

CLAIMS

1. A method ~~(100)~~ for forming a semiconductor structure ~~(200)~~ comprising a silicon-on-insulator layer structure with crystalline silicon oxide SiO_x as the insulator material, the method comprising:

providing ~~(120)~~ a crystalline silicon substrate ~~(201)~~ having a substantially clean deposition surface ~~(202)~~ in a vacuum chamber;

10 heating ~~(130)~~ the crystalline silicon substrate to an oxidation temperature T_0 in the range of 550 to 1200~~7~~ ~~550 to 1000, or 550 to 850~~ °C; and

supplying ~~(140)~~, while keeping the crystalline silicon substrate in the oxidation temperature, with an oxidation pressure P_0 in the range of $1 \cdot 10^{-8}$ to $1 \cdot 10^{-4}$ mbar in the vacuum chamber, molecular oxygen O_2 into the vacuum chamber with an oxygen dose D_0 in the range of 0.1 to 1000 Langmuir ~~÷(L)~~;

whereby at least part of the molecular oxygen
20 supplied into the vacuum chamber is adsorbed onto the deposition surface and diffuses into the crystalline silicon substrate, and a crystalline silicon oxide layer ~~(204)~~ with a thickness of at least two molecular layers is formed within the crystalline silicon substrate,
25 between a crystalline silicon base layer ~~(203)~~ and a crystalline silicon top layer ~~(205)~~.

2. A method ~~(100)~~ as defined in claim 1, wherein the oxidation temperature T_0 lies in the range of 550 to 750
30 °C, the oxidation pressure P_0 lies in the range of $1 \cdot 10^{-7}$

to $1 \cdot 10^{-4}$ mbar, and the oxygen dose D_0 lies in the range of 5 to 300 L.

3. A method ~~(100)~~ as defined in claim 2, wherein the oxidation temperature, the oxidation pressure, and the oxygen dose lie within one of the following parameter spaces a) to f):

- a) $T_0 = 550$ to 700 °C, $P_0 = 1 \cdot 10^{-7}$ to $1 \cdot 10^{-4}$ mbar, $D_0 = 10$ to 50 L;
- 10 b) $T_0 = 650$ to 700 °C, $P_0 = 1 \cdot 10^{-7}$ to $1 \cdot 10^{-6}$ mbar, $D_0 = 50$ to 100 L;
- c) $T_0 = 650$ to 750 °C, $P_0 = 1 \cdot 10^{-7}$ to $5 \cdot 10^{-7}$ mbar, $D_0 = 50$ to 300 L;
- d) $T_0 = 700$ to 750 °C, $P_0 = 1 \cdot 10^{-5}$ to $5 \cdot 10^{-5}$ mbar, $D_0 = 5$ to 50 L;
- 15 e) $T_0 = 550$ to 600 °C, $P_0 = 1 \cdot 10^{-7}$ to $5 \cdot 10^{-7}$ mbar, $D_0 = 5$ to 75 L;
- f) $T_0 = 700$ to 750 °C, $P_0 = 5 \cdot 10^{-6}$ to $1 \cdot 10^{-5}$ mbar, $D_0 = 10$ to 100 L.

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4. A method ~~(100)~~ as defined in ~~any of claims 1 to 3~~claim 1, wherein the molecular oxygen is supplied into the vacuum chamber for an oxidation period of at least 0.5 s.

25 5. A method ~~(100)~~ as defined in ~~any of claims 1 to 4~~claim 1 to 4, further comprising cleaning ~~(110)~~ the deposition surface ~~(202)~~ by removing possible native oxide and/or other impurities on the deposition surface of the crystalline silicon substrate therefrom before supplying
30 the molecular oxygen into the vacuum chamber.

6. A method ~~(100)~~ as specified in ~~any of claims~~ claim 1 to 5, wherein the deposition surface ~~(202)~~ is a silicon {100}, silicon {111}, or silicon {110} surface.

5 7. A method ~~(300)~~ as specified in ~~any of claims~~ claim 1 to 6, further comprising annealing ~~(350)~~ the crystalline silicon substrate, after supplying the molecular oxygen, at a post heating temperature in the range of 650 to 750 °C for 30 seconds to 60 minutes, ~~for example, for 5 to 20~~
10 ~~minutes,~~ to remove possible excess oxygen not contained in the crystalline silicon oxide layer.

8. A method ~~(500)~~ as defined in ~~any of claims~~ claim 1 to 7, further comprising depositing ~~(560)~~ a cap layer ~~(606)~~
15 on the crystalline silicon top layer ~~(605)~~, the cap layer comprising, ~~for example,~~ silicon dioxide SiO₂, aluminum oxide Al₂O₃, hafnium oxide HfO₂, or titanium oxide TiO₂.

9. A method ~~(500)~~ as defined in claim 8, wherein the cap
20 layer ~~(606)~~ is deposited so as to have a thickness of 1 to 500 nm ~~or 1 to 400 nm, for example, 3 to 300 nm.~~

10. A semiconductor structure ~~(200)~~ comprising a silicon-on-insulator layer structure with crystalline silicon
25 oxide SiO_x as the insulator material, comprising:

a crystalline silicon base layer ~~(203)~~;

a crystalline silicon oxide layer ~~(204)~~, with a thickness of at least two molecular layers, on the crystalline silicon base layer; and

a crystalline silicon top layer ~~(205)~~ on the crystalline silicon oxide layer.

11. ~~A~~, wherein the semiconductor structure ~~(600)~~ as defined in claim 10, further comprising a cap layer ~~(606)~~ on the crystalline silicon top layer ~~(605)~~, the cap layer comprising, for example, silicon dioxide SiO_2 , aluminum oxide Al_2O_3 , hafnium oxide HfO_2 , or titanium oxide TiO_2 . is formed by:

10 providing a crystalline silicon substrate have a substantially clean deposition surface in a vacuum chamber;

heating the crystalline silicon substrate to an oxidation temperature T_0 in the range of 550 to 1200 °C; and

15 supplying, while keeping the crystalline silicon substrate in the oxidation temperature, with an oxidation pressure P_0 in the range of $1 \cdot 10^{-8}$ to $1 \cdot 10^{-4}$ mbar in the vacuum chamber, molecular oxygen O_2 into the vacuum chamber with an oxygen dose D_0 in the range of 0.1 to 1000 Langmuir;

20 whereby at least part of the molecular oxygen supplied into the vacuum chamber is adsorbed onto the deposition surface and diffuses into the crystalline silicon substrate, and the crystalline silicon oxide layer is formed within the crystalline silicon substrate, between the crystalline silicon base layer and the crystalline silicon top layer.

~~12~~11. A semiconductor structure (600) as defined in claim 10, wherein the deposition surface is silicon {100}, silicon {111}, or silicon {110}.

5 12. A method as defined in claim 11, wherein the cap layer (606) has a thickness of 1 to 500 nm or 1 to 400 nm, for example, 3 to 300 nm¹, wherein the deposition surface is planar.

10 ~~13. A semiconductor structure (200, 600)~~ A method as defined in any claim 1, wherein the oxidation temperature T_0 is in the range of claims 10550 to 12, formed using a method in accordance with any of claims 1 to 9.
~~(Fig. 2)~~850 °C.