conductor wafer before the step of forming the first epitaxial film, and in the method, the process of polishing the outer peripheral portion is performed before the finish-polishing step.

[0017] (6) In the method of producing an epitaxial wafer according to any one of (3) to (5) above, the process of polishing the outer peripheral portion may be performed by using a ring-shaped polishing cloth having a size corresponding to the outer peripheral portion of the first surface.

[0018] (7) The method of producing an epitaxial wafer according to (3) above may further comprise a step of rough-polishing at least one of the first surface and the second surface of the semiconductor wafer, and a step of finish-polishing at least one of the first surface and the second surface of the semiconductor wafer before the step of forming the first epitaxial film, and in the method, a process of mirror-polishing of the beveled portion and the process of polishing of the outer peripheral portion can be performed in parallel between the rough-polishing step and the finish-polishing step.

[0019] (8) An epitaxial wafer comprises a semiconductor wafer having a beveled portion formed on its end portion, a first surface, a second surface opposite to the first surface, and edges on both of the first surface and the second surface, the each edge is boundary with the beveled portion; a first epitaxial film with a thickness of 3 mm or more formed on the second surface of the semiconductor wafer; and a second epitaxial film formed on an outer peripheral portion of the first surface, and in the epitaxial wafer, an ESFQRmean value which represents the flatness of a surface including at least a surface of the second epitaxial film on the first surface is 100 nm or less.

Advantageous Effects of Invention

[0020] According to the present invention, an outer peripheral portion of a rear surface of a semiconductor wafer is previously rolled off purposely before forming an epitaxial film and then the epitaxial film is formed. Thus, the present invention can provide an epitaxial wafer having a highly flat rear surface obtained without polishing top and rear surfaces of the wafer after forming the epitaxial film and a method of producing the same.

Brief Description of Drawings

[0021] [fig.1]Fig. 1 is a schematic cross-sectional view illustrating a representative method of producing an epitaxial wafer in accordance with the present invention;

[fig.2]Fig. 2 is a schematic cross-sectional view illustrating an example of a method of polishing an outer peripheral portion of a wafer rear surface in a method of producing an epitaxial wafer in accordance with the present invention, where polishing is performed by using a ring-shaped polishing cloth;

[fig.3]Fig. 3(a) and 3(b) are views illustrating a case of another example of a method of

polishing an outer peripheral portion of a wafer rear surface in a method of producing an epitaxial wafer in accordance with the present invention, in which a process of mirror-polishing of a beveled portion and a process of polishing of an outer peripheral portion of a rear surface are performed in parallel; specifically, FIG. 3(a) is a schematic cross-sectional view of the vicinity of the outer peripheral portion of the wafer, and FIG. 3(b) is a schematic top view of the wafer and a polishing pad;

[fig.4]Fig. 4(a) is a schematic cross-sectional view illustrating a representative epitaxial wafer in accordance with the present invention, and FIG. 4(b) is a view for explaining ESFQR;

[fig.5]Fig. 5(a) and 5(b) are graphs showing height profiles in the vicinity of an outer peripheral portion of a rear surface of an epitaxial wafer; specifically, FIG. 5(a) illustrates an epitaxial wafer obtained by Experiment Example 1 (Comparative Example), and FIG. 5(b) illustrates an epitaxial wafer obtained by Experiment Example 3 (Example);

[fig.6]Fig. 6 is a graph showing the relationship between thickness of a first epitaxial film to be formed on a top surface of a semiconductor wafer and thickness of a second epitaxial film attaching to the outer peripheral portion of the rear surface in accordance with Experiment Example 2;

[fig.7]Fig. 7 is a graph showing ESFQR of an outer peripheral portion of a rear surface when thickness of a first epitaxial film to be formed on a top surface of a semiconductor wafer is 2 mm, 3 mm, 4 mm, or 5 mm (Experiment Example 1) (Comparative Examples) and ESFQR of an outer peripheral portion of a rear surface when a first epitaxial film having a thickness of 2 mm, 3 mm, 4 mm, or 5 mm is formed in the like manner after performing the roll-off process of the present invention (Example), in accordance with Experiment Example 4; and

[fig.8]Fig. 8 is a schematic cross-sectional view illustrating a conventional method of producing an epitaxial wafer.

Description of Embodiments

[0022] The present invention will be described below in more detail with reference to the accompanying drawings. In principle, the same components are denoted by the same reference numeral, and the description will not be repeated.

[0023] (Method of producing epitaxial wafer)

FIG. 1 is a schematic cross-sectional view illustrating a representative method of producing an epitaxial wafer in accordance with the present invention, which only illustrates the vicinity of an end portion of the wafer. First, a semiconductor wafer 10 is prepared (FIG. 1(a)). Examples of the semiconductor wafer 10 may include a silicon wafer which is obtained by cutting a single crystal silicon ingot into slices using a wire

conductor wafer. Actually, those four polishing pads are arranged at different circumferential positions on the outer peripheral portion 14, for example, in each of the regions obtained by dividing the outer periphery of the semiconductor wafer into quarters as shown in FIG. 3(b) so that the four polishing pads 3, 4, 5, and 6, contact the outer peripheral portion 14 of the rear surface of the semiconductor wafer 10. So processing of the beveled portion 11, mirror-polishing of the beveled portion 11, and polishing of the outer peripheral portion 14 of the rear surface can be performed in parallel by rotating the semiconductor wafer 10 by using the rotation stage. Further, such an apparatus is preferable also because it can be obtained by minor modification of a conventional apparatus for mirror-polishing the beveled portion 11 of the wafer.

[0043] (Epitaxial wafer)

The epitaxial wafer 100 which can be obtained by the production method described heretofore will be described with reference to FIG. 4. The epitaxial wafer 100 comprises a semiconductor wafer 10 having a beveled portion 11 formed on its end portion, a top surface 12a as a second surface, a rear surface 12b as a first surface opposite to the top surface 12a, and edges 13a and 13b on the surfaces 12a and 12b, which form boundaries between the beveled portion 11 and the surfaces 12a and 12b, respectively; a first epitaxial film 20 having a thickness of 3 mm or more which is formed on the top surface 12a of the semiconductor wafer 10; and a second epitaxial film 30 which is formed only on the outer peripheral portion 14 on the rear surface 12b. Despite the existence of the second epitaxial film 30 attached on the rear surface 12b, an ESFQRmean value which is the flatness of a surface including at least the second epitaxial film surface 31 on the rear surface 12b is characteristically 100 nm or less since the outer peripheral portion 14 includes the roll-off region.

[0044] Here, when the film thickness of the first epitaxial film 20 formed on the surface 12a is very thin, a small amount of the second epitaxial film 30 accordingly attaches to the outer peripheral portion 14 of the rear surface. Therefore, a relatively flat rear surface can be obtained without applying a production method of the present invention. However, the epitaxial wafer 100 characteristically has an ESFQRmean value of 100 nm or less even though the first epitaxial film 20 is formed thereon with a thickness of 3 mm or more.

[0045] ESFQR (Edge flatness metric, Sector based, Front surface referenced, least sQuares fit reference plane, Range of the data within sector) here means SFQR measured inside a fan-shaped region (sector) formed on the entire outer peripheral area of the wafer. ESFQRmax means a maximum value among ESFQRs of all the sectors on the wafer. ESFQRmean is a mean value of ESFQRs of all the sectors. ESFQR prescribed by the present invention is a value measured in a sector (site size) obtained by dividing the entire periphery of the wafer evenly into 72 sectors and having a sector length of 30

apparatus (WaferSight manufactured by KLA-Tencor Corporation). A reference plane was determined as a height of the substrate in the region of 139 mm to 143 mm from the center of the rear surface in a radial direction. FIG. 5(a) reveals that the flatness is degraded at an outer peripheral portion of the rear surface of the epitaxial wafer (when the distance from the wafer center is 145 mm or more).

[0051] (Experiment Example 2)

Next, in this experiment example, the relationship between the film thickness of a first epitaxial film formed on a surface of a semiconductor wafer and the film thickness of a second epitaxial film which attaches to an outer peripheral portion of the rear surface by forming the first epitaxial film was examined. In Experiment Example 1, the epitaxial film with a thickness of 5 mm was formed on the silicon wafer surface; in this experiment example, epitaxial wafers were produced, each of which has a first epitaxial film with a various film thickness by controlling the time for forming the epitaxial film. At that time, epitaxial conditions except for the film formation time was set to be the same as Experiment Example 1.

[0052] The film thickness of the second epitaxial film which have attached to the outer peripheral portion of the rear surface of each epitaxial wafer was measured at a position inside the wafer which is 1 mm and 2 mm inner than the edge position on the rear surface, respectively. FIG. 6 shows the obtained relationship between the film thickness of the first epitaxial film formed on the top surface of the semiconductor wafer and the film thickness of the second epitaxial film attached to the outer peripheral portion of the rear surface. FIG. 6 reveals that the film thickness of the second epitaxial film attached to the outer peripheral portion of the rear surface has a direct correlation with the film thickness of the first epitaxial film formed on the top surface of the semiconductor wafer.

[0053] Note that since the thickness of the second epitaxial film attached to the outer peripheral portion of the rear surface is on the order of tens to hundreds of nanometers, it is difficult to measure the thickness using an FT-IR (Fourier Transform Infrared) metrology film thickness measuring device. Thus, in this experiment example, the measurement was performed as described below. First, the film thickness profile of the first epitaxial film grown on the top surface side of the silicon wafer was measured using an FT-IR metrology film thickness measuring device (QS3300 EG manufactured by Nanometrics Incorporated) and is set as an initial value. After that, the epitaxial wafer was reversed to form an epitaxial film on the rear surface side of the silicon wafer under the same conditions as the growth conditions of the first epitaxial film. This allows the second epitaxial film to be formed also on the outer peripheral portion of the first epitaxial film grown on the top surface of the silicon wafer. The thickness of the epitaxial film, including the thicknesses of the first epitaxial film and the second

how much flatness of the outer peripheral portion of the rear surface differ depending on the varying thickness of the first epitaxial film with or without the roll-off process of the present invention.

[0058] First, as a comparative example, with respect to a silicon wafer having the same specification as the silicon wafer used in Experiment Example 1 (Comparative Example), the time for forming the epitaxial film was controlled to form epitaxial wafers having the first epitaxial film with variously changed thickness. On this occasion, the same epitaxial conditions as Experiment Example 1 were used except for the film formation time. In particular, 25 epitaxial silicon wafers were produced for each of four film thickness standards of the first epitaxial film of 2 mm, 3 mm, 4 mm, and 5 mm.

[0059] Next, as an example, the roll-off amount of the case where the film thickness of the first epitaxial films are 2 mm, 3 mm, 4 mm, and 5 mm was found based on the correlation relationship found in Experiment Example 2, and the 25 silicon wafers per each thickness were subjected to a roll-off process on the rear surface in the same procedural steps as Experiment Example 3. After that, a first epitaxial film was formed in the like manner as the above comparative example to form an epitaxial silicon wafer.

[0060] With respect to the 100 epitaxial wafers obtained by example and the 100 epitaxial wafers obtained by comparative example, ESFQR of the outer peripheral portion of the rear surface was measured by way of the foregoing method. The results are shown in FIG. 7. As apparent from FIG. 7, the epitaxial silicon wafers obtained by Example is found to achieve ESFQRmean value of 100 nm or less regardless of the thickness of the first epitaxial film. On the other hand, the epitaxial silicon wafers obtained by Comparative Example were significantly affected by the film thickness of the first epitaxial film. Some of them achieved ESFQRmean values of 100 nm or less in 2 mm-thick epitaxial growth; however, it was found impossible to achieve the ESFQRmean value of 100 nm or less in epitaxial growth for the thickness of 3 mm or more.

Industrial Applicability

[0061] According to the present invention, an outer peripheral portion of a rear surface of a semiconductor wafer is previously rolled off purposely before forming an epitaxial film, and then the epitaxial film is formed. Thus, the present invention can provide an epitaxial wafer having a highly flat rear surface obtained without polishing top and rear surfaces of the wafer after forming the epitaxial film and a method of producing the same.

Reference Signs List

[0062] 1: ring-shaped polishing cloth

further comprising:
a step of rough-polishing at least one of the first surface and the second surface of the semiconductor wafer, and
a step of finish-polishing at least one of the first surface and the second surface of the semiconductor wafer before the step of forming the first epitaxial film,
wherein a process of mirror-polishing of the beveled portion and the process of polishing the outer peripheral portion are performed in parallel between the rough-polishing step and the finish-polishing step.

[Claim 8] An epitaxial wafer comprising:
a semiconductor wafer having a beveled portion formed on its end portion, a first surface, a second surface opposite to the first surface, and edges on both of the first surface and the second surface, the each edge is boundary with the beveled portion;
a first epitaxial film with a thickness of 3 mm or more formed on the second surface of the semiconductor wafer; and
a second epitaxial film formed on an outer peripheral portion of the first surface,
wherein an ESFQRmean value which represents the flatness of a surface including at least a surface of the second epitaxial film on the first surface is 100 nm or less.

conductor wafer before the step of forming the first epitaxial film, and in the method, the process of polishing the outer peripheral portion is performed before the finish-polishing step.

[0017] (6) In the method of producing an epitaxial wafer according to any one of (3) to (5) above, the process of polishing the outer peripheral portion may be performed by using a ring-shaped polishing cloth having a size corresponding to the outer peripheral portion of the first surface.

[0018] (7) The method of producing an epitaxial wafer according to (3) above may further comprise a step of rough-polishing at least one of the first surface and the second surface of the semiconductor wafer, and a step of finish-polishing at least one of the first surface and the second surface of the semiconductor wafer before the step of forming the first epitaxial film, and in the method, a process of mirror-polishing of the beveled portion and the process of polishing of the outer peripheral portion can be performed in parallel between the rough-polishing step and the finish-polishing step.

[0019] (8) An epitaxial wafer comprises a semiconductor wafer having a beveled portion formed on its end portion, a first surface, a second surface opposite to the first surface, and edges on both of the first surface and the second surface, the each edge is boundary with the beveled portion; a first epitaxial film with a thickness of 3 μm or more formed on the second surface of the semiconductor wafer; and a second epitaxial film formed on an outer peripheral portion of the first surface, and in the epitaxial wafer, an ESFQRmean value which represents the flatness of a surface including at least a surface of the second epitaxial film on the first surface is 100 nm or less.

Advantageous Effects of Invention

[0020] According to the present invention, an outer peripheral portion of a rear surface of a semiconductor wafer is previously rolled off purposely before forming an epitaxial film and then the epitaxial film is formed. Thus, the present invention can provide an epitaxial wafer having a highly flat rear surface obtained without polishing top and rear surfaces of the wafer after forming the epitaxial film and a method of producing the same.

Brief Description of Drawing

[0021] [fig.1] FIG. 1 is a schematic cross-sectional view illustrating a representative method of producing an epitaxial wafer in accordance with the present invention;

[fig.2] FIG. 2 is a schematic cross-sectional view illustrating an example of a method of polishing an outer peripheral portion of a wafer rear surface in a method of producing an epitaxial wafer in accordance with the present invention, where polishing is performed by using a ring-shaped polishing cloth;

[fig.3] FIG. 3(a) and 3(b) are views illustrating a case of another example of a method of

polishing an outer peripheral portion of a wafer rear surface in a method of producing an epitaxial wafer in accordance with the present invention, in which a process of mirror-polishing of a beveled portion and a process of polishing of an outer peripheral portion of a rear surface are performed in parallel; specifically, FIG. 3(a) is a schematic cross-sectional view of the vicinity of the outer peripheral portion of the wafer, and FIG. 3(b) is a schematic top view of the wafer and a polishing pad;

[fig.4] FIG. 4(a) is a schematic cross-sectional view illustrating a representative epitaxial wafer in accordance with the present invention, and FIG. 4(b) is a view for explaining ESFQR;

[fig.5] FIG. 5(a) and 5(b) are graphs showing height profiles in the vicinity of an outer peripheral portion of a rear surface of an epitaxial wafer; specifically, FIG. 5(a) illustrates an epitaxial wafer obtained by Experiment Example 1 (Comparative Example), and FIG. 5(b) illustrates an epitaxial wafer obtained by Experiment Example 3 (Example);

[fig.6] FIG. 6 is a graph showing the relationship between thickness of a first epitaxial film to be formed on a top surface of a semiconductor wafer and thickness of a second epitaxial film attaching to the outer peripheral portion of the rear surface in accordance with Experiment Example 2;

[fig.7] FIG. 7 is a graph showing ESFQR of an outer peripheral portion of a rear surface when thickness of a first epitaxial film to be formed on a top surface of a semiconductor wafer is 2 μm, 3 μm, 4 μm, or 5 μm (Experiment Example 1) (Comparative Examples) and ESFQR of an outer peripheral portion of a rear surface when a first epitaxial film having a thickness of 2 μm, 3 μm, 4 μm, or 5 μm is formed in the like manner after performing the roll-off process of the present invention (Example), in accordance with Experiment Example 4; and

[fig.8] FIG. 8 is a schematic cross-sectional view illustrating a conventional method of producing an epitaxial wafer.

Description of Embodiments

[0022] The present invention will be described below in more detail with reference to the accompanying drawings. In principle, the same components are denoted by the same reference numeral, and the description will not be repeated.

[0023] (Method of producing epitaxial wafer)

FIG. 1 is a schematic cross-sectional view illustrating a representative method of producing an epitaxial wafer in accordance with the present invention, which only illustrates the vicinity of an end portion of the wafer. First, a semiconductor wafer 10 is prepared (FIG. 1(a)). Examples of the semiconductor wafer 10 may include a silicon wafer which is obtained by cutting a single crystal silicon ingot into slices using a wire

conductor wafer. Actually, those four polishing pads are arranged at different circumferential positions on the outer peripheral portion 14, for example, in each of the regions obtained by dividing the outer periphery of the semiconductor wafer into quarters as shown in FIG. 3(b) so that the four polishing pads 3, 4, 5, and 6, contact the outer peripheral portion 14 of the rear surface of the semiconductor wafer 10. So processing of the beveled portion 11, mirror-polishing of the beveled portion 11, and polishing of the outer peripheral portion 14 of the rear surface can be performed in parallel by rotating the semiconductor wafer 10 by using the rotation stage. Further, such an apparatus is preferable also because it can be obtained by minor modification of a conventional apparatus for mirror-polishing the beveled portion 11 of the wafer.

[0043] (Epitaxial wafer)

The epitaxial wafer 100 which can be obtained by the production method described heretofore will be described with reference to FIG. 4. The epitaxial wafer 100 comprises a semiconductor wafer 10 having a beveled portion 11 formed on its end portion, a top surface 12a as a second surface, a rear surface 12b as a first surface opposite to the top surface 12a, and edges 13a and 13b on the surfaces 12a and 12b, which form boundaries between the beveled portion 11 and the surfaces 12a and 12b, respectively; a first epitaxial film 20 having a thickness of 3 μm or more which is formed on the top surface 12a of the semiconductor wafer 10; and a second epitaxial film 30 which is formed only on the outer peripheral portion 14 on the rear surface 12b. Despite the existence of the second epitaxial film 30 attached on the rear surface 12b, an ESFQRmean value which is the flatness of a surface including at least the second epitaxial film surface 31 on the rear surface 12b is characteristically 100 nm or less since the outer peripheral portion 14 includes the roll-off region.

[0044] Here, when the film thickness of the first epitaxial film 20 formed on the surface 12a is very thin, a small amount of the second epitaxial film 30 accordingly attaches to the outer peripheral portion 14 of the rear surface. Therefore, a relatively flat rear surface can be obtained without applying a production method of the present invention. However, the epitaxial wafer 100 characteristically has an ESFQRmean value of 100 nm or less even though the first epitaxial film 20 is formed thereon with a thickness of 3 μm or more.

[0045] ESFQR (Edge flatness metric, Sector based, Front surface referenced, least sQuares fit reference plane, Range of the data within sector) here means SFQR measured inside a fan-shaped region (sector) formed on the entire outer peripheral area of the wafer. ESFQRmax means a maximum value among ESFQRs of all the sectors on the wafer. ESFQRmean is a mean value of ESFQRs of all the sectors. ESFQR prescribed by the present invention is a value measured in a sector (site size) obtained by dividing the entire periphery of the wafer evenly into 72 sectors and having a sector length of 30

apparatus (WaferSight manufactured by KLA-Tencor Corporation). A reference plane was determined as a height of the substrate in the region of 139 mm to 143 mm from the center of the rear surface in a radial direction. FIG. 5(a) reveals that the flatness is degraded at an outer peripheral portion of the rear surface of the epitaxial wafer (when the distance from the wafer center is 145 mm or more).

[0051] (Experiment Example 2)

Next, in this experiment example, the relationship between the film thickness of a first epitaxial film formed on a surface of a semiconductor wafer and the film thickness of a second epitaxial film which attaches to an outer peripheral portion of the rear surface by forming the first epitaxial film was examined. In Experiment Example 1, the epitaxial film with a thickness of 5 μm was formed on the silicon wafer surface; in this experiment example, epitaxial wafers were produced, each of which has a first epitaxial film with a various film thickness by controlling the time for forming the epitaxial film. At that time, epitaxial conditions except for the film formation time was set to be the same as Experiment Example 1.

[0052] The film thickness of the second epitaxial film which have attached to the outer peripheral portion of the rear surface of each epitaxial wafer was measured at a position inside the wafer which is 1 mm and 2 mm inner than the edge position on the rear surface, respectively. FIG. 6 shows the obtained relationship between the film thickness of the first epitaxial film formed on the top surface of the semiconductor wafer and the film thickness of the second epitaxial film attached to the outer peripheral portion of the rear surface. FIG. 6 reveals that the film thickness of the second epitaxial film attached to the outer peripheral portion of the rear surface has a direct correlation with the film thickness of the first epitaxial film formed on the top surface of the semiconductor wafer.

[0053] Note that since the thickness of the second epitaxial film attached to the outer peripheral portion of the rear surface is on the order of tens to hundreds of nanometers, it is difficult to measure the thickness using an FT-IR (Fourier Transform Infrared) metrology film thickness measuring device. Thus, in this experiment example, the measurement was performed as described below. First, the film thickness profile of the first epitaxial film grown on the top surface side of the silicon wafer was measured using an FT-IR metrology film thickness measuring device (QS3300 EG manufactured by Nanometrics Incorporated) and is set as an initial value. After that, the epitaxial wafer was reversed to form an epitaxial film on the rear surface side of the silicon wafer under the same conditions as the growth conditions of the first epitaxial film. This allows the second epitaxial film to be formed also on the outer peripheral portion of the first epitaxial film grown on the top surface of the silicon wafer. The thickness of the epitaxial film, including the thicknesses of the first epitaxial film and the second

how much flatness of the outer peripheral portion of the rear surface differ depending on the varying thickness of the first epitaxial film with or without the roll-off process of the present invention.

[0058] First, as a comparative example, with respect to a silicon wafer having the same specification as the silicon wafer used in Experiment Example 1 (Comparative Example), the time for forming the epitaxial film was controlled to form epitaxial wafers having the first epitaxial film with variously changed thickness. On this occasion, the same epitaxial conditions as Experiment Example 1 were used except for the film formation time. In particular, 25 epitaxial silicon wafers were produced for each of four film thickness standards of the first epitaxial film of 2 μm, 3 μm, 4 μm, and 5 μm.

[0059] Next, as an example, the roll-off amount of the case where the film thickness of the first epitaxial films are 2 μm, 3 μm, 4 μm, and 5 μm was found based on the correlation relationship found in Experiment Example 2, and the 25 silicon wafers per each thickness were subjected to a roll-off process on the rear surface in the same procedural steps as Experiment Example 3. After that, a first epitaxial film was formed in the like manner as the above comparative example to form an epitaxial silicon wafer.

[0060] With respect to the 100 epitaxial wafers obtained by example and the 100 epitaxial wafers obtained by comparative example, ESFQR of the outer peripheral portion of the rear surface was measured by way of the foregoing method. The results are shown in FIG. 7. As apparent from FIG. 7, the epitaxial silicon wafers obtained by Example is found to achieve ESFQRmean value of 100 nm or less regardless of the thickness of the first epitaxial film. On the other hand, the epitaxial silicon wafers obtained by Comparative Example were significantly affected by the film thickness of the first epitaxial film. Some of them achieved ESFQRmean values of 100 nm or less in 2 μm-thick epitaxial growth; however, it was found impossible to achieve the ESFQRmean value of 100 nm or less in epitaxial growth for the thickness of 3 μm or more.

Industrial Applicability

[0061] According to the present invention, an outer peripheral portion of a rear surface of a semiconductor wafer is previously rolled off purposely before forming an epitaxial film, and then the epitaxial film is formed. Thus, the present invention can provide an epitaxial wafer having a highly flat rear surface obtained without polishing top and rear surfaces of the wafer after forming the epitaxial film and a method of producing the same.

Reference Signs List

[0062] 1: ring-shaped polishing cloth

further comprising:

a step of rough-polishing at least one of the first surface and the second surface of the semiconductor wafer, and

a step of finish-polishing at least one of the first surface and the second surface of the semiconductor wafer before the step of forming the first epitaxial film,

wherein a process of mirror-polishing of the beveled portion and the process of polishing the outer peripheral portion are performed in parallel between the rough-polishing step and the finish-polishing step.

[Claim8]

An epitaxial wafer comprising:

a semiconductor wafer having a beveled portion formed on its end portion, a first surface, a second surface opposite to the first surface, and edges on both of the first surface and the second surface, the each edge is boundary with the beveled portion;

a first epitaxial film with a thickness of 3 μm or more formed on the second surface of the semiconductor wafer; and

a second epitaxial film formed on an outer peripheral portion of the first surface,

wherein an ESFQRmean value which represents the flatness of a surface including at least a surface of the second epitaxial film on the first surface is 100 nm or less.