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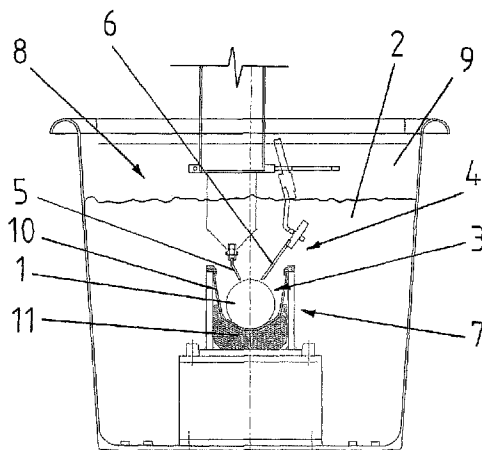
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(54) Titre : PROCEDE POUR FRAGMENTER UN MATERIAU EN FORME DE BARRE, EN PARTICULIER EN SILICIUM POLYCRISTALLIN

(54) Title: METHOD FOR FRAGMENTING A ROD-LIKE MATERIAL, IN PARTICULAR MADE OF POLYCRYSTALLINE SILICON



(57) Abrégé/Abstract:

The invention relates to a method for fragmenting a rod-like semiconductor material (1), comprising the steps: a) providing a section (3) of the rod-like material (1) that is surrounded by a process fluid (2); b) arranging an electrode arrangement (4) comprising two electrodes (5, 6) in the region of this section (3) in such a way that the electrodes (5, 6) are immersed in the process fluid (2) and are at a distance from one another and are each at a distance from the rod-like material (1), c) generating high-voltage breakdowns through the rod-like material (1) and/or along the surface of the rod-like material (1) in the region of the electrodes (5, 6) by applying high-voltage pulses to the electrode arrangement (4), wherein, during the generation of the high-voltage breakdowns, a relative movement in the longitudinal direction of the rod-like material (1) is generated between the electrode arrangement (4) and the rod-like material (1). By virtue of the method according to the invention, it is possible to comminute rod-like semiconductor material into a fraction of relatively uniform size and shape with a low energy expenditure, and to maintain a low contamination with foreign material.

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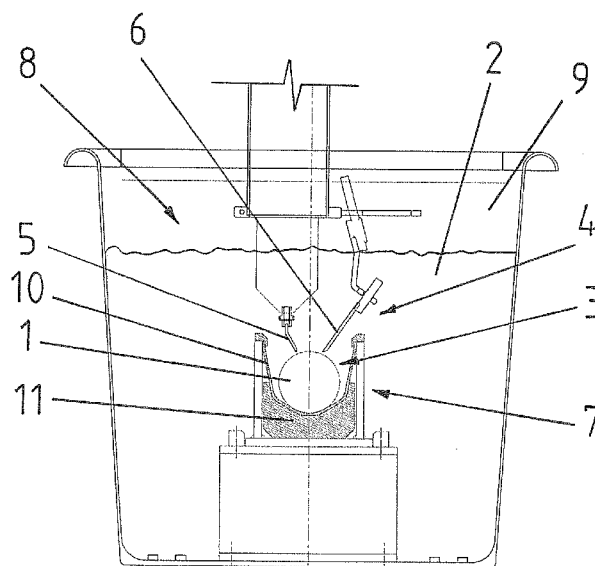
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(54) Title: METHOD FOR FRAGMENTING A ROD-LIKE MATERIAL, IN PARTICULAR MADE OF POLYCRYSTALLINE SILICON

(54) Bezeichnung : VERFAHREN ZUM FRAGMENTIEREN EINES STANGENARTIGEN MATERIALS, INSBESONDERE AUS POLYKRISTALLINEM SILIZIUM

Fig.1



(57) Abstract: The invention relates to a method for fragmenting a rod-like semiconductor material (1), comprising the steps: a) providing a section (3) of the rod-like material (1) that is surrounded by a process fluid (2); b) arranging an electrode arrangement (4) comprising two electrodes (5, 6) in the region of this section (3) in such a way that the electrodes (5, 6) are immersed in the process fluid (2) and are at a distance from one another and are each at a distance from the rod-like material (1), c) generating high-voltage breakdowns through the rod-like material (1) and/or along the surface of the rod-like material (1) in the region of the electrodes (5, 6) by applying high-voltage pulses to the electrode arrangement (4), wherein, during the generation of the high-voltage breakdowns, a relative movement in the longitudinal direction of the rod-like material (1) is generated between the electrode arrangement (4) and the rod-like material (1). By virtue of the method according to the invention, it is possible to comminute rod-like semiconductor material into a fraction of relatively uniform size and shape with a low energy expenditure, and to maintain a low contamination with foreign material.

(57) Zusammenfassung:

[Fortsetzung auf der nächsten Seite]

WO 2015/143572 A1**Veröffentlicht:**

— mit internationalem Recherchenbericht (Artikel 21 Absatz 3)

Die Erfindung betrifft ein Verfahren zum Fragmentieren eines stangenartigen Halbleitermaterials (1), umfassend die Schritte: a) Bereitstellen eines von einem Prozessfluid (2) umgebenen Abschnitts (3) des stangenartigen Materials (1); b) Anordnen einer Elektrodenanordnung (4) mit zwei Elektroden (5, 6) im Bereich dieses Abschnitts (3) derart, dass die Elektroden (5, 6) in das Prozessfluid (2) eingetaucht sind und dabei einen Abstand zueinander und jeweils einen Abstand zu dem stangenartigen Material (1) aufweisen, c) Erzeugen von Hochspannungsdurchschlägen durch das stangenartige Material (1) und/oder entlang der Oberfläche des stangenartigen Materials (1) im Bereich der Elektroden (5, 6) durch Beaufschlagen der Elektrodenanordnung (4) mit Hochspannungspulsen, wobei während dem Erzeugen der Hochspannungsdurchschläge eine Relativbewegung in Längsrichtung des stangenartigen Materials (1) zwischen der Elektrodenanordnung (4) und dem stangenartigen Material (1) erzeugt wird. Mit dem erfindungsgemässen Verfahren ist es möglich, stangenartiges Halbleitermaterial mit einem geringen Energieaufwand in eine Fraktion mit relativ gleichmässiger Grösse und Form zu zerkleinern und dabei die Kontamination mit Fremdmaterial gering zu halten.

**Method for fragmenting a rod-like material,
in particular made of polycrystalline silicon**

Technical Field

5 The invention relates to a method for fragmenting a rod-like material, in particular made of polycrystalline silicon, an equipment for performing the method and a use of the equipment.

Background Art

10 For producing ultrapure polysilicon as a base material for the crystal growing of polycrystalline or monocrystalline substrates for the solar or electronic industry, the Siemens method is mainly used. By this method, polycrystalline silicon rods with thicknesses in the range between 100 mm and 150 mm
15 are produced, which have to be broken into small pieces for the use in crystal ovens.

 Thereby, it has to be considered that the pieces should preferably have a size between 10 mm and 30 mm, must not be smaller than 2 mm and additionally should not be spicular,
20 because this has a negative effect on the flow characteristics. Due to the special crystalline structure of silicon, the breaking of silicon rods into such a fraction with preferably even sizes and shapes is very difficult.

 Further it has to be considered that the ultrapure base
25 material must not be contaminated by the contact with extraneous material during breaking. A contamination of the material with extraneous material, in particular with metals, is critical and should lie below 5 ppb, better even below 2 ppb.

Different methods for breaking silicon rods are known from the state of the art, at which the rods are broken by mechanical or thermal impact, or by a combination of mechanical and thermal impact. It is also known to break the rods by shock waves.

But all these known methods have substantial disadvantages regarding to the operation- or the equipment costs, respectively, the energy input, the grain size distribution and/or the contamination of the material.

Disclosure of the Invention

Therefore, it is an object to provide methods and devices which do not have these disadvantages of the state of the art or at least partly avoid them.

Accordingly, a first aspect of the invention relates to a method for fragmenting a rod-like material, preferably of a semiconductor material, like polycrystalline silicon for example.

Thereby, an electrode arrangement with two or more electrodes is arranged in the region of a section of the rod-like material to be fragmented, immersed in a process fluid, preferably water, such that the electrodes are immersed in the process fluid and are at a distance from one another and are each at a distance from the rod-like material.

These distances are chosen such that in the region of these electrodes high voltage breakdowns through the rod-like material and/or along the surface of the rod-like material can be generated by applying high voltage impulses to the electrode arrangement. The size of these distances depends on the conductivity of the process fluid, on the conductivity of the rod-like material and on the height of the high voltage pulses. Appropriate distances for the particular operation situation

can be determined by the person skilled in the art by simple trial and error.

High voltage pulses are applied to the electrode arrangement such that high voltage breakdowns
5 through the rod-like material and/or along the surface of the rod-like material in the region of the electrodes are generated. During the generation of the high voltage breakdowns, a relative movement in longitudinal direction of the rod-like material is generated between the elec-
10 trode arrangement and the rod-like material whereby the location of the high voltage breakdowns through the rod-like material and/or along the surface of the rod-like material progressively changes in longitudinal direction of the rod-like material.

15 By the inventive method, e.g. it is possible to break rod-like semiconductor material and in particular silicon rods into a fraction with relatively equal size and shape with a comparatively small energy input, which fraction ideally suits for the further processing
20 in crystal ovens. Also the contamination with extraneous material can be kept extremely small with this method.

In a preferred embodiment of the method, the rod-like material is completely immersed in the process fluid during fragmentation. Advantageously, it thereby
25 has an essentially horizontal position.

Thereby, it is further preferred that the rod-like material during fragmentation is received in a container, which is open to the top and which is tub-like or shell-like, and that the fragments arising from the
30 fragmentation are collected in this container and are transported away with this container after the complete fragmentation.

Thereby, the method can be performed in the industrial batch mode with relatively simple equipment
35 without a costly transport equipment.

In another preferred embodiment of the method, the rod-like material is immersed with one end in

the process fluid during fragmentation and thereby preferably has an inclined position at which the lower end of the rod-like material is immersed in the process fluid. Hereby, the method can be realized in a simple way in a
5 quasi-continuous operation by a constant supply of rod-like material in the fragmentation zone flooded with process fluid.

Advantageously, the relative movement between the electrode arrangement and the rod-like material is
10 generated at least partly by moving the rod-like material in its longitudinal direction.

Alternatively or additionally, it is envisaged that the electrode arrangement is moved in longitudinal direction of the rod-like material for the generation of the relative movement between the electrode arrangement and the rod-like material.
15

Depending on the equipment concept, one or the other variant or a combination of both variants is particularly preferred.

20 Thereby, it is preferred in the last mentioned variant that the electrode arrangement is moved in longitudinal direction of the rod-like material together with a high voltage generator generating the high voltage pulses. Hereby, a costly movable coupling of the electrode arrangement to the high voltage generator is not
25 necessary.

If the rod-like material has an inclined or preferably a horizontal position during fragmentation and the electrodes of the electrode arrangement are arranged
30 above the rod-like material, with advantage essentially centred with respect to the longitudinal axis of the rod-like material, then a particular constant fragmentation result can be reached.

The electrodes of the electrode arrangement
35 are preferably arranged such that the distance of the respective electrodes to the surface of the rod-like material in each case lies in the range between 2 mm to 40 mm

and the distance between the electrodes lies in the range between 40 mm and 100 mm. Distances in these ranges have proved to be particularly appropriate.

For generating the high voltage breakdowns
5 through the rod-like material and/or along the surface of the rod-like material, the electrode arrangement is preferably charged with high voltage pulses in the range between 100 KV and 300 KV, in particular in the range between 150 KV and 200 KV.

10 The high voltage pulses preferably have a power per pulse between 300 Joule and 1000 Joule, in particular between 500 Joule and 750 Joule.

These voltage and power ranges have proved to be particularly appropriate.

15 The application of high voltage pulses to the electrode arrangement for generating the high voltage breakdowns through the rod-like material and/or along the surface of the rod-like material is preferably performed with pulse frequencies in the range between 0.5 Hz and 40
20 Hz, in particular in the range between 1 Hz and 5 Hz.

The relative movement between the electrode arrangement and the rod-like material and/or the application of the high voltage pulses to the electrode arrangement is preferably performed such that 0.5 until 1.0
25 pulses, in particular 0.1 until 2.0 pulses, are applied to the electrode arrangement per millimetre relative movement.

Such pulse frequencies and pulse applications per millimetre relative movement proved to be particularly appropriate.
30

The region between the electrodes of the electrode arrangement and the rod-like material, which is flooded with process fluid, is preferably flushed with process liquid. In this way the fine material can be re-
35 moved from the process zone and a consistent quality of the process fluid available in the process zone can be

ensured, what can be beneficial for a stable process control.

In a preferred embodiment of the method, high voltage pulses are applied to a first of the at least two electrodes of the electrode arrangement for generating the high voltage breakdowns through the rod-like material and/or along the surface of the rod-like material while a second of these two electrodes lies on a fixed potential, in particular on ground potential.

In another preferred embodiment of the method, pulses with different potential unequal to the ground potential are simultaneously applied to the at least two electrodes of the electrode arrangement for generating the high voltage breakdowns through the rod-like material and/or along the surface of the rod-like material.

Depending on the type and the composition of the used high voltage pulse source, the one or the other variant can be more preferred.

A second aspect of the invention relates to an equipment for performing the method according to the first aspect of the invention. The equipment comprises a process room, which can be filled with a process fluid, particularly with water, and in which the rod-like material or a section of this can be arranged such that the rod-like material or the section of the rod-like material is surrounded by process fluid when the process room is filled with process fluid.

Furthermore, the equipment comprises an electrode arrangement with at least two electrodes, which, when the process room is filled with process fluid and as intended receives the rod-like material or the section of the rod-like material, can be arranged in the region of the rod-like material or of this section of the rod-like material such that the electrodes are immersed in the process fluid and thereby are at a distance from one an-

other and each are at a distance from the rod-like material, which distances allow to generate high voltage breakdowns through the rod-like material and/or along the surface of the rod-like material in the region of these electrodes in the intended operation by applying high voltage pulses to the electrode arrangement.

As already mentioned, these distances depend on the conductivity of the process fluid, on the conductivity of the rod-like material and on the height of the high voltage pulses. Appropriate distances for the respective operation situation can be determined by the person skilled in the art by simple trial and error.

Furthermore, the equipment comprises means for applying high voltage pulses to the electrode arrangement for generating the high voltage breakdowns through the rod-like material and/or along the surface of the rod-like material, and means for generating a relative movement in longitudinal direction of the rod-like material between the electrode arrangement and the rod-like material during the generation of the high voltage breakdowns during the intended operation such that the location of the high voltage breakdowns through the rod-like material and/or along the surface of the rod-like material in longitudinal direction of this material is progressively changed, wherein the rod-like material is surrounded by process fluid at this location respectively and the electrodes are immersed in the process fluid at this location.

The method according to the first aspect of the invention can easily be performed by the equipment according to the invention.

In a preferred embodiment, the equipment has a device for receiving the rod-like material, preferably a container, which is open to the top and which is tub-like or shell-like, for receiving the rod-like material. With this container, the rod-like material during the intended operation can be kept fully surrounded by process

fluid in the process room, and indeed preferably in a horizontal position.

The equipment is preferably constructed such that this tub-like or shell-like container after the intended fragmentation operation can be taken from the equipment together with the fragments of the rod-like material arranged therein, which have emerged from the fragmentation.

By this, a relatively simple equipment can be provided for the industrial batch operation without costly transport equipment.

In another preferred embodiment, the equipment has a device for receiving the rod-like material, by means of which the rod-like is held such that it is immersed in the process fluid in the process room with one end, particularly such that it thereby has an inclined position and the lower end is immersed in the process fluid in the process room. Through this, a quasi-continuous equipment can be realized in a simple way, at which rod-like material is continuously supplied into the fragmentation zone flooded with process fluid, particularly by gravity transportation, and fragmented therein.

The means for generating a relative movement between the electrode arrangement and the rod-like material are constructed for moving the rod-like material along its longitudinal axis in a preferred embodiment.

Alternatively or additionally, these means are constructed for moving the electrode arrangement along the longitudinal axis of the rod.

Depending on the equipment concept the one or the other variant or a combination of both variants are particularly preferred.

Thereby, it is preferred in the last mentioned variant that the means for applying high voltage pulses to the electrode arrangement comprise a high voltage generator and that the means for generating a relative movement between the electrode arrangement and the

rod-like material are constructed for moving the electrode arrangement together with the high voltage generator along the longitudinal axis of the rod-like material. Through this, a costly movable coupling of the electrode arrangement to the high voltage generator is not necessary.

Preferably, the equipment is constructed such that the at least two electrodes of the electrode arrangement can be arranged above the rod-like material in an intended way, with advantage essentially centred with respect to the longitudinal axis of the rod-like material. A particular even fragmentation result can be reached with such equipment.

The electrodes of the electrode arrangement can preferably be arranged such that the distance of the electrodes to the surface of the rod-like material in each case lies in the range between 2 mm and 40 mm and the distance between the electrodes lies in the range between 40 mm and 100 mm. Such distances proved to be particularly appropriate.

Furthermore, it is preferred that the equipment has means for a particular automated setting of the respective distance of the electrodes to the rod-like material, preferably for the setting of the respective distance during the intended operation of the equipment.

The means for applying high voltage pulses to the electrode arrangement are preferably constructed for applying high voltage pulses to the electrode arrangement in the range between 100 KV and 300 KV, in particular in the range between 150 KV and 200 KV, with a power per pulse in the range between 300 Joule and 1000 Joule, in particular between 500 Joule and 750 Joule and with a pulse frequency in the range between 0.5 Hz and 40 Hz, in particular between 1 Hz and 5 Hz.

Such parameter ranges proved to be particularly appropriate.

Furthermore, it is preferred that the means for generating a relative movement in longitudinal direction of the rod-like material between the electrode arrangement and the rod-like material or the means for applying high voltage pulses to the electrode arrangement, respectively, are constructed such that 0.5 until 1.0 pulses, particularly 0.1 until 2.0 pulses, per millimetre relative movement are applied to the electrode arrangement in the fragmentation operation. Such pulse rates per mm relative movement proved to be particularly appropriate.

In a further preferred embodiment, the equipment comprises means for flushing the region between the electrodes of the electrode arrangement and the rod-like material with process fluid during the fragmentation operation. Such means comprise one or several supplying nozzles, via which fresh or prepared process liquid can be injected into the region between the electrodes and the rod-like material, for example. Through this, it is possible to remove fine particles from this region and to keep the electrical conductivity of the process liquid constant in this region, which favours a stabile process control.

In an even further preferred embodiment of the equipment, high voltage pulses can be applied to a first of the at least two electrodes of the electrode arrangement for generating the high voltage breakdowns through the rod-like material and/or along the surface of the rod-like material, while another of the at least two electrodes lies on a fixed potential, particularly on ground potential.

In another preferred embodiment of the equipment, pulses with different potentials unequal to the ground potential can simultaneously be applied to the at least two electrodes of the electrode arrangement for generating the high voltage breakdowns through the rod-

like material and/or along the surface of the rod-like material.

The one or the other embodiment can be more preferred depending on the electrode arrangement and on
5 the used high voltage pulse generator.

Furthermore, it is preferred that the equipment according to the invention has an equipment control, by means of which the energy of the high voltage pulses, the frequency of the high voltage pulses, the relative
10 speed between the electrode arrangement and the rod-like material, the distance between the electrodes and the rod-like material and/or specific equipment parameters can be set and controlled, preferably during the fragmentation operation, preferably automated, preferably in de-
15 pendence on equipment and/or process parameters determined during the intended operation.

A third aspect of the invention concerns the use of the equipment according to the second aspect of the invention for fragmenting rods made of semiconductor
20 material, preferably made of polycrystalline silicon. The advantages of the invention particularly become apparent in such a use of the equipment.

Brief Description of the Drawing

Further embodiments, advantages and applications of the invention result from the dependent claims and from the now following description by means of Fig.
1. This shows a sectional view through a part of an
equipment according to the invention.

30

Modes for Carrying Out the Invention

Fig. 1 shows a part of an equipment according to the invention for fragmenting polycrystalline silicon rods 1 according to the method according to the first as-
35 pect of the invention in a sectional view crosswise to the longitudinal direction of a silicon rod 1 to be fragmented arranged therein.

As can be seen, the equipment has a basin 9 extending in the longitudinal direction of the silicon rod 1, which builds a process room 8 according to the claim, which is filled with process fluid 2, in the present case water 2.

The silicon rod 1 to be fragmented is arranged in the process room 8 in a tub-like container 7, the inside walls of which are built by a polyurethane mat 10, which is supported downwards by an underlayment 11 made of PE. Thereby, it has a horizontal position and is completely surrounded by process fluid 2. The tub-like container 7 is built and arranged in the process room 8 such that that it can be taken from the process room 8 after the complete fragmentation of the silicon rod 1 together with the fragments of the silicon rod 1 that have emerged therefrom, which then are loosely arranged therein.

Furthermore, the equipment comprises an electrode arrangement 4 with two electrodes 5, 6, which are arranged centred with respect to the longitudinal axis of the silicon rod 1 above it. Both electrodes 5, 6 are immersed in the process fluid 2 and high voltage pulses are applied to the left electrode 5 by a high voltage generator (not shown) also part of the equipment during the fragmentation operation, while the right electrode 6 is grounded. Both electrodes 5, 6 have a clearly bigger distance to each other than each to the silicon rod 1. These distances are chosen such that, in the region of these electrodes 5, 6, high voltage breakdowns through the silicon rod 1 and/or along the surface of the silicon rod 1, which lead to the fragmentation of the silicon rod 1, are generated at the application of high voltage pulses to the left electrode 5 by the high voltage generator. In the present case, the diameter of the silicon rod 1 is about 120 mm, its length is about 2 m. The distances of the electrodes 5, 6 to the surface of the silicon rod 1 are about 8 mm. The distance of the electrodes 5, 6 to

each other are about 60 mm. The high voltage pulses producible by the high voltage pulse generator have a voltage of about 200 KV and are generated at a pulse frequency of 5 Hz. The power per pulse is about 700 Joule.

5 Thereby, the electrode arrangement 4 is movable together with the high voltage pulse generator on a (not shown) moving carrier plate in longitudinal direction of the silicon rod 1 along it during the generation of the high voltage breakdowns such that the location of
10 the high voltage breakdowns through the silicon rod 1 or along the surface of the silicon rod 1, respectively, progressively changes in longitudinal direction of it without thereby essentially changing the distances of the electrodes 5, 6 to the silicon rod 1. The electrode ar-
15 rangement 4 moves with a speed in the range between 6 mm and 10 mm per second along the silicon rod 1 during the intended operation.

 The equipment additionally comprises an equipment control, by means of which the distance between
20 the electrodes 5, 6 and the silicon rod 1 and the moving speed of the electrode arrangement 4 can be set during the fragmentation operation.

 While preferred embodiments of the invention have been described in this application, it is clearly
25 noted that the invention is not restricted to them and may be carried out in other ways within the scope of the now following claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. Method for fragmenting a rod-like material comprising the steps:

a) providing a section of the rod-like material surrounded by a process fluid;

b) arranging an electrode arrangement comprising at least two electrodes in the region of this section such that the at least two electrodes are immersed in the process fluid and are at a distance from one another and are each at a distance from the rod-like material; and

c) generating high voltage breakdowns through the rod-like material and/or along the surface of the rod-like material in the region of the at least two electrodes by applying high voltage pulses to the electrode arrangement,

wherein, during the generation of the high-voltage breakdowns, a relative movement in the longitudinal direction of the rod-like material is generated between the electrode arrangement and the rod-like material such that the location of the high voltage breakdowns through the rod-like material and/or along the surface of the rod-like material progressively changes in longitudinal direction of the rod-like material.

2. Method according to claim 1, wherein the rod-like material is made of a semiconductor material.

3. Method according to claim 1 or 2, wherein the rod-like material is made of polycrystalline silicon.

4. Method according to any one of claims 1 to 3, wherein process fluid is water.

5. Method according to any one of claims 1 to 4, wherein the rod-like material is provided completely immersed in the process fluid.

6. Method according to claim 5, wherein the rod-like material has a horizontal position.

7. Method according to claim 5 or 6, wherein the rod-like material is provided received in a container which is open to a top and which is tub-like or shell-like, and wherein fragments of the rod-like material emerging after fragmentation of the rod-like material are transported with this tub-like or shell-like container from the location of the fragmentation to another location.

8. Method according to any one of claims 1 to 4, wherein the rod-like material is provided immersed with one end in the process fluid.

9. Method according to claim 8, wherein the rod-like material has an inclined position and a lower end of the rod-like material is immersed in the process fluid.

10. Method according to any one of claims 1 to 9, wherein the rod-like material is moved in its longitudinal direction for

generating the relative movement between the electrode arrangement and the rod-like material.

11. Method according to any one of claims 1 to 9, wherein the electrode arrangement is moved in the longitudinal direction of the rod-like material for generating the relative movement between the electrode arrangement and the rod-like material.

12. Method according to claim 11, wherein the electrode arrangement together with a high voltage generator generating the high voltage pulses is moved in the longitudinal direction of the rod-like material.

13. Method according to any one of claims 1 to 12, wherein the rod-like material is provided in an inclined or horizontal position and the at least two electrodes of the electrode arrangement are arranged above the rod-like material.

14. Method according to claim 13, wherein the at least two electrodes of the electrode arrangement are arranged essentially centred with respect to the longitudinal axis of the rod-like material.

15. Method according to any one of claims 1 to 14, wherein the at least two electrodes of the electrode arrangement are arranged such that the distance of the electrodes to the surface of the rod-like material lies each in the range between 2 mm and 40 mm and the distance between the electrodes lies in the range between 40 mm and 100 mm.

16. Method according to any one of claims 1 to 15, wherein high voltage pulses are applied to the electrode arrangement in the range between 100 KV and 300 KV for generating the high voltage breakdowns through the rod-like material and/or along the surface of the rod-like material.

17. Method according to claim 16, wherein the high voltage pulses are applied to the electrode arrangement in the range between 150 KV and 200 KV.

18. Method according to any one of claims 1 to 17, wherein high voltage pulses are applied to the electrode arrangement with a power per pulse between 300 Joule and 1000 Joule for generating the high voltage breakdowns through the rod-like material and/or along the surface of the rod-like material.

19. Method according to claim 18, wherein the high voltage pulses are applied to the electrode arrangement with a power per pulse between 500 Joule and 750 Joule.

20. Method according to any one of claims 1 to 19, wherein high voltage pulse frequencies in the range between 0.5 Hz and 40 Hz are applied to the electrode arrangement for generating the high voltage breakdowns through the rod-like material and/or along the surface of the rod-like material.

21. Method according to claim 20, wherein the high voltage pulse frequencies are in the range between 1 Hz and 5 Hz.

22. Method according to any one of claims 1 to 21, wherein the relative movement between the electrode arrangement and the rod-like material and/or the application of high voltage pulses to the electrode arrangement take place such that 0.1 to 2.0 pulses per millimetre relative movement are applied to the electrode arrangement.

23. Method according to claim 22, wherein 0.5 to 1.0 pulses per millimetre relative movement are applied to the electrode arrangement.

24. Method according to any one of claims 1 to 23, wherein the region between the electrodes of the electrode arrangement and the rod-like material is flushed with process liquid.

25. Method according to any one of claims 1 to 24, wherein the high voltage pulses are applied to a first of the at least two electrodes of the electrode arrangement for generating the high voltage breakdowns through the rod-like material and/or along the surface of the rod-like material while a second of the at least two electrodes lies on a fixed potential.

26. Method according to claim 25, wherein the second of the at least two electrodes is grounded.

27. Method according to claim 26, wherein pulses with different potentials unequal to ground potential are simultaneously applied to the at least two electrodes of the electrode arrangement for generating the high voltage

breakdowns through the rod-like material and/or along the surface of the rod-like material.

28. Equipment for performing the method according to any one of claims 1 to 27, comprising:

a) a process room fillable with a process fluid, for receiving the rod-like material or a section of the rod-like material such that the rod-like material or the section of the rod-like material is surrounded by the process fluid when the process room is filled with the process fluid;

b) an electrode arrangement comprising at least two electrodes which, when the process room is filled with the process fluid and as intended is receiving the rod-like material or the section of the rod-like material, can be arranged as intended such in the region of the rod-like material or of this section of the rod-like material that the at least two electrodes are immersed in the process fluid and thereby are at a distance from one another and each are at a distance from the rod-like material, which distances allow to generate, during the intended operation, high voltage breakdowns through the rod-like material and/or along the surface of the rod-like material in the region of these electrodes by applying the high voltage pulses to the electrode arrangement;

c) means for applying high voltage pulses to the electrode arrangement for generating the high voltage breakdowns through the rod-like material and/or along the surface of the rod-like material; and

d) means for generating a relative movement in longitudinal direction of the rod-like material between the

electrode arrangement and the rod-like material during the generation of the high voltage breakdowns during the intended operation such that the location of the high voltage breakdowns through the rod-like material and/or along the surface of the rod-like material is progressively changed in the longitudinal direction of this material, wherein the rod-like material at this location in each case is surrounded by the process fluid and the electrodes in each case are immersed in the process fluid at this location.

29. Equipment according to claim 28, wherein the process fluid is water.

30. Equipment according to claim 28 or 29, wherein the equipment has an arrangement for receiving the rod-like material by means of which the rod-like material is held completely surrounded by process liquid in the process room during the intended operation.

31. Equipment according to claim 30, wherein the arrangement is a container for receiving the rod-like material which is open to a top and which is tub-like or shell-like.

32. Equipment according to claim 31, wherein the rod-like material has a horizontal position.

33. Equipment according to claim 31 or 32, wherein the tub-like or shell-like container after an intended fragmentation operation can be taken from the equipment together with

fragments of the rod-like material which have emerged from the fragmentation.

34. Equipment according to claim 28 or 29, wherein the equipment has an arrangement for receiving the rod-like material, by means of which the rod-like material can be held such that it is immersed with one end in the process fluid in the process room.

35. Equipment according to claim 34, wherein the rod-like material has a inclined position and its lower end is immersed in the process fluid in the process room.

36. Equipment according to any one of claims 28 to 35, wherein the means for generating a relative movement between the electrode arrangement and the rod-like material are designed for moving the rod-like material along its longitudinal axis.

37. Equipment according to one of claims 28 to 35, wherein the means for generating a relative movement between the electrode arrangement and the rod-like material are designed for moving the electrode arrangement along the longitudinal axis of the rod-like material.

38. Equipment according to claim 37, wherein the means for applying high voltage pulses to the electrode arrangement comprise a high voltage pulse generator and the means for generating a relative movement between the electrode arrangement and the rod-like material are designed for moving

the electrode arrangement together with the high voltage pulse generator along the longitudinal axis of the rod-like material.

39. Equipment according to any one of claims 28 to 38, wherein the at least two electrodes of the electrode arrangement can be arranged as intended above the rod-like material.

40. Equipment according to claim 39, wherein the at least two electrodes of the electrode arrangement are arranged essentially centred with respect to the longitudinal axis of the rod-like material.

41. Equipment according to any one of claims 28 to 40, wherein the at least two electrodes of the electrode arrangement can be arranged as intended such that the distance of the electrodes to the surface of the rod-like material in each case lies in the range of 2 mm to 40 mm and the distance between the electrodes lies in the range between 40 mm and 100 mm.

42. Equipment according to any one of claims 28 to 41, wherein the equipment comprises means for automatically adjusting the distance of the electrodes to the rod-like material.

43. Equipment according to claim 42, wherein the means for automatically adjust the distance of the electrodes is for adjusting during the intended operation of the equipment.

44. Equipment according to any one of claims 28 to 43, wherein the means for applying the high voltage pulses to the electrode arrangement are designed for applying high voltage pulses to the electrode arrangement in the range between 100 KV and 300 KV.

45. Equipment according to claim 44, wherein the means for applying the high voltage pulses to the electrode arrangement are designed for applying high voltage pulses to the electrode arrangement in the range between 150 KV and 200 KV.

46. Equipment according to any one of claims 28 to 45, wherein the means for applying high voltage pulses to the electrode arrangement are designed for applying high voltage pulses to the electrode arrangement with a power per pulse in the range between 300 Joule and 1000 Joule.

47. Equipment according to claim 46, wherein the means for applying high voltage pulses to the electrode arrangement are designed for applying high voltage pulses to the electrode arrangement with a power per pulse in the range between 500 Joule and 750 Joule.

48. Equipment according to any one of claims 28 to 47, wherein the means for applying high voltage pulses to the electrode arrangement are designed to apply high voltage pulses to the electrode arrangement with a pulse frequency in the range between 0.5 Hz and 40 Hz.

49. Equipment according to claim 48, wherein the means for applying high voltage pulses to the electrode arrangement are designed to apply high voltage pulses to the electrode arrangement with a pulse frequency in the range between 1 Hz and 5 Hz.

50. Equipment according to any one of the claims 28 to 49, wherein the means for generating a relative movement in the longitudinal direction of the rod-like material between the electrode arrangement and the rod-like material and/or the means for applying high voltage pulses to the electrode arrangement are designed such that 0.1 to 2.0 pulses can be applied to the electrode arrangement per millimetre relative movement during the intended operation.

51. Equipment according to claim 50, wherein the means for generating a relative movement in the longitudinal direction of the rod-like material between the electrode arrangement and the rod-like material and/or the means for applying high voltage pulses to the electrode arrangement are designed such that 0.5 to 1.0 pulses can be applied to the electrode arrangement per millimetre relative movement during the intended operation.

52. Equipment according to any one of claims 28 to 51, wherein means are provided for flushing the region between the electrodes of the electrode arrangement and the rod-like material with process liquid during the intended operation.

53. Equipment according to any one of claims 28 to 52, wherein the high voltage pulses can be applied to a first of the at least two electrodes of the electrode arrangement while a second of the at least two electrodes lies on a fixed potential.

54. Equipment according to claim 53, where the second of the at least two electrodes is grounded.

55. Equipment according to claim 54, wherein pulses with different potential unequal to the ground potential are simultaneously applied to the at least two electrodes of the electrode arrangement for generating the high voltage breakdowns through the rod-like material and/or along the surface of the rod-like material.

56. Equipment according to any one of claims 28 to 55, further comprising an equipment controller, by means of which, during the intended operation, the energy of the high voltage pulses, the frequency of the high voltage pulses, the relative speed between the electrode arrangement and the rod-like material, the distance between the electrodes and the rod-like material and/or certain parameters of the equipment can be adjusted and/or controlled.

57. Equipment according to claim 56, wherein the energy of the high voltage pulses, the frequency of the high voltage pulses, the relative speed between the electrode arrangement and the rod-like material, the distance between the electrodes and the rod-like material and/or certain parameters of the

equipment can be adjusted and/or controlled in an automated way.

58. Equipment according to claim 56 or 57, wherein the energy of the high voltage pulses, the frequency of the high voltage pulses, the relative speed between the electrode arrangement and the rod-like material, the distance between the electrodes and the rod-like material and/or certain parameters of the equipment can be adjusted and/or controlled in dependence on equipment and/or process parameters determined during the intended operation.

59. Use of the equipment according to any one of claims 28 to 58 for fragmenting rods made of a semiconductor material.

60. Use according to claim 59, wherein the rods are made of polycrystalline silicon.

Fig.1

