

WHAT IS CLAIMED IS:

1. A semiconductor element mounting structure, comprising:
 - a semiconductor element comprising an element electrode, and a substrate comprising a substrate electrode that is provided on a surface facing the semiconductor element at a position facing the element electrode, the semiconductor element and the substrate being connected via the element electrode and the substrate electrode, wherein:
 - one of the element electrode or the substrate electrode is a first protruding electrode comprising a solder layer at a tip portion thereof,
 - the other of the element electrode or the substrate electrode is a first electrode pad comprising one or more metal protrusions on a surface thereof,
 - the one or more metal protrusions of the first electrode pad extend into the solder layer of the first protruding electrode,
 - a bottom area of each of the one or more metal protrusions of the first electrode pad is 75% or less with respect to a maximum cross-sectional area of the solder layer of the first protruding electrode,
 - at an opposite side of the semiconductor element from the side facing the substrate, one or more further semiconductor elements are layered in a state such that each semiconductor element is connected via an element electrode,
 - in two of the further semiconductor elements that are disposed in a connected relationship, one of an element electrode of one further semiconductor element or an element electrode of the other further semiconductor element is a second protruding electrode comprising a solder layer at a tip portion thereof,
 - the other of the element electrode of the one further semiconductor element or the element electrode of the other further semiconductor element is a second electrode pad comprising one or more metal protrusions on a surface thereof,
 - the one or more metal protrusions of the second electrode pad extend into the solder layer of the second protruding electrode, and
 - a bottom area of each of the one or more metal protrusions of the second electrode pad is 75% or less with respect to a maximum cross-sectional area of the solder layer of the second protruding electrode.
2. The semiconductor element mounting structure according to claim 1, wherein a shape of each of the one or more metal protrusions is a cylindrical column or a rectangular

parallelepiped.

3. The semiconductor element mounting structure according to any one of claim 1 or claim 2, wherein each of the one or more metal protrusions has a shape wherein at least two cylindrical columns or rectangular parallelepipeds are stacked in a height direction.

4. The semiconductor element mounting structure according to any one of claim 1 to claim 3, wherein each of the one or more metal protrusions is photolithographically formed.

5. The semiconductor element mounting structure according to any one of claim 1 to claim 4, obtained by temporarily fixing the semiconductor element and the substrate in a state wherein at least a portion of the one or more metal protrusions of the first electrode pad is extended into the solder layer of the first protruding electrode by pressurization, and melting the solder layer of the first protruding electrode by heating to connect the element electrode and the substrate electrode.

6. A combination of a semiconductor element and a substrate, comprising:
the semiconductor element comprising an element electrode, and the substrate comprising a substrate electrode that is provided on a surface facing the semiconductor element at a position facing the element electrode, wherein:

one of the element electrode or the substrate electrode is a protruding electrode comprising a solder layer at a tip portion thereof,

the other of the element electrode or the substrate electrode is an electrode pad comprising one or more metal protrusions on a surface thereof,

a bottom area of each of the one or more metal protrusions is 75% or less with respect to a maximum cross-sectional area of the solder layer of the protruding electrode,

at an opposite side of the semiconductor element from the side facing the substrate, one or more further semiconductor elements are layered in a state such that each semiconductor element is connected via an element electrode,

in two of the further semiconductor elements that are disposed in a connected relationship, one of an element electrode of one further semiconductor element or an element electrode of the other further semiconductor element is a second protruding electrode comprising a solder layer at a tip portion thereof,

the other of the element electrode of the one further semiconductor element or the element electrode of the other further semiconductor element is a second electrode pad comprising one or more metal protrusions on a surface thereof,

the one or more metal protrusions of the second electrode pad extend into the solder layer of the second protruding electrode, and

a bottom area of each of the one or more metal protrusions of the second electrode pad is 75% or less with respect to a maximum cross-sectional area of the solder layer of the second protruding electrode.

7. A semiconductor element mounting structure, comprising:

a semiconductor element comprising an element electrode, and a substrate comprising a substrate electrode that is provided on a surface facing the semiconductor element at a position facing the element electrode, the semiconductor element and the substrate being connected via the element electrode and the substrate electrode, wherein:

one of the element electrode or the substrate electrode is a first protruding electrode comprising a solder layer at a tip portion thereof,

the other of the element electrode or the substrate electrode is a first electrode pad comprising one or more metal protrusions on a surface thereof,

the one or more metal protrusions of the first electrode pad extend into the solder layer of the first protruding electrode, a bottom area of each of the one or more metal protrusions of the first electrode pad is 70% or less with respect to an area of the first electrode pad,

at an opposite side of the semiconductor element from the side facing the substrate, one or more further semiconductor elements are layered in a state such that each semiconductor element is connected via an element electrode,

in two of the further semiconductor elements that are disposed in a connected relationship, one of an element electrode of one further semiconductor element or an element electrode of the other further semiconductor element is a second protruding electrode comprising a solder layer at a tip portion thereof,

the other of the element electrode of the one further semiconductor element or the element electrode of the other further semiconductor element is a second electrode pad comprising one or more metal protrusions on a surface thereof,

the one or more metal protrusions of the second electrode pad extend into the solder layer of the second protruding electrode, and

a bottom area of each of the one or more metal protrusions of the second electrode pad is 70% or less with respect to an area of the second electrode pad.

8. The semiconductor element mounting structure according to claim 7, wherein a shape of each of the one or more metal protrusions is a cylindrical column or a rectangular parallelepiped.

9. The semiconductor element mounting structure according to any one of claim 7 or claim 8, wherein each of the one or more metal protrusions has a shape wherein at least two cylindrical columns or rectangular parallelepipeds are stacked in a height direction.

10. The semiconductor element mounting structure according to any one of claim 7 to claim 9, wherein each of the one or more metal protrusions is photolithographically formed.

11. The semiconductor element mounting structure according to any one of claim 7 to claim 10, obtained by temporarily fixing the semiconductor element and the substrate in a state wherein at least a portion of the one or more metal protrusions of the first electrode pad is extended into the solder layer of the first protruding electrode by pressurization, and melting the solder layer of the first protruding electrode by heating to connect the element electrode and the substrate electrode.

12. A combination of a semiconductor element and a substrate, comprising:
the semiconductor element comprising an element electrode, and the substrate comprising a substrate electrode that is provided on a surface facing the semiconductor element at a position facing the element electrode, wherein:

one of the element electrode or the substrate electrode is a protruding electrode comprising a solder layer at a tip portion thereof,

the other of the element electrode or the substrate electrode is an electrode pad comprising one or more metal protrusions on a surface thereof, and a bottom area of each of the one or more metal protrusions is 70% or less with respect to an area of the electrode pad,

at an opposite side of the semiconductor element from the side facing the substrate, one or more further semiconductor elements are layered in a state such that each semiconductor element is connected via an element electrode,

in two of the further semiconductor elements that are disposed in a connected relationship, one of an element electrode of one further semiconductor element or an element electrode of the other further semiconductor element is a second protruding electrode comprising a solder layer at a tip portion thereof,

the other of the element electrode of the one further semiconductor element or the element electrode of the other further semiconductor element is a second electrode pad comprising one or more metal protrusions on a surface thereof,

the one or more metal protrusions of the second electrode pad extend into the solder layer of the second protruding electrode, and

a bottom area of each of the one or more metal protrusions of the second electrode pad is 70% or less with respect to an area of the second electrode pad.