material melt in an identical crucible within a chamber by a Czochralski method, the method having the following steps. The material melt is prepared in the crucible having a diameter of 18 inches. Single-crystal silicon is pulled up from the material melt. A polycrystalline material is additionally charged into and dissolved / melted in the remaining material melt while continuing heating of the material melt. Next single-crystal silicon is pulled up from the material melt having the polycrystalline material additionally charged and dissolved / melted therein. The step of additionally charging and dissolving / melting the polycrystalline material and the step of pulling up next single-crystal silicon are repeated one or more times. In at least one of the step of pulling up single-crystal silicon and the step of pulling up next single-crystal silicon, which is repeated one or more times, at least a part of formation of a tail part of the single-crystal silicon is omitted and the single-crystal silicon is separated from the material melt. A layer containing barium is ~~formed on~~added to a surface of an inner wall of the crucible, and an amount of the barium added to the surface of the inner wall is $1.4 \times 10^{16}$ atoms$\cdot$cm$^{-2}$ or more and $5.4 \times 10^{16}$ atoms$\cdot$cm$^{-2}$ or less.

The amount of added barium herein refers to an amount of added barium on the inner surface of the crucible per unit area. The layer containing barium may be a layer of barium alone or a layer of a barium compound such as barium carbonate or barium hydroxide. Furthermore, the layer containing barium may be a barium-rich layer obtained by injecting barium onto the surface of the crucible.

A method for manufacturing single-crystal silicon

according to the present invention is directed to a method for manufacturing single-crystal silicon using a multi-pulling method for pulling up a plurality of pieces of single-crystal silicon from a material melt in an identical crucible within a chamber by a Czochralski method. The material melt is prepared in the crucible having a diameter of 24 inches. Single-crystal silicon is pulled up from the material melt. A polycrystalline material is additionally charged into and dissolved / melted in the remaining material melt while continuing heating of the material melt. Next single-crystal silicon is pulled up from the material melt having the polycrystalline material additionally charged and dissolved / melted therein. The step of additionally charging and dissolving / melting the polycrystalline material and the step of pulling up next single-crystal silicon are repeated one or more times. In at least one of the step of pulling up single-crystal silicon and the step of pulling up next single-crystal silicon, which is repeated one or more times, at least a part of formation of a tail part of the single-crystal silicon is omitted and the single-crystal silicon is separated from the material melt. A layer containing barium is ~~formed on~~added to a surface of an inner wall of the crucible, and an amount of the barium added to the surface of the inner wall is $5.4 \times 10^{15}$ atoms$\cdot$cm$^{-2}$ or more and $2.7 \times 10^{16}$ atoms$\cdot$cm$^{-2}$ or less.

A method for manufacturing single-crystal silicon according to the present invention is directed to a method for manufacturing single-crystal silicon using a multi-pulling method for pulling up a plurality of pieces of single-crystal silicon from a material melt in an identical crucible within a chamber by a Czochralski

method, the method having the following steps. The material melt is prepared in the crucible having a diameter of 32 inches. Single-crystal silicon is pulled up from the material melt. A polycrystalline material is additionally charged into and dissolved / melted in the remaining material melt while continuing heating of the material melt. Next single-crystal silicon is pulled up from the material melt having the polycrystalline material additionally charged and dissolved / melted therein. The step of additionally charging and dissolving / melting the polycrystalline material and the step of pulling up next single-crystal silicon are repeated one or more times. In at least one of the step of pulling up single-crystal silicon and the step of pulling up next single-crystal silicon, which is repeated one or more times, at least a part of formation of a tail part of the single-crystal silicon is omitted and the single-crystal silicon is separated from the material melt. A layer containing barium is added to a surface of ~~formed on~~ an inner wall of the crucible, and an amount of the barium added to the surface of the inner wall is $1.4 \times 10^{15}$ atoms$\cdot$cm$^{-2}$ or more and $5.4 \times 10^{15}$ atoms$\cdot$cm$^{-2}$ or less.

**Effects of the Invention**

In the method for manufacturing single-crystal silicon according to the present invention, there can be reduced occurrence of dislocation of the single-crystal silicon when the single-crystal silicon is grown using the multi-pulling method for pulling up a plurality of pieces of single-crystal silicon from a material melt in an identical crucible.

**Claim:**

A method for manufacturing single-crystal silicon using a multi-pulling method for pulling up a plurality of pieces of single-crystal silicon from a material melt in an identical crucible within a chamber by a Czochralski method, the method comprising the steps of:

preparing said material melt in said crucible, wherein the crucible has a diameter of 18, 24 or 32 inches, and a layer containing barium is formed on an inner wall of the crucible, and an amount of said barium is $1.4\times10^{16}$ atoms$\bullet$cm$^{-2}$ or more and $5.4\times10^{16}$ atoms$\bullet$cm$^{-2}$ or less in case the diameter of the crucible is 18 inches, $5.4\times10^{15}$ atoms$\bullet$cm$^{-2}$ or more and $2.7\times10^{16}$ atoms$\bullet$cm$^{-2}$ or less in case the diameter of the crucible is 24 inches, or $1.4\times10^{15}$ atoms$\bullet$cm$^{-2}$ or more and $5.4\times10^{15}$ atoms$\bullet$cm$^{-2}$ or less in case the diameter of the crucible is 32 inches;

pulling up a single-crystal silicon from said material melt;

additionally charging a polycrystalline material into said material melt remaining after pulling up the single-crystal silicon and melting the polycrystalline material in said material melt while continuing heating of said material melt; and

pulling up a next single-crystal silicon from said material melt having said polycrystalline material additionally charged and melted therein, wherein

said step of additionally charging and melting the polycrystalline material and said step of pulling up a next single-crystal silicon are repeated one or more times, and wherein at least one of said step of pulling up a single-crystal silicon and said step of pulling up a next

single-crystal silicon, which is repeated one or more times, includes a step of omitting at least a part of formation of a tail part of the single-crystal silicon and separating the single-crystal silicon from said material melt.

**Claims**

1. A method for manufacturing single-crystal silicon using a multi-pulling method for pulling up a plurality of pieces of single-crystal silicon from a material melt in an identical crucible within a chamber by a Czochralski method, the method comprising the steps of:

preparing said material melt in said crucible having a diameter of 18 inches;

pulling up single-crystal silicon from said material melt;

additionally charging a polycrystalline material into remaining said material melt and dissolving the polycrystalline material in said material melt while continuing heating of said material melt; and

pulling up next single-crystal silicon from said material melt having said polycrystalline material additionally charged and dissolved therein, wherein

said step of additionally charging and dissolving the polycrystalline material and said step of pulling up next single-crystal silicon are repeated one or more times,

at least one of said step of pulling up single-crystal silicon and said step of pulling up next single-crystal silicon, which is repeated one or more times, includes a step of omitting at least a part of formation of a tail part of the single-crystal silicon and separating the single-crystal silicon from said material melt, and

barium is added to a surface of an inner wall of said crucible, and an amount of said barium added to the surface of the inner wall is $1.4 \times 10^{16}$ atoms$\cdot$cm$^{-2}$ or more and $5.4 \times 10^{16}$ atoms$\cdot$cm$^{-2}$ or less.

2. A method for manufacturing single-crystal silicon using a multi-pulling method for pulling up a plurality of pieces of single-crystal silicon from a material melt in an identical crucible within a chamber by a Czochralski method, the method comprising the steps of:

preparing said material melt in said crucible having a diameter of 24 inches;

pulling up single-crystal silicon from said material melt;

additionally charging a polycrystalline material into remaining said material melt and dissolving the polycrystalline material in said material melt while continuing heating of said material melt; and

pulling up next single-crystal silicon from said material melt having said polycrystalline material additionally charged and dissolved therein, wherein

said step of additionally charging and dissolving the polycrystalline material and said step of pulling up next single-crystal silicon are repeated one or more times,

at least one of said step of pulling up single-crystal silicon and said step of pulling up next single-crystal silicon, which is repeated one or more times, includes a step of omitting at least a part of formation of a tail part of the single-crystal silicon and separating the single-crystal silicon from said material melt, and

barium is added to a surface of an inner wall of said crucible, and an amount of said barium added to the surface of the inner wall is $5.4 \times 10^{15}$ atoms$\cdot$cm$^{-2}$ or more and $2.7 \times 10^{16}$ atoms$\cdot$cm$^{-2}$ or less.

3. A method for manufacturing single-crystal silicon using a multi-pulling method for pulling up a plurality of pieces of single-crystal silicon from a material melt in an identical crucible within a chamber by a Czochralski method, the method comprising the steps of:

preparing said material melt in said crucible having a diameter of 32 inches;

pulling up single-crystal silicon from said material melt;

additionally charging a polycrystalline material into remaining said material melt and dissolving the polycrystalline material in said material melt while continuing heating of said material melt; and

pulling up next single-crystal silicon from said material melt having said polycrystalline material additionally charged and dissolved therein, wherein

said step of additionally charging and dissolving the polycrystalline material and said step of pulling up next single-crystal silicon are repeated one or more times,

at least one of said step of pulling up single-crystal silicon and said step of pulling up next single-crystal silicon, which is repeated one or more times, includes a step of omitting

at least a part of formation of a tail part of the single-crystal silicon and separating the single-crystal silicon from said material melt, and

barium is added to a surface of an inner wall of said crucible, and an amount of said barium added to the surface of the inner wall is $1.4 \times 10^{15}$ atoms$\cdot$cm$^{-2}$ or more and $5.4 \times 10^{15}$ atoms$\cdot$cm$^{-2}$ or less.