu and Ni disclosed in the same document are used for soldering the Cu electrode on which, for example, the electroless Ni plating has been performed, it is hard to think that the following problems can be solved thereby.

[0012]

[0018]

Here, the present invention is as follows:

(1) A lead-free solder alloy having an alloy composition which contains 31 to 59 mass % of Bi, 0.3 to 1.0 mass % of Cu, 0.01 to 0.06 mass % of Ni and balance of Sn wherein the solder alloy has a melting point of 185 degrees C or less, a tensile strength of 70 MPa or more and elongation of 65 % or more.

[0019]

(2) The lead-free solder alloy described in Claim 1, further containing at least one element selected from a group consisting of P and Ge in a total of 0.003 to 0.05 mass %.

[0020]

(3) A solder joint formed on a Cu electrode having a Ni plating layer by using the lead-free solder alloy described in the above-mentioned item (1) or (2).

[0021]

(4) The solder joint described in the above-mentioned item (3) wherein the Ni plating layer includes an electroless plating layer containing P.

[0022]

(5) A substrate having a thickness of 5 mm or less and plural Cu electrodes each having Ni plating layer wherein each of the Cu electrodes includes a solder joint formed by the lead-free solder alloy described in the above-mentioned item (1) or (2) .

[0023]

(6) The substrate described in the above-mentioned item (5) wherein the Ni plating layer contains P.

The lead-free solder alloy according to the invention is applicable to a use of the soldering on the Cu electrode formed on a thin substrate having a thickness of 5 mm or less, on which electroless Ni plating is performed. The effect of the invention is best exhibited by using it for the soldering on an electrode having any electroless Ni plating layer. Therefore, curvature of the thin substrate when performing the soldering is limited to its minimum because of a low melting point of the solder alloy according to the invention. Thus, joining

CLAIMS

1. A lead-free solder alloy having an alloy composition which contains 31 to 59 mass % of Bi, 0.3 to 1.0 mass % of Cu, 0.01 to 0.06 mass % of Ni and balance of Sn wherein the solder alloy has a melting point of 185 degrees C or less, a tensile strength of 70 MPa or more and elongation of 65 % or more.

2. The lead-free solder alloy according to Claim 1, further containing at least one element selected from a group consisting of P and Ge in a total of 0.003 to 0.05 mass %.

3. A solder joint formed on a Cu electrode having a Ni plating layer by using the lead-free solder alloy according to Claim 1 or 2.

4. The solder joint according to claim 3 wherein the Ni plating layer includes an electroless plating layer containing P.

5. A substrate having a thickness of 5 mm or less and plural Cu electrodes each having Ni plating layer wherein each of the Cu electrodes includes a solder joint formed by using the lead-free solder alloy according to Claim 1 or 2.

6. The substrate according to Claim 5 wherein the Ni plating layer contains P.