above.

[0038a] In an aspect of the present disclosure, there is provided a solder alloy having an alloy composition consisting of, by mass%,

Ag: 0.3 to 1.9%,

Cu: 0.40 to 1.00%,

Bi: 0.5 to 4.9%,

P: 0.00100 to 0.02000%,

and optionally

Ga in an amount of 0.06% or less, and /or

at least one of As, In, Zr, Mn, Ti, Zn, Fe, Al, Au, Mg, and Pt, where

each may be present in an amount of 0.06% or less,

with the balance being Sn and unavoidable impurities.

[0038b] In another aspect of the present disclosure, there is provided a solder paste comprising a solder powder consisting of the solder alloy as disclosed herein.

[0038c] In a further aspect of the present disclosure, there is provided a solder ball consisting of the solder alloy as disclosed herein.

[0038d] In another aspect of the present disclosure, there is provided a solder preform consisting of the solder alloy as disclosed herein.

[0038e] In a further aspect of the present disclosure, there is provided a solder joint comprising the solder alloy as disclosed herein.

Brief Description of Drawings

[0039] FIG. 1 FIG. 1 is a cross-sectional SEM photograph of a solder joint, FIG. 1(a) illustrates Comparative Example 1, and FIG. 1(b) illustrates Example 22.

Description of Embodiments

[0040] The present invention will be described in greater detail below. In the present specification, “%” used for indicating an alloy composition of the solder alloy is “mass%” unless otherwise specified.

[0041] 1. Solder Alloy

(1) Ag: 0.3 to 1.9%

Ag is an element that improves drop impact resistance, heat cycle resistance and EM resistance, and suppresses chip standing. Ag can suppress deformation of the solder alloy by precipitation strengthening of $Ag_3Sn$, and thus contributes to improvement of heat cycle resistance and drop impact resistance. In addition, due to precipitation of $Ag_3Sn$, electron transfer is inhibited and EM resistance is improved. Furthermore, in the thermal history using DSC, two large endothermic peaks are shown between the solidus-line temperature and the liquidus-line temperature during heating.

[0042] When the Ag content is less than 0.3%, due to an insufficient precipitation amount of $Ag_3Sn$, the heat cycle resistance and the EM resistance deteriorate. In addition, chip standing frequently occurs. In terms of the lower limit, the Ag content is 0.3% or more, preferably 0.4% or more, more preferably 0.5% or more, and further preferably 0.6% or more.

[0043] On the other hand, when the Ag content is more than 1.9%, $Ag_3Sn$ is formed in a network shape, and therefore drop impact resistance deteriorates. In addition, when the Ag content is 2.5% or more, there is one endothermic peak, and chip standing frequently occurs. In terms of the upper limit, the Ag content is 1.9% or less, preferably 1.7% or less, more preferably 1.6% or less, further preferably 1.4% or less, still further preferably 1.3% or less, particularly preferably 1.2% or less, and most preferably 1.1% or less.

# CLAIMS

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

Ag: 0.3 to 1.9%,

Cu: 0.40 to 1.00%,

Bi: 0.5 to 4.9%,

P: 0.00100 to 0.02000%,

and optionally

Ga in an amount of 0.06% or less, and /or

at least one of As, In, Zr, Mn, Ti, Zn, Fe, Al, Au, Mg, and Pt, where each may be present in an amount of 0.06% or less,

with the balance being Sn and unavoidable impurities.

2. The solder alloy according to claim 1, wherein the alloy composition satisfies all of the following Relations (1) to (3):

$0.0007 \leqq Ag \times Cu \times Bi \times P \leqq 0.0110$ Relation (1)

$110 \leqq Ag/(P \times Cu) \leqq 799$ Relation (2)

$0.67 \leqq (Ag+Bi)/(Ag+Cu+Bi) \leqq 0.91$ Relation (3)

wherein Ag, Cu, Bi and P in the Relations (1) to (3) above represent the contents thereof as mass% in the alloy composition.

3. A solder paste comprising a solder powder consisting of the solder alloy according to claim 1 or 2.

4. A solder ball consisting of the solder alloy according to claim 1 or 2.

5. A solder preform consisting of the solder alloy according to claim 1 or 2.

6. A solder joint comprising the solder alloy according to claim 1 or 2.