

Description

Title of Invention:

POLYCRYSTALLINE SILICON CRUSHING DEVICE
AND POLYCRYSTALLINE SILICON CRUSHING METHOD

5

Technical Field

[0001]

The present invention relates to a polycrystalline
silicon crushing device and a polycrystalline silicon
10 crushing method.

Background Art

[0002]

Patent Literature 1 discloses a method for crushing
15 polycrystalline silicon with use of a jaw crusher that has
a fixed blade and a movable blade, wherein a shortest gap
between the fixed blade and the movable blade is
adjustable to 2 mm to 16 mm.

20 Citation List

[Patent Literature]

[0003]

[Patent Literature 1]

Japanese Patent Application Publication *Tokukai*
25 No. 2015-047594

Summary of Invention

Technical Problem

[0004]

5 There is a problem in that the shortest gap between
the fixed blade and the movable blade disclosed in Patent
Literature 1 increases an amount of generated fine
powder of polycrystalline silicon, thus failing to
sufficiently increase the yield of the polycrystalline
10 silicon having a desired particle size.

[0005]

It is an object of an aspect of the present invention
to improve the yield of polycrystalline silicon having a
desired particle size and sufficiently reduce an amount
15 of generated fine powder of polycrystalline silicon.

Solution to Problem

[0006]

In order to solve the foregoing problem, a
polycrystalline silicon crushing device in accordance
20 with an aspect of the present invention includes: a first
member; a second member disposed so as to face the first
member; and a driving section configured to crush
polycrystalline silicon by driving at least one of the first
member and the second member to sandwich the
25 polycrystalline silicon between the first member and the

second member, the driving section driving the at least one of the first member and the second member so that a shortest distance between the first member and the second member becomes not less than 17 mm and not
5 more than 30 mm.

[0007]

Further, a polycrystalline silicon crushing method in accordance with an aspect of the present invention includes: an introducing step of introducing
10 polycrystalline silicon to an area between a first member and a second member disposed so as to face the first member; and a driving step of crushing the polycrystalline silicon by driving at least one of the first member and the second member to sandwich, between the
15 first member and the second member, the polycrystalline silicon that has been introduced in the introducing step, the at least one of the first member and the second member being driven in the driving step so that a shortest distance between the first member and the
20 second member becomes not less than 17 mm and not more than 30 mm.

Advantageous Effects of Invention

[0008]

According to an aspect of the present invention, it
25 is possible to improve the yield of polycrystalline silicon

having a desired particle size and sufficiently reduce an amount of generated fine powder of polycrystalline silicon.

5 Brief Description of Drawings

[0009]

Fig. 1 is a view schematically illustrating an example configuration of a crushing device for polycrystalline silicon in accordance with an embodiment
10 of the present invention.

Fig. 2 is a view for explaining a first sensor included in the crushing device illustrated in Fig. 1.

Fig. 3 is a view for explaining a shortest distance between a first member and a second member in the
15 crushing device illustrated in Fig. 1.

Fig. 4 is a view for explaining a housing provided below the first member and the second member included in the crushing device illustrated in Fig. 1.

Fig. 5 is a view schematically illustrating an
20 example configuration of a crushing device in accordance with Variation 2 of the crushing device illustrated in Fig. 1.

Fig. 6 is a graph illustrating a fine powder generation rate and a yield in accordance with Example
25 1 of the present invention.

Fig. 7 is a graph illustrating a relationship between a filling rate and a percentage in accordance with Example 2 of the present invention.

Fig. 8 is a graph illustrating a relationship between
5 a fine powder generation rate and a yield in accordance with Example 3 of the present invention.

Description of Embodiments

[0010]

10 [Polycrystalline silicon crushing device]

Fig. 1 is a view schematically illustrating an example configuration of a crushing device 1 for polycrystalline silicon S in accordance with an embodiment of the present invention. Fig. 2 is a view for
15 explaining a first sensor 50 included in the crushing device 1 illustrated in Fig. 1. In Fig. 2, a driving section 30, a control section 60, a plate receiving section 70, and a toggle plate T1 are omitted. The following description will discuss the crushing device 1 but also includes an
20 explanation for a crushing method for polycrystalline silicon S.

[0011]

The crushing device 1, which is a device configured to crush polycrystalline silicon S, is called a jaw crusher.
25 As illustrated in Fig. 1, the crushing device 1 includes a

first member 10, a second member 20, the driving section 30, a conveyance section 40, a first sensor 50, the control section 60, the plate receiving section 70, and the toggle plate T1.

5 [0012]

(First member and second member)

The first member 10 is fixed in a predetermined position and is fixed to an unillustrated frame included in the crushing device 1. The first member 10 has a fixed
10 jaw 10a. The first member 10 and the second member 20 are used for crushing the polycrystalline silicon S. The second member 20 is fixed to the driving section 30, and is disposed so as to face the first member 10. The second member 20 has a movable jaw 20a.

15 [0013]

(Driving section)

The driving section 30 crushes the polycrystalline silicon S by driving the second member 20 to sandwich, between the first member 10 and the second member 20,
20 the polycrystalline silicon S introduced by the conveyance section 40. The driving section 30 has a rotation shaft 31, and the second member 20 is fixed to the rotation shaft 31. The driving section 30 includes an unillustrated motor and rotates the rotation shaft 31
25 with use of the motor to cause the second member 20 to

move about the rotation shaft 31. In this manner, the driving section 30 drives the second member 20 so as to change the distance between the first member 10 and the second member 20.

5 [0014]

The driving section 30 drives the second member 20 so that a shortest distance D1 between the first member 10 and the second member 20 becomes not less than 17 mm and not more than 30 mm. Specifically, the shortest
10 distance D1 is a distance defined while the first member 10 and the second member 20 are located closest to each other. That is, the driving section 30 is configured such that a range in which the rotation shaft 31 is rotatable is limited so as to set the shortest distance D1 to not less
15 than 17 mm and not more than 30 mm.

[0015]

As such, the driving section 30 drives the second member 20 so that the shortest distance D1 between the first member 10 and the second member 20 becomes not
20 less than 17 mm and not more than 30 mm. It is thus possible to improve the yield of the polycrystalline silicon S having a particle size of greater than 8 mm and not more than 50 mm, and to reduce the amount of generated fine powder of the polycrystalline silicon S having a
25 particle size of not more than 8 mm.

[0016]

This effect also contributes, for example, to achieving goal 12 "Ensure sustainable consumption and production patterns", and the like of the Sustainable Development Goals (SDGs) established by the United Nations. The effect of enabling improvement in the yield of the polycrystalline silicon S and the effect of enabling reduction in the amount of generated fine powder of the polycrystalline silicon S will be described in detail in Example 1 described later.

[0017]

As described above, the shortest distance D1 between the first member 10 and the second member 20 becomes not less than 17 mm and not more than 30 mm while the first member 10 and the second member 20 are located closest to each other. It is thus possible to further improve the yield of the polycrystalline silicon S having a particle size of greater than 8 mm and not more than 50 mm, and to further reduce the amount of generated fine powder of the polycrystalline silicon S having a particle size of not more than 8 mm.

[0018]

Fig. 3 is a view for explaining the shortest distance D1 between the first member 10 and the second member 20 in the crushing device 1 illustrated in Fig. 1. Fig. 3 is

a view illustrating the fixed jaw 10a of the first member 10 and the movable jaw 20a of the second member 20 as seen from above. As illustrated in Fig. 3, the fixed jaw 10a and the movable jaw 20a are each provided with a plurality of peak portions M1 and a plurality of valley portions V1 formed alternately. The shortest distance D1 is a distance between an apex of the peak portions M1 of one of the fixed jaw 10a and the movable jaw 20a, and a lowest position of the valley portions V1 of the other of the fixed jaw 10a and the movable jaw 20a, which face the peak portions M1 of the aforementioned one of them. [0019]

(Conveyance section)

The conveyance section 40 conveys the polycrystalline silicon S to introduce the polycrystalline silicon S to an area between the first member 10 and the second member 20 from above. The step of introducing the polycrystalline silicon S by the conveyance section 40 is one example of an introducing step. The polycrystalline silicon S introduced by the conveyance section 40 enters between the fixed jaw 10a and the movable jaw 20a and then is crushed by the fixed jaw 10a and the movable jaw 20a, followed by falling downward through a gap between the fixed jaw 10a and the movable jaw 20a.

[0020]

The conveyance section 40 may include, for example, an unillustrated vibrating feeder configured to vibrate to convey the polycrystalline silicon S. Vibration
5 of the vibrating feeder allows the polycrystalline silicon S to be conveyed in a conveyance direction F1. The conveyance direction F1 is a direction from the conveyance section 40 toward the driving section 30. The vibration of the vibrating feeder is controlled by the
10 control section 60.

[0021]

The vibrating feeder vibrates in an obliquely upward direction with respect to the conveyance direction F1. Specifically, the vibration direction of the
15 vibrating feeder is a direction between the conveyance direction F1 and a vertically upward direction orthogonal to a horizontal plane. The vibrating feeder is, for example, a vibrating feeder that vibrates with use of a vibrator, or an electromagnetic feeder that vibrates with use of an
20 electromagnet.

[0022]

Use of the vibrating feeder as the conveyance section 40 for conveying the polycrystalline silicon S facilitates control over the conveyance of the
25 polycrystalline silicon S to the outside of the conveyance

section 40. Further, when the vibrating feeder vibrates, the plurality of pieces of polycrystalline silicon S spread out in the horizontal direction on the conveyance section 40, so that an amount of polycrystalline silicon S introduced to an area between the first member 10 and the second member 20 can be made as constant as possible.

[0023]

(First sensor)

10 As illustrated in Fig. 2, the first sensor 50 is provided above the first member 10 and the second member 20. The first sensor 50 is configured to detect a distance D2 between the polycrystalline silicon S sandwiched between the first member 10 and the second member 20 and the first sensor 50. The first sensor 50 is, for example, a laser sensor including an unillustrated light emitting section configured to emit laser light L1 downward and an unillustrated light receiving section configured to receive light L2 resulting from reflection of
15 the laser light L1 on the polycrystalline silicon S.
20

[0024]

Specifically, the first sensor 50 may be, for example, a laser sensor configured to detect the distance D2 on the basis of a time period from the time at the emission of laser light L1 by the above-described light emitting
25

section to the time at the reception of light L2 by the above-described light receiving section. The first sensor 50 may be a triangulation laser sensor.

[0025]

5 (Control section)

The control section 60 controls driving by the driving section 30 and conveyance by the conveyance section 40. The control section 60 controls driving of the conveyance section 40 on the basis of a result of
10 detection of a distance D2 by the first sensor 50. The distance D2 detected by the first sensor 50 has a negative correlation with a filling rate of the polycrystalline silicon S.

[0026]

15 Specifically, the shorter the distance D2 is, the larger the filling rate of the polycrystalline silicon S becomes, and the longer the distance D2 is, the smaller the filling rate of the polycrystalline silicon S becomes. The filling rate of the polycrystalline silicon S is a
20 percentage of the volume of a portion filled with the polycrystalline silicon S to the volume of a space SP1 between the fixed jaw 10a and the movable jaw 20a.

[0027]

The control section 60 determines whether or not
25 the distance D2 detected by the first sensor 50 is equal

to or greater than a predetermined value. In a case where the control section 60 determines that the distance D2 detected by the first sensor 50 is equal to or greater than the predetermined value, the control section 60
5 continues driving of the conveyance section 40, that is, continues the vibration of the vibrating feeder.

[0028]

In a case where the control section 60 determines that the distance D2 detected by the first sensor 50 is
10 less than the predetermined value, the control section 60 stops driving of the conveyance section 40, that is, stops the vibration of the vibrating feeder. The control section 60 can accurately control the filling rate of the polycrystalline silicon S by controlling driving of the
15 conveyance section 40 on the basis of a result of detection by the first sensor 50.

[0029]

The control section 60 continues driving by the driving section 30 while controlling driving of the
20 conveyance section 40. Accordingly, while the conveyance by the conveyance section 40 is stopped, the polycrystalline silicon S is crushed by the first member 10 and the second member 20 and falls downward through a gap between the first member 10 and the
25 second member 20, so that the filling rate of the

polycrystalline silicon S decreases. In a case where, after
stop of the driving of the conveyance section 40, the
distance D2 becomes equal to or greater than the
predetermined value, the control section 60 resumes
5 driving of the conveyance section 40.

[0030]

As such, the control section 60 controls driving of
the conveyance section 40 on the basis of the detection
result from the first sensor 50 that detects the distance
10 D2 between the polycrystalline silicon S sandwiched
between the first member 10 and the second member 20
and the first sensor 50. This makes it possible to
accurately control the amount of the polycrystalline
silicon S sandwiched between the first member 10 and
15 the second member 20.

[0031]

Therefore, it is possible to improve the yield of the
polycrystalline silicon S having a desired size and control
the amount of the polycrystalline silicon S sandwiched
20 between the first member 10 and the second member 20
so as to reduce the amount of generated fine powder of
the polycrystalline silicon S. The effects of enabling
improvement in the yield of the polycrystalline silicon S
and reduction in the amount of generated fine powder of

the polycrystalline silicon S will be described in detail in Example 2 described later.

[0032]

(Plate receiving section and toggle plate)

5 The toggle plate T1 is connected to a lower part of the second member 20 which is located on an opposite side from the movable jaw 20a. The toggle plate T1 connects the lower part of the second member 20 and the plate receiving section 70 so as to enable relative
10 movement of the lower part and the plate receiving section 70. The crushing device 1 is a single-toggle device including the single toggle plate T1. The plate receiving section 70 is fixed to the above-described frame.

[0033]

15 (Housing)

Fig. 4 is a view for explaining a housing 80 provided below the first member 10 and the second member 20 included in the crushing device 1 illustrated in Fig. 1. In Fig. 4, the driving section 30, the conveyance section 40,
20 the first sensor 50, the control section 60, the plate receiving section 70, and the toggle plate T1 are omitted. As illustrated in Fig. 4, the crushing device 1 may further include housings 80 and 81, a detector 82, and a second sensor 83.

25 [0034]

The housing 80 is provided below the first member 10 and the second member 20, and forms a space SP2 in which the polycrystalline silicon S crushed by the first member 10 and the second member 20 is deposited. In
5 the space SP2, the polycrystalline silicon S falling downward through a gap between the first member 10 and the second member 20 is deposited. The housing 80 is, for example, made of resin and formed into a box shape opened at an upper portion thereof.

10 [0035]

Since as described above, the polycrystalline silicon S crushed by the first member 10 and the second member 20 is deposited in the space SP2 formed by the housing 80, some of the polycrystalline silicon S
15 deposited in the housing 80 is not brought into contact with the housing 80. This enables reduction of contact of the polycrystalline silicon S with another member, thus making it possible to reduce surface contamination of the polycrystalline silicon S.

20 [0036]

In a state in which the polycrystalline silicon S is deposited in the housing 80 as a result of the deposition of the polycrystalline silicon S in the housing 80, the polycrystalline silicon S that has fallen downward from
25 the first member 10 and the second member 20 collides

with the polycrystalline silicon S already deposited in the housing 80, and thus does not collide with a bottom surface 80a of the housing 80. This enables reduction of contact of the polycrystalline silicon S with the housing
5 80, thus making it possible to reduce contamination of the surface of the polycrystalline silicon S due to resin.
[0037]

The housing 81 is connected to a side of the housing 80, and the interior of the housing 81 is in
10 communication with the interior of the housing 80. That is, a space SP3 formed by the housing 81 is in communication with the space SP2 formed by the housing 80. The polycrystalline silicon S that flows from the space SP2 into the space SP3 enters the space SP3. The
15 housing 81 is, for example, made of resin and formed into a box shape opened at a lower portion thereof. The polycrystalline silicon S that has fallen from the lower portion of the housing 81 is placed on the detector 82. The housing 81 extends further downward than the
20 bottom surface 80a of the housing 80.

[0038]

(Second sensor)

The second sensor 83 is provided inside the housing 80 and detects whether or not the polycrystalline
25 silicon S deposited inside the housing 80 has reached a

predetermined height H1 from the bottom surface 80a of the housing 80. The second sensor 83 may be implemented as the same sensor as the first sensor 50. A light emitting section included in the second sensor 83
5 emits, for example, laser light in the horizontal direction, and a light receiving section included in the second sensor 83 receives light resulting from reflection, on the polycrystalline silicon S, of the laser light emitted from the light emitting section. In a case where the light
10 receiving section has received the light, the second sensor 83 detects that the polycrystalline silicon S has reached the predetermined height H1.

[0039]

When the second sensor 83 detects that the
15 polycrystalline silicon S deposited inside the housing 80 has reached the predetermined height H1, the control section 60 stops the driving of the conveyance section 40. This makes it possible to prevent the polycrystalline silicon S from continuing to be deposited in the interior
20 of the housing 80, and to prevent the interior of the housing 80 from becoming clogged with the polycrystalline silicon S. Furthermore, it is possible to prevent the polycrystalline silicon S from being partly exposed outside the housing 80, and to prevent the
25 polycrystalline silicon S from coming into contact with

members outside the housing 80. Therefore, it is possible to reduce surface contamination of the polycrystalline silicon S.

[0040]

5 Specifically, continuous deposition of the polycrystalline silicon S inside the housing 80 can be prevented, thus making it possible to reduce the likelihood of bridging occurring inside the housing 80. Furthermore, it is possible to prevent the polycrystalline
10 silicon S from being partly exposed outside the housing 80, and thus to prevent the polycrystalline silicon S from coming into contact with the first member 10 or the second member 20.

[0041]

15 (Detector)

 The detector 82 is, for example, a metal detector configured to detect the presence of an object containing metal. The detector 82 detects the polycrystalline silicon S that has fallen from the lower portion of the housing
20 81 and has been placed on the detector 82. The detector 82 functions also as a placement table on which the polycrystalline silicon S can be placed.

[0042]

 The detector 82 may be configured to supply the
25 polycrystalline silicon S from a first position to a second

position and be movable between the first position and the second position. The first position is a position in which the polycrystalline silicon S falling from the lower portion of the housing 81 can be placed. The second
5 position is located away from the first position and is, for example, a position to which the polycrystalline silicon S is supplied.

[0043]

The movement of the detector 82 may be controlled
10 by the control section 60. The polycrystalline silicon S that has fallen from the lower portion of the housing 81 is placed on the detector 82 in the first position, and the detector 82 supplies the polycrystalline silicon S to the second position. In the second position, the
15 polycrystalline silicon S may be removed from the detector 82. When the polycrystalline silicon S has been removed, the detector 82 returns to the first position from the second position.

[0044]

20 [Variation 1]

The driving section 30 may be configured to drive at least one of the first member 10 and the second member 20. In this case, the driving section 30 sandwiches the polycrystalline silicon S between the first
25 member 10 and the second member 20 to crush the

polycrystalline silicon S. The driving section 30 drives at least one of the first member 10 and the second member 20 so that the shortest distance D1 becomes not less than 17 mm and not more than 30 mm. The step of driving at least one of the first member 10 and the second member 20 by the driving section 30 is one example of a driving step.

[0045]

For example, the driving section 30 may be configured to drive only the first member 10 among the first member 10 and the second member 20. In this case, the first member 10 is fixed to the driving section 30, and the second member 20 is fixed to the above-described frame.

[0046]

Alternatively, the driving section 30 may be configured to drive both the first member 10 and the second member 20. In this case, the first member 10 is fixed to a rotation shaft different from the rotation shaft 31 illustrated in Fig. 1, and the second member 20 is fixed to the rotation shaft 31. The driving section 30 has the different rotation shaft above, rotates the different rotation shaft by an unillustrated motor, and causes the first member 10 to move about the different rotation shaft.

[0047]

[Variation 2]

Fig. 5 is a view schematically illustrating an example configuration of a crushing device 1D in accordance with Variation 2 of the crushing device 1 illustrated in Fig. 1. As illustrated in Fig. 5, the crushing device 1D includes a first member 10D, a second member 20D, a driving section 30D, a plate receiving section 70D, toggle plates T2 and T3, and a support section TS. The crushing device 1D further includes the conveyance section 40, the first sensor 50, and the control section 60 which are illustrated in Fig. 1. The crushing device 1D may further include the housings 80 and 81, the detector 82, and the second sensor 83 which are illustrated in Fig. 4.

15 [0048]

The first member 10D is the same as the first member 10, the second member 20D is the same as the second member 20, and the driving section 30D is the same as the driving section 30. The toggle plate T2 is connected to a lower part of the second member 20D. The toggle plate T2 connects the lower part of the second member 20D and the support section TS so as to enable relative movement of the lower part and the support section TS. The support section TS is fixed to a frame included in the crushing device 1D.

20
25

[0049]

The toggle plate T3 connects the plate receiving section 70D and the support section TS so as to enable relative movement of the plate receiving section 70D and the support section TS. The plate receiving section 70D is fixed to the above-described frame included in the crushing device 1D. The crushing device 1D is a double-toggle device including the two toggle plates T2 and T3. Although the crushing device 1 can reduce the amount of generated fine powder of the polycrystalline silicon S as compared with the crushing device 1D, the crushing device 1D may also be encompassed in the technical scope of the present invention.

[0050]

[Example 1]

Fig. 6 is a graph illustrating a fine powder generation rate and a yield in accordance with Example 1 of the present invention. In Example 1, the crushing device 1 illustrated in Fig. 1 was used to crush the polycrystalline silicon S while varying the shortest distance D1 between the first member 10 and the second member 20.

[0051]

In the graph indicated by the reference numeral 601 of Fig. 6, the horizontal axis represents the shortest

distance D1 [mm], and the vertical axis represents a fine powder generation rate [%]. The fine powder generation rate is a percentage of the amount of generated fine powder of polycrystalline silicon S having a particle size of not more than 8 mm to the amount of the polycrystalline silicon S introduced to an area between the first member 10 and the second member 20.

[0052]

In the graph indicated by the reference numeral 602 of Fig. 6, the horizontal axis represents the shortest distance D1 [mm], and the vertical axis represents a yield [%]. The yield is a percentage of the amount of polycrystalline silicon S having a particle size of not more than 50 mm to the amount of the polycrystalline silicon S introduced to an area between the first member 10 and the second member 20.

[0053]

Regarding the results shown by the graphs indicated by the reference numerals 601 and 602 of Fig. 6, the present inventors conducted a diligent study on the shortest distance D1. As a result, the present inventors have found a numerical range RA of the shortest distance D1 that maximizes the yield of polycrystalline silicon S having an optimal particle size, while minimizing the fine powder generation rate. Here,

the optimum particle size is greater than 8 mm and not more than 50 mm. The numerical range RA is not less than 17 mm and not more than 30 mm.

[0054]

5 [Example 2]

Fig. 7 is a graph illustrating a relationship between a filling rate and a percentage in accordance with Example 2 of the present invention. In Example 2, the crushing device 1 illustrated in Fig. 1 was used to crush
10 the polycrystalline silicon S while varying the filling rate of the polycrystalline silicon S. In the graph illustrated in Fig. 7, the horizontal axis represents the filling rate [%], and the vertical axis represents a percentage [%] of the amount of specific polycrystalline silicon S to the
15 amount of the polycrystalline silicon S introduced to an area between the first member 10 and the second member 20.

[0055]

In the graph illustrated in Fig. 7, the graph G1
20 represents a percentage of the amount of generated fine powder of polycrystalline silicon S having a particle size of not more than 8 mm to the amount of the polycrystalline silicon S introduced. The graph G2 represents a percentage of the amount of the
25 polycrystalline silicon S having a particle size of not more

than 50 mm to the amount of the polycrystalline silicon S introduced. The graph G3 represents a percentage of the amount of the polycrystalline silicon S having a particle size of greater than 50 mm to the amount of the
5 polycrystalline silicon S introduced.

[0056]

As illustrated in Fig. 7, increase of the filling rate leads to increase of the percentage of the amount of the polycrystalline silicon S having a particle size of not more
10 than 50 mm, whereas also leading to increase of the percentage of the amount of generated fine powder of the polycrystalline silicon S that has a particle size of not more than 8 mm. Therefore, when the filling rate increases excessively, a plurality of pieces of
15 polycrystalline silicon S collide with each other, thus being cracked, and are crushed into unnecessarily small pieces.

[0057]

According to the graph illustrated in Fig. 7, it is
20 preferable to control the filling rate in order to reduce the amount of generated fine powder while increasing the amount of the polycrystalline silicon S having a particle size of not more than 50 mm. Therefore, as described above, the control section 60 preferably controls driving

of the conveyance section 40 on the basis of a result of detection of the distance D2 by the first sensor 50.

[0058]

[Example 3]

5 Fig. 8 is a graph illustrating a relationship between a fine powder generation rate and a yield in accordance with Example 3 of the present invention. In Example 3, the single-toggle crushing device 1 illustrated in Fig. 1 and the double-toggle crushing device 1D illustrated in
10 Fig. 5 were each used to crush the polycrystalline silicon S. In the graph illustrated in Fig. 8, the horizontal axis represents the fine powder generation rate [%], and the vertical axis represents the yield [%]. The definitions of the fine powder generation rate and the yield in Fig. 8
15 are the same as those in Example 1.

[0059]

 In the graph illustrated in Fig. 8, the graph G4 represents the yield obtained in a case where the polycrystalline silicon S was crushed with use of the
20 crushing device 1, and the graph G5 represents the yield obtained in a case where the polycrystalline silicon S was crushed with use of the crushing device 1D. As illustrated in Fig. 8, the use of the crushing device 1 tended to result in a higher yield and a lower fine powder
25 generation rate than the use of the crushing device 1D.

Therefore, the crushing device 1 makes it possible to improve the yield of the polycrystalline silicon S and reduce the amount of generated fine powder as compared with the crushing device 1D.

5 [0060]

[Software Implementation Example]

The functions of each crushing device 1 and 1D (hereinafter, referred to as "device") can be realized by a program for causing a computer to function as the device,
10 the program causing the computer to function as control blocks (control section 60) of the device.

[0061]

In this case, the device includes, as hardware for executing this program, a computer that has at least one
15 control device (e.g., processor) and at least one storage device (e.g., memory). The functions described in the above embodiments are realized by executing the program by the control device and the storage device.

[0062]

20 The program can be stored in one or more non-transitory, computer-readable storage media. The one or more storage media may or may not be provided in the device. In the latter case, the program may be made available to the device via any wired or wireless
25 transmission medium.

[0063]

Further, some or all of functions of the control blocks can be realized by a logic circuit. For example, the present invention encompasses, in its scope, an
5 integrated circuit in which a logic circuit that functions as the control blocks is formed. In addition, it is possible to realize the functions of the control blocks by, for example, a quantum computer.

[0064]

10 Aspects of the present invention can also be expressed as follows:

A polycrystalline silicon crushing device in accordance with Aspect 1 of the present invention includes: a first member; a second member disposed so
15 as to face the first member; and a driving section configured to crush polycrystalline silicon by driving at least one of the first member and the second member to sandwich the polycrystalline silicon between the first member and the second member, the driving section
20 driving the at least one of the first member and the second member so that a shortest distance between the first member and the second member becomes not less than 17 mm and not more than 30 mm.

[0065]

The driving section drives at least one of the first member and the second member so that the shortest distance between the first member and the second member becomes not less than 17 mm and not more than 5 30 mm. This makes it possible to improve the yield of the polycrystalline silicon having a particle size of greater than 8 mm and not more than 50 mm, and to reduce the amount of generated fine powder of the polycrystalline silicon having a particle size of not more than 8 mm.

10 [0066]

A polycrystalline silicon crushing device in accordance with Aspect 2 of the present invention may be configured, in Aspect 1, to further include: a conveyance section configured to convey the 15 polycrystalline silicon to an area between the first member and the second member from above; a first sensor disposed above the first member and the second member and configured to detect a distance between the polycrystalline silicon sandwiched between the first 20 member and the second member and the first sensor; and a control section configured to control driving of the conveyance section on the basis of a result of detection of the distance by the first sensor.

[0067]

The control section controls driving of the conveyance section on the basis of the detection result from the first sensor that detects the distance between the polycrystalline silicon sandwiched between the first member and the second member and the first sensor. This makes it possible to accurately control the amount of the polycrystalline silicon sandwiched between the first member and the second member. Therefore, it is possible to improve the yield of the polycrystalline silicon having a desired size and control the amount of the polycrystalline silicon sandwiched between the first member and the second member so as to reduce the amount of generated fine powder of the polycrystalline silicon.

[0068]

A polycrystalline silicon crushing device in accordance with Aspect 3 of the present invention may be configured, in Aspect 1 or 2, to further include a housing provided below the first member and the second member and forming a space in which the polycrystalline silicon that has been crushed by the first member and the second member is deposited.

[0069]

Since the polycrystalline silicon crushed by the first member and the second member is deposited in the

space formed by the housing, some of the polycrystalline silicon deposited in the housing is not brought into contact with the housing. This enables reduction of contact of the polycrystalline silicon with another
5 member, thus making it possible to reduce surface contamination of the polycrystalline silicon.

[0070]

A polycrystalline silicon crushing device in accordance with Aspect 4 of the present invention may
10 be configured, in any one of Aspects 1 to 3, to further include: a conveyance section configured to convey the polycrystalline silicon to an area between the first member and the second member from above; a second sensor provided inside the housing and configured to
15 detect whether or not the polycrystalline silicon deposited inside the housing has reached a predetermined height from a bottom surface of the housing; and a control section configured to stop driving of the conveyance section in a case where the second
20 sensor has detected that the polycrystalline silicon deposited inside the housing has reached the predetermined height.

[0071]

When the second sensor detects that the
25 polycrystalline silicon deposited inside the housing has

reached the predetermined height, the control section stops the driving of the conveyance section. This makes it possible to prevent the polycrystalline silicon S from continuing to be deposited in the interior of the housing, and to prevent the interior of the housing from becoming clogged with the polycrystalline silicon. Furthermore, it is possible to prevent the polycrystalline silicon from being partly exposed outside the housing, and to prevent the polycrystalline silicon from coming into contact with the members outside the housing. Therefore, it is possible to reduce surface contamination of the polycrystalline silicon.

[0072]

A polycrystalline silicon crushing device in accordance with Aspect 5 of the present invention may be configured, in any one of Aspects 1 to 4, such that the shortest distance is a distance defined while the first member and the second member are located closest to each other.

[0073]

The shortest distance between the first member and the second member becomes not less than 17 mm and not more than 30 mm while the first member and the second member are located closest to each other. This makes it possible to further improve the yield of the

polycrystalline silicon having a particle size of greater than 8 mm and not more than 50 mm, and to further reduce the amount of generated fine powder of the polycrystalline silicon having a particle size of not more
5 than 8 mm.

[0074]

A polycrystalline silicon crushing method in accordance with Aspect 6 of the present invention includes: an introducing step of introducing
10 polycrystalline silicon to an area between a first member and a second member disposed so as to face the first member; and a driving step of crushing the polycrystalline silicon by driving at least one of the first member and the second member to sandwich, between the
15 first member and the second member, the polycrystalline silicon that has been introduced in the introducing step, the at least one of the first member and the second member being driven in the driving step so that a shortest distance between the first member and the
20 second member becomes not less than 17 mm and not more than 30 mm.

[0075]

The present invention is not limited to the above embodiments, but can be altered within the scope of the
25 claims. The present invention also encompasses, in its

technical scope, any embodiment derived by combining technical means disclosed in the embodiments as appropriate.

5 Reference Signs List

[0076]

- 1, 1D Crushing device
- 10, 10D First member
- 20, 20D Second member
- 10 30, 30D Driving section
- 40 Conveyance section
- 50 First sensor
- 60 Control section
- 80 Housing
- 15 80a Bottom surface
- 83 Second sensor
- D1 Shortest distance
- D2 Distance
- F1 Conveyance direction
- 20 S Polycrystalline silicon
- SP2 Space

Claims

[Claim 1]

A polycrystalline silicon crushing device comprising:

5 a first member;

a second member disposed so as to face the first member; and

a driving section configured to crush polycrystalline silicon by driving at least one of the first
10 member and the second member to sandwich the polycrystalline silicon between the first member and the second member,

the driving section driving the at least one of the first member and the second member so that a shortest
15 distance between the first member and the second member becomes not less than 17 mm and not more than 30 mm.

[Claim 2]

20 The polycrystalline silicon crushing device according to claim 1, further comprising:

a conveyance section configured to convey the polycrystalline silicon to an area between the first member and the second member from above;

a first sensor disposed above the first member and the second member and configured to detect a distance between the polycrystalline silicon sandwiched between the first member and the second member and the first
5 sensor; and

a control section configured to control driving of the conveyance section on the basis of a result of detection of the distance by the first sensor.

10 [Claim 3]

The polycrystalline silicon crushing device according to claim 1, further comprising a housing provided below the first member and the second member and forming a space in which the polycrystalline silicon
15 that has been crushed by the first member and the second member is deposited.

[Claim 4]

The polycrystalline silicon crushing device
20 according to claim 3, further comprising:

a conveyance section configured to convey the polycrystalline silicon to an area between the first member and the second member from above;

a second sensor provided inside the housing and
25 configured to detect whether or not the polycrystalline

silicon deposited inside the housing has reached a predetermined height from a bottom surface of the housing; and

5 a control section configured to stop driving of the conveyance section in a case where the second sensor has detected that the polycrystalline silicon deposited inside the housing has reached the predetermined height.

[Claim 5]

10 The polycrystalline silicon crushing device according to claim 1, wherein the shortest distance is a distance defined while the first member and the second member are located closest to each other.

15 [Claim 6]

A polycrystalline silicon crushing method comprising:

an introducing step of introducing polycrystalline silicon to an area between a first member and a second member disposed so as to face the first member; and

20 a driving step of crushing the polycrystalline silicon by driving at least one of the first member and the second member to sandwich, between the first member and the second member, the polycrystalline silicon that
25 has been introduced in the introducing step,

the at least one of the first member and the second member being driven in the driving step so that a shortest distance between the first member and the second member becomes not less than 17 mm and not 5 more than 30 mm.