[0023]

Preferably, a total amount of 0.0005 mass % through 0.05 mass % of at least one selected from the group consisting of P and Ge is added to the lead-free solder ball as defined in the third aspect.

[0024]

According to a fourth aspect of the present invention, there is provided a solder joint for use in a semiconductor package, wherein a lead-free solder containing Ag of 2 mass % through 4.5 mass %, Cu of 0.25 mass % through 0.75 mass %, Bi of 3 mass % through 5 mass %, Ni of 0.01 mass % or more and less than 0.1 mass % and Sn as the remainder is used, wherein after 1000 thermal cycles on the semiconductor package, with each thermal cycle comprises a temperature of -40°C for 10 minutes and followed by a temperature of 125°C for 10 minutes, a resistance value of the semiconductor package is less than double of the resistance value of the semiconductor package prior to the thermal cycles.

[0025]

Preferably, the lead-free solder containing Ag of 2 mass % through 4 mass %, Cu of 0.25 mass % through 0.75 mass %, Bi of 3 mass % through 5 mass %, Ni of 0.01 mass % or more and less than 0.1 mass % and Sn as the remainder is used.

[0026]

Preferably, the lead-free solder containing Ag of 2.5 mass % through 3.5 mass %, Cu of 0.5 mass % through 0.75 mass %, Bi of 3 mass % through 5 mass %, Ni of 0.02 mass % or more and less than 0.1 mass % and Sn as the remainder is used.

[0027]

Preferably, the lead-free solder in which a total amount of 0.0005 mass % through 0.05 mass % of at least one selected from the group consisting of P and Ge is added to the lead-free solder composition as defined in the fourth aspect.

[0028]

According to a fifth aspect of the present invention, there is provided a semiconductor circuit for use in a semiconductor package, wherein a lead-free solder containing Ag of 2 mass % through 4.5 mass %, Cu of 0.25 mass % through 0.75 mass %, Bi of 3 mass % through 5 mass %, Ni of 0.01 mass % or more and less than 0.1 mass % and Sn as the remainder is used, wherein after 1000 thermal cycles on the semiconductor package, with each thermal cycle comprises a temperature of -40°C for 10 minutes and followed by a temperature of 125°C for 10 minutes, a resistance value of the semiconductor package is less than

double of the resistance value of the semiconductor package prior to the thermal cycles.
[0029]

Preferably, the lead-free solder containing Ag of 2 mass % through 4 mass %, Cu of 0.25 mass % through 0.75 mass %, Bi of 3 mass % through 5 mass %, Ni of 0.01 mass % or more and less than 0.1 mass % and Sn as the remainder is used.
[0030]

[Claim 7]

The lead-free solder ball according to Claim 5 wherein the lead-free solder ball contains Ag of 2.5 mass % through 3.5 mass %; Cu of 0.5 mass % through 0.75 mass %; Bi of 3 mass % through 5 mass %; Ni of 0.02 mass % or more and less than 0.1 mass % and Sn as the remainder.

[Claim 8]

Lead-free solder ball according to any one of Claims 5 through 7 wherein a total amount of 0.0005 mass % through 0.05 mass % of at least one selected from the group consisting of P and Ge is added to the lead-free solder.

[Claim 9]

Solder joint for use in a semiconductor package, wherein a lead-free solder containing Ag of 2 mass % through 4.5 mass %; Cu of 0.25 mass % through 0.75 mass %; Bi of 3 mass % through 5 mass %; Ni of 0.01 mass % or more and less than 0.1 mass % and Sn as the remainder is used, wherein after 1000 thermal cycles, with each thermal cycle comprises a temperature of -40°C for 10 minutes and followed by a temperature of 125°C for 10 minutes, a resistance value of the semiconductor package is less than double of the resistance value of the semiconductor package prior to the thermal cycles.

[Claim 10]

The solder joint according to Claim 9 wherein the lead-free solder containing Ag of 2 mass % through 4 mass %; Cu of 0.25 mass % through 0.75 mass %; Bi of 3 mass % through 5 mass %; Ni of 0.01 mass % or more and less than 0.1 mass % and Sn as the remainder is used.

[Claim 11]

The solder joint according to Claim 9 wherein the lead-free solder containing Ag of 2.5 mass % through 3.5 mass %; Cu of 0.5 mass % through 0.75 mass %; Bi of 3 mass % through 5 mass %; Ni of 0.02 mass % or more and less than 0.1 mass % and Sn as the remainder is used.

[Claim 12]

Solder joint according to any one of Claims 9 through 11 wherein the lead-free solder to which a total amount of 0.0005 mass % through 0.05 mass % of at least one selected from the group consisting of P and Ge is added is used to the lead-free solder.

[Claim 13]

Semiconductor circuit for use in a semiconductor package, wherein a lead-free solder containing Ag of 2 mass % through 4.5 mass %; Cu of 0.25 mass % through 0.75 mass %; Bi of 3 mass % through 5 mass %; Ni of 0.01 mass % or more and less than 0.1 mass % and Sn as the remainder is used, wherein after 1000 thermal cycles on the semiconductor package, with each thermal cycle comprises a temperature of -40°C for 10 minutes and followed by a temperature of 125°C for 10 minutes, a resistance value of the semiconductor package is less than double of the resistance value of the semiconductor package prior to the thermal cycles.

[Claim 14]

The semiconductor circuit according to Claim 13 wherein the lead-free solder containing Ag of 2 mass % through 4 mass %; Cu of 0.25 mass % through 0.75 mass %; Bi of 3 mass % through 5 mass %; Ni of 0.01 mass % or more and less than 0.1 mass % and Sn as the remainder is used.

[Claim 15]

The semiconductor circuit according to Claim 13 wherein the lead-free solder containing Ag of 2.5 mass % through 3.5 mass %; Cu of 0.5 mass % through 0.75 mass %; Bi of 3 mass % through 5 mass %; Ni of 0.02 mass % or more and less than 0.1 mass % and Sn as the remainder is used.

[Claim 16]

Semiconductor circuit according to any one of Claims 13 through 15 wherein the lead-free solder to which a total amount of 0.0005 mass % through 0.05 mass % of at least one selected from the group consisting of P and Ge is added is used to the lead-free solder.