[0015] However, when the volume change is large, the solder joint ruptures at a joint interface. Therefore, from the viewpoint of wettability of molten solder and refinement of the alloy structure in the solder alloy and the alloy structure at the joint interface, the inventors examined contents of Cu, Sb, and Ni in detail. Further, the inventors focused on the fact that, at the time of a temperature rise of a solder joint in a cooling/heating cycle, when solid-phase transformation from βSn to γSn immediately occurs, the stress is quickly relaxed, and also examined the content of Ag in detail. As a result, the inventors found that a solder alloy with contents of Ag, Cu, Sb, In, and Ni as additive elements concurrently falling within predetermined ranges has excellent wettability, and prevents rupture of solder joints, and completed the present invention.

[0016] The present invention obtained from these findings is as follows.

(1) A solder alloy having an alloy composition consisting of, by mass%,

Ag: 1.0 to 3.7%,

Cu: 0.4 to 0.8%,

Sb: 0.50 to 2.90%,

In: 5.00 to 10.00%,

Ni: 0.01 to 0.06%, with the balance being Sn.

[0016a] In one aspect, there is provided a solder alloy having an alloy composition consisting of, by mass%

Ag: 1.0 to 3.7%,

Cu: 0.4 to 0.8%,

Sb: 0.50 to 2.90%,

In: 5.00 to 10.00%,

Ni: 0.01 to 0.06%,

optionally, Co: 0.100% or less,

optionally, Bi: 1.0% or less, and

optionally, at least one of Zr, Fe, Ge, Ga, P, As, Pb, Zn, Mg, Cr, Ti, Mn, Mo, Pt, Pd, Au, Al, and Si: 0.1% or less in total,

with the balance being Sn.

[0016b] In another aspect, there is provided a solder alloy having an alloy composition consisting of, by mass%,

Ag: 1.0 to 3.7%,

Cu: 0.4 to 0.8%,

Sb: 0.50 to 2.90%,

In: 5.00 to 10.00%,

Ni: 0.01 to 0.06%,

optionally, Co: 0.100% or less,

optionally, Bi: 5.0% or less, and

optionally, at least one of Zr, Ge, Ga, As, Pb, Mg, Cr, Ti, Mn, Mo, Pt, Pd, and Si: 0.1% or less in total,

with the balance being Sn.

[0017] (2) The solder alloy according to (1) above, further containing, by mass%, Co: 0.100% or less.

[0018] (3) The solder alloy according to (1) or (2) above, further containing, by mass%, Bi: 5.0% or less.

[0019] (4) The solder alloy according to any one of (1) to (3) above, further containing, by mass%, at least one of Zr, Fe, Ge, Ga, P, As, Pb, Zn, Mg, Cr, Ti, Mn, Mo, Pt, Pd, Au, Al, and Si: 0.1% or less in total.

[0020] (5) The solder alloy according to any one of (1) to (5) above, satisfying the following relations (1) and (2):

$132 \leq (In/Sb) \times (Sn/Ag) \leq 450$ Relation (1)

$251 \leq In/(Cu \times Sb \times Ni) \leq 699$ Relation (2)

wherein In, Sb, Sn, Ag, Cu, and Ni in the relations (1) and (2) each represent the contents (mass%) thereof in the alloy composition.

[0021] (6) A solder ball consisting of the solder alloy according to any one of (1) to (5) above.

[0022] (7) A solder preform consisting of the solder alloy according to any one of (1) to (5) above.

CLAIMS

1. A solder alloy having an alloy composition consisting of, by mass%,

Ag: 1.0 to 3.7%,

Cu: 0.4 to 0.8%,

Sb: 0.50 to 2.90%,

In: 5.00 to 10.00%,

Ni: 0.01 to 0.06%,

optionally, Co: 0.100% or less,

optionally, Bi: 1.0% or less, and

optionally, at least one of Zr, Fe, Ge, Ga, P, As, Pb, Zn, Mg, Cr, Ti, Mn, Mo, Pt, Pd, Au, Al, and Si: 0.1% or less in total,

with the balance being Sn.

2. The solder alloy according to claim 1, wherein the alloy composition consists of, by mass%,

Ag: 1.0 to 3.7%,

Cu: 0.4 to 0.8%,

Sb: 0.50 to 2.90%,

In: 5.00 to 10.00%, and

Ni: 0.01 to 0.06%,

with the balance being Sn.

3. The solder alloy according to claim 1, wherein the alloy composition consists of, by mass%,

Ag: 1.0 to 3.7%,

Cu: 0.4 to 0.8%,

Sb: 0.50 to 2.90%,

In: 5.00 to 10.00%,

Ni: 0.01 to 0.06%, and

Co: 0.100% or less,

with the balance being Sn.

4. The solder alloy according to claim 1, wherein the alloy composition consists of, by mass%,

Ag: 1.0 to 3.7%,

Cu: 0.4 to 0.8%,

Sb: 0.50 to 2.90%,

In: 5.00 to 10.00%,

Ni: 0.01 to 0.06%, and

Bi: 1.0% or less,

with the balance being Sn.

5. The solder alloy according to claim 1, wherein the alloy composition consists of, by mass%,

Ag: 1.0 to 3.7%,

Cu: 0.4 to 0.8%,

Sb: 0.50 to 2.90%,

In: 5.00 to 10.00%,

Ni: 0.01 to 0.06%, and

at least one of Zr, Fe, Ge, Ga, P, As, Pb, Zn, Mg, Cr, Ti, Mn, Mo, Pt, Pd, Au, Al, and Si: 0.1% or less in total,

with the balance being Sn.

6. The solder alloy according to claim 1, wherein the alloy composition consists of, by mass%,

Ag: 1.0 to 3.7%,

Cu: 0.4 to 0.8%,

Sb: 0.50 to 2.90%,

In: 5.00 to 10.00%,

Ni: 0.01 to 0.06%,

Co: 0.100% or less, and

at least one of Zr, Fe, Ge, Ga, P, As, Pb, Zn, Mg, Cr, Ti, Mn, Mo, Pt, Pd, Au, Al, and Si: 0.1% or less in total,

with the balance being Sn.

7. A solder alloy having an alloy composition consisting of, by mass%,

Ag: 1.0 to 3.7%,

Cu: 0.4 to 0.8%,

Sb: 0.50 to 2.90%,

In: 5.00 to 10.00%,

Ni: 0.01 to 0.06%,

optionally, Co: 0.100% or less,

optionally, Bi: 5.0% or less, and

optionally, at least one of Zr, Ge, Ga, As, Pb, Mg, Cr, Ti, Mn, Mo, Pt, Pd, and Si: 0.1% or less in total,

with the balance being Sn.

8. The solder alloy according to claim 7, wherein the alloy composition consists of, by mass%,

Ag: 1.0 to 3.7%,

Cu: 0.4 to 0.8%,

Sb: 0.50 to 2.90%,

In: 5.00 to 10.00%,

Ni: 0.01 to 0.06%, and

Bi: 5.0% or less,

with the balance being Sn.

9. The solder alloy according to claim 7, wherein the alloy composition consists of, by mass%,

Ag: 1.0 to 3.7%,

Cu: 0.4 to 0.8%,

Sb: 0.50 to 2.90%,

In: 5.00 to 10.00%,

Ni: 0.01 to 0.06%,

Bi: 5.0% or less, and

at least one of Zr, Ge, Ga, As, Pb, Mg, Cr, Ti, Mn, Mo, Pt, Pd, and Si: 0.1% or less in total,

with the balance being Sn.

10. The solder alloy according to claim 7, wherein the alloy composition consists of, by mass%,

Ag: 1.0 to 3.7%,

Cu: 0.4 to 0.8%,

Sb: 0.50 to 2.90%,

In: 5.00 to 10.00%,

Ni: 0.01 to 0.06%,

Co: 0.100% or less, and

Bi: 5.0% or less,

with the balance being Sn.

11. The solder alloy according to any one of claims 1 to 10,

wherein the alloy composition satisfies the following relations (1) and (2):

$132 \leq (In/Sb) \times (Sn/Ag) \leq 450$ Relation (1)

$251 \leq In/(Cu \times Sb \times Ni) \leq 699$ Relation (2)

wherein In, Sb, Sn, Ag, Cu, and Ni in the relations (1) and (2) each represent the contents (mass%) thereof in the alloy composition.

12. A solder ball consisting of the solder alloy according to any one of claims 1 to 11.

13. A solder preform consisting of the solder alloy according to any one of claims 1 to 11.

14. A solder paste comprising a solder powder consisting of the solder alloy according to any one of claims 1 11.

15. A solder joint comprising the solder alloy according to any one of claims 1 to 11.