CLAIMS:

1. A film structure body comprising:

a silicon substrate including a principal surface composed of a (100) plane;

a zirconium oxide film that is formed on said principal surface, and that have a cubic crystal structure and be (100)-oriented; and

a first conductive film that is formed on said zirconium oxide film, and that includes a platinum film having a cubic crystal structure and being (100)-oriented,

wherein a <100> direction of said platinum film is along a <110> direction of said silicon substrate in said principal surface of said silicon substrate.

2. The film structure body according to claim 1, comprising

a first piezoelectric film that is formed on said first conductive film, and that includes a first lead zirconate titanate film having a tetragonal crystal structure and being (001)-oriented.

3. A film structure body comprising:

a silicon substrate including a principal surface composed of a (100) plane;

a first film that is formed on said principal

surface, and that includes a zirconium oxide film having a cubic crystal structure and being (100)-oriented;

a first conductive film that is formed on said first film, and that includes a platinum film having a cubic crystal structure and being (100)-oriented; and

a first piezoelectric film that is formed on said first conductive film, and that includes a first lead zirconate titanate film having a tetragonal crystal structure and being (001)-oriented,

wherein

in an X-ray diffraction pattern of said first piezoelectric film by a θ-2θ method using a CuKα ray, when:

a diffraction angle of a diffraction peak of a (004) plane of lead zirconate titanate is denoted as $2\theta_{004}$; and

relative permittivity of said first piezoelectric film is denoted as ε_r,

said $2\theta_{004}$ satisfies a following formula (Mathematical Formula 1), and ε_r satisfies a following formula (Mathematical Formula 2):

$$2\theta_{004} \leq 96.5^\circ \quad \text{(Mathematical Formula 1); and}$$

$$\varepsilon_r \leq 450 \quad \text{(Mathematical Formula 2).}$$

4. The film structure body according to claim 3, wherein

when a residual polarization value of said first

piezoelectric film is denoted as P_r,

said P_r satisfies a following formula (Mathematical Formula 3):

$$P_r \geq 28\ \mu C/cm^2 \quad \text{(Mathematical Formula 3)}.$$

5. The film structure body according to claim 3 or 4, comprising

a second conductive film formed on said first piezoelectric film, wherein

said relative permittivity is measured by applying an alternating voltage having a frequency of 1 kHz between said first conductive film and said second conductive film.

6. A film structure body comprising:

a silicon substrate including a principal surface composed of a (100) plane;

a first film that is formed on said principal surface, and that includes a zirconium oxide film having a cubic crystal structure and being (100)-oriented;

a first conductive film that is formed on said first film, and that includes a platinum film having a cubic crystal structure and being (100)-oriented; and

a first piezoelectric film that is formed on said first conductive film, and that includes a first lead zirconate titanate film having a tetragonal crystal structure and being (001)-oriented,

wherein

said first piezoelectric film includes:

a second piezoelectric film that is formed on said first conductive film and that includes a second lead zirconate titanate film having a tetragonal crystal structure and being (001)-oriented; and

a third piezoelectric film that is formed on said second piezoelectric film and that includes a third lead zirconate titanate film;

said second piezoelectric film has compression stress; and

said third piezoelectric film has tensile stress.

7. The film structure body according to claim 6, wherein

said second lead zirconate titanate film has a first composite oxide composed of lead zirconate titanate represented by a following general formula (Chemical Formula 1):

$$Pb(Zr_{1-x}Ti_x)O_3 \quad \text{(Chemical Formula 1)};$$

said third lead zirconate titanate film has a second composite oxide composed of lead zirconate titanate represented by a following general formula (Chemical Formula 2):

$$Pb(Zr_{1-y}Ti_y)O_3 \quad \text{(Chemical Formula 2)};$$

said x satisfies $0.32 \leq x \leq 0.52$; and

said y satisfies $0.32 \leq y \leq 0.52$.

8. The film structure body according to any one of claims 2 to 7, comprising

a second film that is formed on said first conductive film and that contains a third composite oxide represented by a following general formula (Chemical Formula 3) and (100)-oriented in a pseudo-cubic representation,

$Sr(Ti_{1-z}Ru_z)O_3$ (Chemical Formula 3), wherein:

said first piezoelectric film is formed over said first conductive film via said second film; and

said z satisfies $0 \leq z \leq 1$.

9. A film structure body, comprising:

a silicon substrate including a principal surface composed of a (100) plane;

a first film that is formed on said principal surface and that contains zirconium oxide having a cubic crystal structure and being (100)-oriented;

a first conductive film that is formed on said first film and contains platinum having a cubic crystal structure and being (100)-oriented; and

a first piezoelectric film that is formed on said first conductive film and contains lead zirconate titanate having a tetragonal crystal structure and being (001)-oriented, wherein:

in an X-ray diffraction pattern of said first

piezoelectric film by a θ-2θ method using a CuKα ray, when:

a diffraction angle of a diffraction peak of a (004) plane of lead zirconate titanate is denoted as $2\theta_{004}$; and

relative permittivity of said first piezoelectric film is denoted as ε_r,

said $2\theta_{004}$ satisfies a following formula (Mathematical Formula 1), and ε_r satisfies a following formula (Mathematical Formula 2):

$$2\theta_{004} \leq 96.5^\circ \quad \text{(Mathematical Formula 1); and}$$

$$\varepsilon_r \leq 450 \quad \text{(Mathematical Formula 2).}$$

10. The film structure body according to claim 9, wherein

when a residual polarization value of said first piezoelectric film is denoted as P_r,

said P_r satisfies a following formula (Mathematical Formula 3):

$$P_r \geq 28\ \mu C/cm^2 \quad \text{(Mathematical Formula 3).}$$

11. The film structure body according to claim 9 or 10, comprising

a second conductive film formed on said first piezoelectric film, wherein

said relative permittivity is measured by applying an alternating voltage having a frequency of 1 kHz

between said first conductive film and said second conductive film.

12. The film structure body according to any one of claims 9 to 11, wherein

said first piezoelectric film includes:

a second piezoelectric film that is formed on said first conductive film and that contains a first composite oxide composed of lead zirconate titanate; and

a third piezoelectric film that is formed on said second piezoelectric film and that contains a second composite oxide composed of lead zirconate titanate;

said second piezoelectric film has compression stress; and

said third piezoelectric film has tensile stress.

13. The film structure body according to claim 12, wherein

said second piezoelectric film contains said first composite oxide represented by a following general formula (Chemical Formula 1):

$$Pb(Zr_{1-x}Ti_x)O_3 \quad \text{(Chemical Formula 1)};$$

said third piezoelectric film contains said second composite oxide represented by a following general formula (Chemical Formula 2):

$$Pb(Zr_{1-y}Ti_y)O_3 \quad \text{(Chemical Formula 2)};$$

said x satisfies $0.32 \leq x \leq 0.52$; and

said y satisfies $0.32 \leq y \leq 0.52$.

14. The film structure body according to any one of claims 9 to 13, comprising

a second film that is formed on said first conductive film and that contains a third composite oxide represented by a following general formula (Chemical Formula 3) and (100)-oriented in a pseudo-cubic representation;

$Sr(Ti_{1-z}Ru_z)O_3$ (Chemical Formula 3), wherein

said first piezoelectric film is formed over said first conductive film via said second film; and

said z satisfies $0 \leq z \leq 1$.

15. The film structure body according to any one of claims 9 to 14, wherein:

said first film is epitaxially grown on said principal surface;

said first conductive film is epitaxially grown on said first film; and

said first piezoelectric film is epitaxially grown on said first conductive film.

16. A method for manufacturing a film structure body, comprising the steps of:

(a) preparing a silicon substrate including a

principal surface composed of a (100) plane;

(b) forming a zirconium oxide film having a cubic crystal structure and being (100)-oriented, on said principal surface; and

(c) forming a first conductive film including a platinum film having a cubic crystal structure and being (100)-oriented, on said zirconium oxide film,

wherein a <100> direction of said platinum film is along a <110> direction of said silicon substrate in said principal surface of said silicon substrate.

17. The method for manufacturing a film structure body according to claim 16, the method comprising the step of:

(d) forming a first piezoelectric film that includes a first lead zirconate titanate film having a tetragonal crystal structure and being (001)-oriented, on said first conductive film.

18. A method for manufacturing a film structure body, comprising the steps of:

(a) preparing a silicon substrate including a principal surface composed of a (100) plane;

(b) forming a first film including a zirconium oxide film having a cubic crystal structure and being (100)-oriented, on said principal surface;

(c) forming a first conductive film including a

platinum film having a cubic crystal structure and being (100)-oriented, on said first film; and

(d) forming a first piezoelectric film that includes a first lead zirconate titanate film having a tetragonal crystal structure and being (001)-oriented, on said first conductive film,

wherein:

in an X-ray diffraction pattern of said first piezoelectric film by a θ-2θ method using a CuKα ray, when:

a diffraction angle of a diffraction peak of a (004) plane of lead zirconate titanate is denoted as $2\theta_{004}$; and

relative permittivity of said first piezoelectric film is denoted as ε_r,

said $2\theta_{004}$ satisfies a following formula (Mathematical Formula 1); and

said ε_r satisfies a following formula (Mathematical Formula 2):

$$2\theta_{004} \leq 96.5^\circ \quad \text{(Mathematical Formula 1); and}$$

$$\varepsilon_r \leq 450 \quad \text{(Mathematical Formula 2).}$$

19. The method for manufacturing a film structure body according to claim 18, wherein:

when a residual polarization value of said first piezoelectric film is denoted as P_r,

said P_r satisfies a following formula (Mathematical

Formula 3):

$$P_r \geq 28\ \mu C/cm^2 \quad \text{(Mathematical Formula 3).}$$

20. The method for manufacturing a film structure body according to claim 18 or 19, the method comprising the step of:

(e) forming a second conductive film on said first piezoelectric film, wherein

said relative permittivity is measured by applying an alternating voltage having a frequency of 1 kHz between said first conductive film and said second conductive film.

21. A method for manufacturing a film structure body, comprising the steps of:

(a) preparing a silicon substrate including a principal surface composed of a (100) plane;

(b) forming a first film including a zirconium oxide film having a cubic crystal structure and being (100)-oriented, on said principal surface;

(c) forming a first conductive film including a platinum film having a cubic crystal structure and being (100)-oriented, on said first film; and

(d) forming a first piezoelectric film that includes a first lead zirconate titanate film having a tetragonal crystal structure and being (001)-oriented, on said first conductive film,

wherein:

said step (d) includes the steps of:

(f) forming a second piezoelectric film that includes a second lead zirconate titanate film having a tetragonal crystal structure and being (001)-oriented, on said first conductive film; and

(g) forming a third piezoelectric film including a third lead zirconate titanate film, on said second piezoelectric film;

said step (f) forms said second piezoelectric film having compression stress; and

said step (g) forms said third piezoelectric film having tensile stress.

22. The method for manufacturing a film structure body according to claim 21, wherein

said second lead zirconate titanate film has a first composite oxide composed of lead zirconate titanate represented by a following general formula (Chemical Formula 1):

$$Pb(Zr_{1-x}Ti_x)O_3 \quad \text{(Chemical Formula 1);}$$

said third lead zirconate titanate film has a second composite oxide composed of lead zirconate titanate represented by a following general formula (Chemical Formula 2):

$$Pb(Zr_{1-y}Ti_y)O_3 \quad \text{(Chemical Formula 2);}$$

said x satisfies $0.32 \leq x \leq 0.52$; and

said y satisfies $0.32 \leq y \leq 0.52$.

23. The method for manufacturing a film structure body according to claim 22, wherein:

said step (f) forms said second piezoelectric film by a sputtering method; and

said step (g) includes the steps of:

(g1) forming a second film containing a first precursor of said second composite oxide by applying a first solution containing lead, zirconium and titanium onto said second piezoelectric film; and

(g2) forming said third piezoelectric film by heat-treating said second film.

24. The method for manufacturing a film structure body according to claim 23, wherein:

said step (f) deposits a third film containing said first composite oxide at a temperature of 425 to 475°C and at a first deposition rate of not more than 0.29 nm/s, and forms said second piezoelectric film composed of said third film having been deposited.

25. The method for manufacturing a film structure body according to claim 23, wherein:

said step (f) includes the steps of:

(f1) depositing a fourth film containing said first composite oxide at a temperature of 425 to 475°C

and at a second deposition rate of not more than 0.29 nm/s; and

(f2) depositing a fifth film containing said first composite oxide at a temperature of 425 to 475°C and at a third deposition rate smaller than said second deposition rate on said fourth film, and forming a second piezoelectric film composed of said fourth film and said fifth film having been deposited.

26. The method for manufacturing a film structure body according to claim 23, wherein:

said step (f) includes the steps of:

(f3), after said step (c), holding said silicon substrate with a substrate-holding part inside a chamber; and

(f4), after said step (f3), depositing said second piezoelectric film on said first conductive film by sputtering a surface of a target containing lead zirconate titanate inside said chamber;

said substrate-holding part is supported with a support part attached to said chamber;

a first insulating member is interposed between said support part and said substrate-holding part, or between said chamber and said support part; and

said step (f3) holds said silicon substrate in a state where an outer peripheral part of said silicon substrate comes into contact with said substrate-holding

part, and a central part of said silicon substrate is separated from said substrate-holding part.

27. The method for manufacturing a film structure body according to claim 23, wherein:

said step (f) includes the steps of:

(f5), after said step (c), holding said silicon substrate with a substrate-holding part inside a chamber; and

(f6), after said step (f5), causing a deposition material to adhere onto said first conductive film by sputtering a surface of a target containing lead zirconate titanate inside said chamber to thereby deposit said second piezoelectric film;

said step (f6) prevents said deposition material from adhering to said substrate-holding part with a deposition-preventive plate that is attached to said chamber and that is composed of a first conductive member;

a second insulating member is interposed between said chamber and said deposition-preventive plate;

said deposition-preventive plate electrically floats; and

said step (f5) holds said silicon substrate in a state where an outer peripheral part of said silicon substrate comes into contact with said substrate-holding part, and a central part of said silicon substrate is

separated from said substrate-holding part.

28. A method for manufacturing a film structure body, comprising the steps of:

(a) preparing a silicon substrate including a principal surface composed of a (100) plane;

(b) forming a first film including a zirconium oxide film having a cubic crystal structure and being (100)-oriented, on said principal surface;

(c) forming a first conductive film including a platinum film having a cubic crystal structure and being (100)-oriented, on said first film;

(d) forming a first piezoelectric film that includes a first lead zirconate titanate film having a tetragonal crystal structure and being (001)-oriented, on said first conductive film; and

(h), after said step (c) and before said step (d), forming a sixth film containing a third composite oxide that is represented by a following general formula (Chemical Formula 3) and that is (100)-oriented in a pseudo-cubic representation, on said first conductive film:

$$Sr(Ti_{1-z}Ru_z)O_3 \quad \text{(Chemical Formula 3)}$$

, wherein said z satisfies $0 \leq z \leq 1$.

29. A method for manufacturing a film structure body, comprising the steps of:

(a) preparing a silicon substrate including a principal surface composed of a (100) plane;

(b) forming a first film containing zirconium oxide having a cubic crystal structure and being (100)-oriented, on said principal surface;

(c) forming a first conductive film containing platinum having a cubic crystal structure and being (100)-oriented, on said first film; and

(d) forming a first piezoelectric film containing lead zirconate titanate having a tetragonal crystal structure and being (001)-oriented, on said first conductive film, wherein

in an X-ray diffraction pattern of said first piezoelectric film by a θ-2θ method using a CuKα ray, when:

a diffraction angle of a diffraction peak of a (004) plane of lead zirconate titanate is denoted as $2\theta_{004}$; and

relative permittivity of said first piezoelectric film is denoted as ε_r,

said $2\theta_{004}$ satisfies a following formula (Mathematical Formula 1), and

said ε_r satisfies a following formula (Mathematical Formula 2):

$$2\theta_{004} \leq 96.5^\circ \quad \text{(Mathematical Formula 1), and}$$

$$\varepsilon_r \leq 450 \quad \text{(Mathematical Formula 2).}$$

30. The method for manufacturing a film structure body according to claim 29, wherein:

when a residual polarization value of said first piezoelectric film is denoted as P_r,

said P_r satisfies a following formula (Mathematical Formula 3):

$$P_r \geq 28\ \mu C/cm^2 \quad \text{(Mathematical Formula 3)}.$$

31. The method for manufacturing a film structure body according to claim 29 or 30, the method comprising the step of:

(e) forming a second conductive film on said first piezoelectric film; wherein

said relative permittivity is measured by applying an alternating voltage having a frequency of 1 kHz between said first conductive film and said second conductive film.

32. The method for manufacturing a film structure body according to any one of claims 29 to 31, wherein:

said step (d) includes the steps of:

(f) forming a second piezoelectric film containing a first composite oxide composed of lead zirconate titanate, on said first conductive film; and

(g) forming a third piezoelectric film containing a second composite oxide composed of lead zirconate titanate, on said second piezoelectric film;

said step (f) forms said second piezoelectric film having compression stress; and

said step (g) forms said third piezoelectric film having tensile stress.

33. The method for manufacturing a film structure body according to claim 32, wherein

said step (f) forms said second piezoelectric film containing said first composite oxide represented by a following general formula (Chemical Formula 1):

$$Pb(Zr_{1-x}Ti_x)O_3 \quad \text{(Chemical Formula 1);}$$

said step (g) forms said third piezoelectric film containing said second composite oxide represented by a following general formula (Chemical Formula 2):

$$Pb(Zr_{1-y}Ti_y)O_3 \quad \text{(Chemical Formula 2);}$$

said x satisfies $0.32 \leq x \leq 0.52$; and

said y satisfies $0.32 \leq y \leq 0.52$.

34. The method for manufacturing a film structure body according to claim 32 or 33, wherein:

said step (f) forms said second piezoelectric film by a sputtering method; and

said step (g) includes the steps of:

(g1) forming a second film containing a first precursor of said second composite oxide by applying a first solution containing lead, zirconium and titanium onto said second piezoelectric film; and

(g2) forming said third piezoelectric film by heat-treating said second film.

35. The method for manufacturing a film structure body according to claim 34, wherein:

said step (f) deposits a third film containing said first composite oxide at a temperature of 425 to 475°C and at a first deposition rate of not more than 0.29 nm/s, and forms said second piezoelectric film composed of said third film having been deposited.

36. The method for manufacturing a film structure body according to claim 34, wherein:

said step (f) includes the steps of:

(f1) depositing a fourth film containing said first composite oxide at a temperature of 425 to 475°C and at a second deposition rate of not more than 0.29 nm/s; and

(f2) depositing a fifth film containing said first composite oxide at a temperature of 425 to 475°C and at a third deposition rate smaller than said second deposition rate on said fourth film, and forming a second piezoelectric film composed of said fourth film and said fifth film having been deposited.

37. The method for manufacturing a film structure body according to any one of claims 29 to 36, the method

comprising the step of

(h), after said step (c) and before said step (d), forming a sixth film containing a third composite oxide that is represented by a following general formula (Chemical Formula 3) and that is (100)-oriented in a pseudo-cubic representation, on said first conductive film:

$Sr(Ti_{1-z}Ru_z)O_3$ **(Chemical Formula 3), wherein**

said z satisfies $0 \leq z \leq 1$.

38. The method for manufacturing a film structure body according to any one of claims 29 to 37, wherein:

said step (b) forms said first film epitaxially grown on said principal surface;

said step (c) forms said first conductive film epitaxially grown on said first film; and

said step (d) forms said first piezoelectric film epitaxially grown on said first conductive film.