

reduce the variation of in-plane thickness. Studies are made on the technique of increasing accuracy by implanting oxygen ions to form a stop layer against grinding or etching. This method suffers from the problem of film thickness distribution and the problem that a peripheral portion is not neat since an unbonded portion at the periphery can be chipped away during the grinding step or left behind. Sometimes the step of trimming the periphery prior to or during the grinding step must be added, making the method cumbersome.

PRIOR ART DOCUMENT

PATENT DOCUMENT

[0008]

Patent Document 1: JP-A 2011-071487

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0009]

~~An object~~Embodiments of the invention, ~~which has been made under the above circumstances, is seek~~ to provide a method for producing a hybrid substrate of SOI structure having a silicon active layer of quality, by bonding a SOI substrate to a support substrate, typically sapphire substrate, having a different coefficient of thermal expansion from the SOI substrate, which method may ~~excludes~~ the influence of damages by hydrogen ion implantation and may ~~eliminates~~ drawbacks such as partial delamination of silicon active layer at the periphery of the substrate without a need for trimming of the substrate periphery; and a hybrid substrate.

MEANS FOR SOLVING THE PROBLEMS

[0010]

~~The above object is attained by~~ Embodiments of the invention ~~that~~ provides a method for producing a hybrid substrate, and a hybrid substrate, as defined below.

~~{1}~~ According to an aspect of the present invention, there is provided a method for producing a hybrid substrate comprising the steps of:

furnishing an SOI substrate which is obtained by stacking a first silicon oxide layer and a silicon active layer in this order on a silicon substrate such that a terrace portion not including the silicon active layer is left on an outer peripheral portion of the silicon substrate surface, forming a second silicon oxide layer on the silicon

active layer surface of the SOI substrate,

prior to bonding the SOI substrate to a support substrate having a different coefficient of thermal expansion from the SOI substrate, subjecting the surface of the SOI substrate and/or the support substrate to be bonded to

activation treatment,

bonding the SOI substrate to the support substrate at a higher temperature than room temperature, with the second silicon oxide layer interposed therebetween, to form a bonded substrate,

subjecting the bonded substrate to a combination of a consolidation heat treatment for increasing the bond strength between the SOI substrate and the support substrate and a grinding/thinning treatment of thinning the silicon substrate by grinding, the combination being repeated at least twice

under the conditions that the temperature of the first consolidation heat treatment is equal to or higher than the bonding temperature, the silicon substrate after the first grinding/thinning treatment has a thickness of 130 μm at the thinnest, the temperature of the final consolidation heat treatment is 200°C to less than 250°C, the silicon substrate after the final grinding/thinning treatment has a thickness of 60 μm at the thinnest,

etching away the thinned silicon substrate until the first silicon oxide layer is exposed, and

etching away the bare first silicon oxide film, yielding a hybrid substrate in which the silicon active layer is disposed on the support substrate via the silicon oxide layer.

~~[2] The method for producing a hybrid substrate of [1]~~
wherein Preferably, the bonding temperature at which the SOI substrate is bonded to the support substrate is in a range from 100°C to less than 250°C.

5 ~~[3] The method for producing a hybrid substrate of [1] or [2]~~ wherein Preferably, the consolidation heat treatment for increasing the bond strength between the SOI substrate and the support substrate is at a temperature which is higher than the bonding temperature by 0 to 100°C and which is lower
10 than 250°C.

~~[4] The method for producing a hybrid substrate of any one of [1] to [3]~~ wherein Preferably, the temperature of second or subsequent consolidation heat treatment is higher than the temperature of the preceding consolidation heat treatment.

15 ~~[5] The method for producing a hybrid substrate of any one of [1] to [3]~~ wherein Preferably, when the temperature of the first consolidation heat treatment is from 200°C to less than 250°C, the second and subsequent consolidation heat treatments are omitted.

20 ~~[6] The method for producing a hybrid substrate of any one of [1] to [5]~~ wherein Preferably, the silicon substrate after the first grinding/thinning treatment has a thickness of 130 μm to 200 μm.

~~[7] The method for producing a hybrid substrate of any one of [1] to [6]~~ wherein Preferably, the silicon substrate after the final grinding/thinning treatment has a thickness of 60
25 μm to 100 μm.

~~[8] The method for producing a hybrid substrate of any one of [1] to [7]~~ wherein Preferably, the terrace portion has a
30 width of 1 mm to 3 mm.

~~[9] The method for producing a hybrid substrate of any one of [1] to [8]~~ wherein Preferably, the silicon active layer in the SOI substrate is free of vacancy defects and suffers no oxidation-induced stacking faults upon thermal oxidation.

35 ~~[10] The method for producing a hybrid substrate of any one of [1] to [9]~~ wherein Preferably, the support substrate is made of quartz glass, borosilicate glass or sapphire.

~~{11}~~ The Preferably the method for producing a hybrid
substrate of any one of ~~[1] to [10]~~, further comprising
comprises the step of subjecting the support substrate to heat
treatment in a reducing atmosphere, prior to the step of
5 bonding the SOI substrate to the support substrate.

~~{12}~~ The method for producing a hybrid substrate of any one of
~~[1] to [11] wherein Preferably,~~ the support substrate is
thinned such that the surface of the support substrate to be
bonded to the SOI substrate includes an outer peripheral region
10 of predetermined width which is depressed relative to a central
portion.

~~{13}~~ There is also provided A a hybrid substrate produced by
the method of any one of [1] to [12] as disclosed, having the
silicon active layer disposed on the support substrate via the
15 silicon oxide layer.

ADVANTAGEOUS EFFECTS OF THE INVENTION

[0011]

According to embodiments of the invention, even when
20 substrates having different coefficients of thermal expansion
are bonded together, the bond strength between the SOI
substrate and the support substrate can be increased by raising
the heat treatment temperature by an increment sufficient for
the substrates to be bonded by heating at a predetermined
25 temperature. The silicon substrate can be thinned by grinding
under ingeniously selected grinding conditions, while
preventing drawbacks such as separation of silicon active layer
at the substrate periphery. This may ~~eliminates~~ the step of
trimming the substrate periphery as adopted in the prior art.
30 While the first silicon oxide layer in the SOI substrate serves
as an etch stop layer, the thickness of the silicon active
layer ~~is~~ may be precision controllable.

BRIEF DESCRIPTION OF THE DIAGRAMS

35 [0012]

[Fig. 1] FIG. 1 is a schematic view showing one embodiment
of the method for producing a hybrid substrate according to the
invention; (a) being a cross-sectional view of SOI