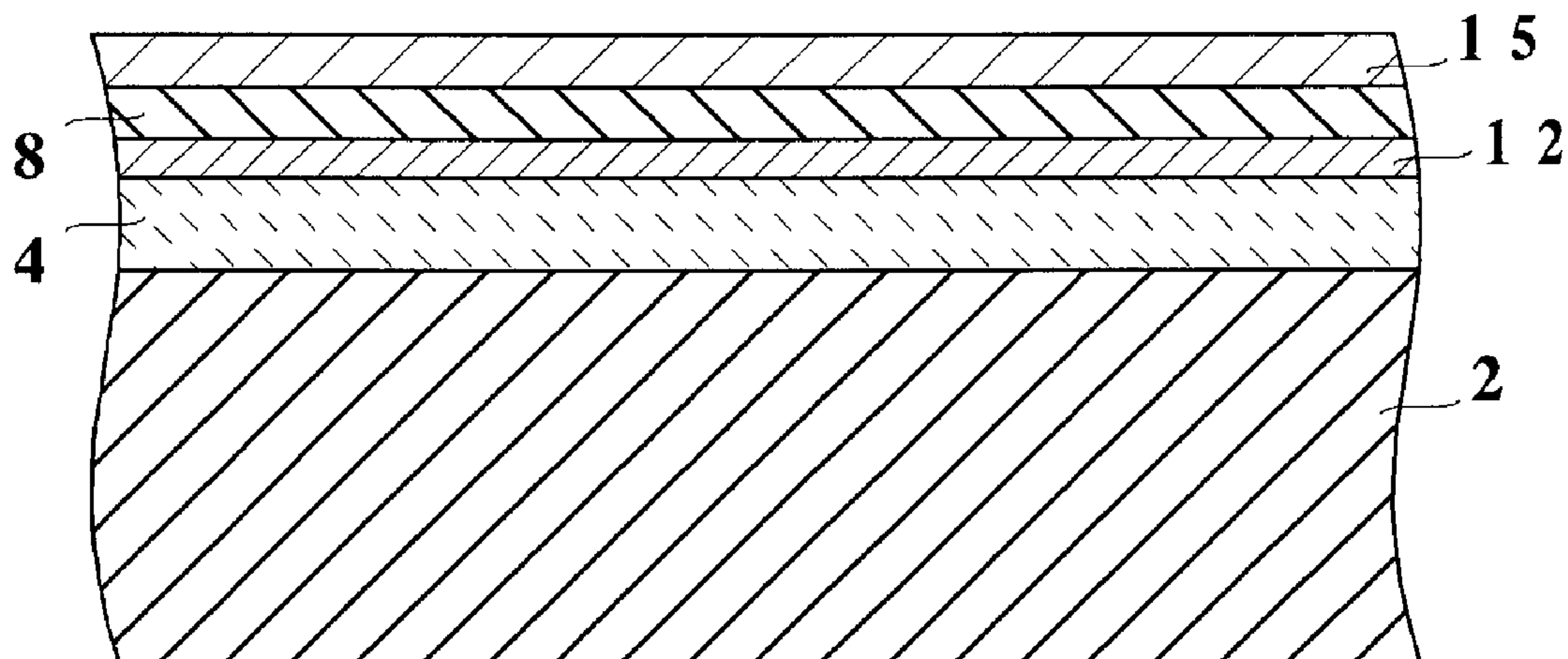




(86) Date de dépôt PCT/PCT Filing Date: 1996/07/05
(87) Date publication PCT/PCT Publication Date: 1997/01/30
(45) Date de délivrance/Issue Date: 2002/01/01
(85) Entrée phase nationale/National Entry: 1997/02/12
(86) N° demande PCT/PCT Application No.: JP 96/01883
(87) N° publication PCT/PCT Publication No.: WO 97/03468
(30) Priorité/Priority: 1995/07/07 (Hei 7-172142) JP

(51) Cl.Int.⁶/Int.Cl.⁶ H01G 7/06
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(54) Titre : CONDENSATEUR FERRO-ELECTRIQUE ET METHODE DE FABRICATION
(54) Title: FERROELECTRIC CAPACITOR AND METHOD FOR MANUFACTURING THEREOF



(57) Abrégé/Abstract:

A dielectric capacitor having excellent dielectric properties which comprises a silicon oxide layer (4), a lower electrode (12), a ferroelectric layer (8), and an upper electrode (15) formed on a silicon substrate (2). The lower electrode (12) is formed of palladium oxide, and so is the upper electrode (15). Palladium oxide prevents the permeation of oxygen through the dielectric layer (8), thus offering a dielectric capacitor having excellent dielectric properties.

Abstract of Disclosure

An object of the present invention is to provide a ferroelectric capacitor which shows excellent ferroelectricity. A silicon oxidation layer 4, a lower electrode 12, a ferroelectric layer 8 and an upper electrode 15 are formed on a silicon substrate 2. The lower electrode 12 is made of palladium oxide. Also, the upper electrode 15 is made by palladium oxide. Since palladium oxide prevents leakage of oxygen contained in the ferroelectric layer 8. So that, a ferroelectric capacitor offers excellent ferroelectricity can be realized.

A Ferroelectric Capacitor and a Method for Manufacturing Thereof

Field of the Invention

5 The present invention relates to a ferroelectric capacitor and, more specifically, to improvement of the ferroelectricity and other characteristics of the capacitor.

Background art

10 Fig. 10 shows a conventional ferroelectric capacitor. A silicon oxidation layer 4 is formed on a silicon substrate 2. A lower electrode 6 made of platinum is provided thereon. A PZT ($\text{PbZr}_x\text{Ti}_{1-x}\text{O}_3$) film 8 as a ferroelectric layer is formed on the lower electrode 6, and
15 an upper electrode 10 made of platinum is provided thereon. Thus, the ferroelectric capacitor is formed by the lower electrode 6, the PZT film 8 and the upper electrode 10.

 The reason to use platinum for the lower electrode 6 is as follows. The PZT film 8 must be formed on a layer
20 which can be oriented, because the ferroelectricity of PZT is degraded when the PZT film is formed on a layer made of amorphous material, since the PZT film cannot be oriented. Meanwhile, the lower electrode 6 must be insulated from the silicon substrate 2, therefore, the silicon oxidation layer
25 4 is formed on the silicon substrate 2. The silicon oxidation layer 4 is amorphous. In general, although a layer formed on an amorphous material becomes nonorientable, a layer made of platinum has a characteristic of becoming orientable even when it is formed on the amorphous material.
30 Therefore, platinum is used for forming the lower electrode because of the reason described above.

 However, the conventional ferroelectric capacitor has the following problem to be resolved.

 The problem is degradation of ferroelectricity
35 caused by frequent inversion of polarization, aging and leakage of oxygen from the ferroelectric substance (PZT),

since platinum has a tendency of allowing oxygen and Pb to pass through it. In other words, there is high probability of leakage of oxygen and Pb contained in the ferroelectric substance between the columnar crystals of platinum, as shown in Fig. 11. The problem also arises in a capacitor using a dielectric substance having high dielectric constant.

Disclosure of the present invention

10 It is an object of the present invention to provide a ferroelectric capacitor having less degradation of ferroelectricity caused by frequent inversion of polarization and aging or a dielectric capacitor maintaining high dielectric constant, both of which resolve the problem
15 described in the above.

The word "capacitor" in the present invention defines structure having electrodes on both sides of an insulator, also it is a concept having the structure stated in the above regardless of whether it is used for electric
20 storage.

In accordance with a first embodiment of the invention, a ferroelectric capacitor comprises:

a lower electrode having an oxidation layer including at least one layer selected from a WOx layer, a TiOx layer, a TaOx layer, an IrO₂ layer, a PtO₂ layer, an RuOx layer, an ReOx layer, a PdOx layer and an OsOx layer,
25 a dielectric layer comprising either a ferroelectric substance or a dielectric substance having a high dielectric constant, the dielectric layer being formed on the lower
30 electrode, and
an upper electrode formed on the dielectric layer.

By providing the lower electrode with at least one oxidation layer selected from a WOx layer, a TiOx layer, a TaOx layer, an IrO₂ layer, a PtO₂ layer, an RuOx layer, an ReOx layer, a PdOx layer and an OsOx layer, it is possible
35 to prevent leakage of oxygen from the dielectric layer as

well as suppressing degradation of ferroelectricity by aging.

Preferably, the lower electrode comprises a
5 conductive layer which includes at least one layer selected from a W layer, a Ti layer, a Ta layer, an Ir layer, a Pt layer, an Ru layer, an Re layer, a Pd layer and an Os layer on the oxidation layer, and a ferroelectric layer is formed on the conductive layer.

10 More preferably, the lower electrode is formed on a silicon oxidation layer located on a substrate, and the lower electrode has a contact layer in contact with the silicon oxidation layer.

15 By providing the lower electrode with a conductive layer which includes at least one layer selected from a W layer, a Ti layer, a Ta layer, an Ir layer, a Pt layer, an Ru layer, an Re layer, a Pd layer and an Os layer on the
20 oxidation layer and providing a ferroelectric layer on the conductive layer, leakage current can be decreased.

In accordance with a second embodiment of the invention, a ferroelectric capacitor comprises:

25 a lower electrode,
a dielectric layer comprising either a ferroelectric substance or a dielectric substance having a high dielectric constant, the dielectric layer being formed on the lower electrode, and

30 an upper electrode formed on the dielectric layer and including at least one layer selected from a WOx layer, a TiOx layer, a TaOx layer, an IrO₂ layer, a PtO₂ layer, an RuOx layer, an ReOx layer, a PdOx layer and an OsOx layer.

35 By providing the upper electrode with at least one oxidation layer selected from a WOx layer, a TiOx layer, a TaOx layer, an IrO₂ layer, a PtO₂ layer, an RuOx layer, an

ReOx layer, a PdOx layer and an OsOx layer, it is possible to prevent leakage of oxygen from the dielectric layer as well as suppressing degradation of ferroelectricity by aging.

5

Preferably, the lower electrode is formed on a silicon oxidation layer located on a substrate, and the lower electrode has a contact layer in contact with the silicon oxidation layer.

10

In accordance with a third embodiment of the invention, a ferroelectric capacitor comprises:

a lower electrode having an oxidation layer including at least one layer selected from a WOx layer, a TiOx layer, a TaOx layer, an IrO₂ layer, a PtO₂ layer, an RuOx layer, an ReOx layer, a PdOx layer and an OsOx layer, a dielectric layer comprising either a ferroelectric substance or a dielectric substance having a high dielectric constant, the dielectric layer being formed on the lower electrode, and

20

an upper electrode having an oxidation layer including at least one layer selected from a WOx layer, a TiOx layer, a TaOx layer, an IrO₂ layer, a PtO₂ layer, an RuOx layer, an ReOx layer, a PdOx layer and an OsOx layer.

25

By providing both the upper and the lower electrode with at least one oxidation layer selected from a WOx layer, a TiOx layer, a TaOx layer, an IrO₂ layer, a PtO₂ layer, an RuOx layer, an ReOx layer, a PdOx layer and an OsOx layer, it is possible to prevent leakage of oxygen from the dielectric layer as well as suppressing degradation of ferroelectricity by aging.

30

Preferably, the lower electrode comprises a conductive layer which includes at least one layer selected from a W layer, a Ti layer, a Ta layer, an Ir layer, a Pt layer, an Ru layer, an Re layer, a Pd layer and an Os layer

35

on the oxidation layer, and a ferroelectric layer is formed on the conductive layer.

More preferably, the lower electrode is formed on a silicon oxidation layer located on a substrate, and the lower electrode has a contact layer in contact with the silicon oxidation layer.

By providing at least one layer selected from a W layer, a Ti layer, a Ta layer, an Ir layer, a Pt layer, an Ru layer, an Re layer, a Pd layer and an Os layer on the oxidation layer and providing a dielectric layer on the conductive layer, leakage current can be decreased.

Thus, in accordance with the invention, a ferroelectric capacitor which offers excellent ferroelectricity and high dielectric property is attainable.

In accordance with a further aspect of the invention, a method of manufacturing a ferroelectric capacitor comprises the steps of:

forming at least one oxidation layer selected from a WO_x layer, a TiO_x layer, a TaO_x layer, an IrO₂ layer, a PtO₂ layer, an RuO_x layer, an ReO_x layer, a PdO_x layer and an OsO_x layer on a substrate as a lower electrode by sputtering,

forming either a ferroelectric film or a dielectric layer having a high dielectric constant on the lower electrode as a dielectric layer, and

forming an upper electrode on the dielectric layer.

In accordance with a second method embodiment of the invention, a method of manufacturing a ferroelectric capacitor comprises the steps of:

forming at least one layer selected from a W layer, a Ti layer, a Ta layer, an Ir layer, a Pt layer, an Ru layer, an Re layer, a Pd layer and an Os layer on a

substrate as a base layer by sputtering,

oxidizing a surface of the base layer,

forming either a ferroelectric film or a dielectric layer having a high dielectric constant on the base layer as
5 a dielectric layer, a surface of the base layer being oxidized, and

forming an upper electrode on the dielectric layer.

In accordance with a third method embodiment of the
10 invention, a method of manufacturing a ferroelectric capacitor comprises the steps of:

forming either a ferroelectric film or a dielectric layer having a high dielectric constant on a lower electrode as a dielectric layer, and

15 forming at least one oxidation layer selected from a WOx layer, a TiOx layer, a TaOx layer, an IrO₂ layer, a PtO₂ layer, an RuOx layer, an ReOx layer, a PdOx layer and an OsOx layer on the dielectric layer as an upper electrode by sputtering.

20

In accordance with a fourth method embodiment of the invention, a method of manufacturing a ferroelectric capacitor comprises the steps of:

forming a lower electrode on a substrate,

25 forming either a ferroelectric film or a dielectric layer having a high dielectric constant on the lower electrode as a dielectric layer,

forming at least one layer selected from a W layer, a Ti layer, a Ta layer, an Ir layer, a Pt layer, an Ru
30 layer, an Re layer, a Pd layer and an Os layer on the dielectric layer as a base layer by sputtering, and
oxidizing a surface of the base layer.

In accordance with a fifth method embodiment of the
35 invention, a method of manufacturing a ferroelectric capacitor comprises the steps of:

forming at least one layer selected from a W layer,

a Ti layer, a Ta layer, an Ir layer, a Pt layer, an Ru layer, an Re layer, a Pd layer and an Os layer on a substrate as a base layer by sputtering,

forming at least one layer selected from a W layer,
5 a Ti layer, a Ta layer, an Ir layer, a Pt layer, an Ru layer, an Re layer, a Pd layer and an Os layer on a surface of the base layer as a conductive layer,

forming a thin conductive layer on a surface of the conductive layer and oxidizing the conductive layer on the
10 surface of which is covered with the thin conductive layer,

forming either a ferroelectric film or a dielectric layer having a high dielectric constant on the conductive layer as a dielectric layer, the conductive layer being oxidized, and

15 forming an upper electrode on the dielectric layer.

Preferably, the step of oxidization is carried out within the step of forming the dielectric layer.

20

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a view showing the structure of a ferroelectric capacitor in an embodiment of the present
25 invention.

Fig. 2 is a diagram showing a nonvolatile memory using a ferroelectric capacitor 22.

Fig. 3A, Fig. 3B, Fig. 3C and Fig. 3D show successive stages in the fabrication of the ferroelectric
30 capacitor.

Fig. 4 is a view showing the structure of the ferroelectric capacitor when a contact layer 30 is provided.

Fig. 5 is a view showing the structure of the ferroelectric capacitor when a dielectric layer 90 having
35 high dielectric constant is provided.

Fig. 6 is a view showing the structure of a ferroelectric capacitor in another embodiment of the present

invention.

Fig. 7 illustrates the mechanism whereby the palladium oxidation layer prevents leakage of oxygen from the ferroelectric film.

5 Fig. 8A, Fig. 8B, Fig. 8C and Fig. 8D are flow charts showing manufacturing processes of the ferroelectric capacitor shown in Fig. 6.

Fig. 9 is a view showing another embodiment of the present invention that carries out oxidation of palladium
10 after forming a thin platinum layer.

Fig. 10 is a view showing the structure of a ferroelectric capacitor in the prior art.

Fig. 11 is a view showing leakage of oxygen through the lower electrode 6 made of platinum.

15

THE BEST MODE OF PREFERRED EMBODIMENT TO CARRY OUT THE PRESENT INVENTION

Fig. 1 shows the structure of a ferroelectric capacitor fabricated in accordance with a first embodiment
20 of the present invention. In the ferroelectric capacitor, a silicon oxidation layer 4, a lower electrode 12, a ferroelectric film (ferroelectric layer) 8 and an upper electrode 15 are formed on a silicon substrate 2. The lower electrode 12 is made of palladium oxide (PdOx), and the
25 upper electrode 15 is also formed by palladium oxide (PdOx).

As shown in Fig. 11 which illustrates the conventional ferroelectric capacitor, oxygen contained in the ferroelectric film 8 passes through the platinum layer 6 having columnar crystals. Palladium oxide is used for the
30 lower electrode 12 in the present embodiment. Since the palladium oxide layer 12 does not have columnar crystals, it is hard for the oxygen to pass through it. Therefore, shortage of oxygen in the ferroelectric film 8 can be prevented. Shortage of oxygen can also be prevented by the
35 upper electrode 15 which does not have columnar crystals. Thus, the ferroelectricity of the ferroelectric film 8 is improved. Remarkable improvement of ferroelectricity

degradation caused by use of remanent polarization P_r is observed when either of the upper electrode 15 or the lower electrode 12 is made of palladium oxide in comparison with when either one of the electrodes is composed of platinum.

5 Since both of the lower electrode 12 and the upper electrode 15 are made of palladium oxide in the embodiment described above, the electrodes made of palladium oxide ensure prevention of leakage of oxygen and Pb. Certain prevention of leakage can be expected when either of the
10 electrodes is made of palladium oxide.

The ferroelectric capacitor described above can be used for a nonvolatile memory when it is combined with a transistor 24 as shown in Fig. 2.

Fig. 3A, Fig. 3B, Fig. 3C and Fig. 3D show
15 successive stages in the fabrication of a ferroelectric capacitor according to the present invention. A silicon oxidation layer 4 is formed by carrying out thermal oxidation of a surface of the silicon substrate 2 (Fig. 3A). In this embodiment, the silicon oxidation layer 4 is formed
20 with a thickness of 600 nm. A palladium oxide formed on the silicon oxide layer 4 by reactive sputtering method using palladium as a target is defined as the lower electrode 12 (Fig. 3B). The lower electrode 12 is formed with a
thickness of 200 nm.

25 A PZT film is formed on the lower electrode 12 as the ferroelectric film 8 by sol-gel method (Fig. 3C). A mixed solution of $Pb(CH_3COO)_2 \cdot 3H_2O$, $Zr(t-OC_4H_9)_4$ and $Ti(i-OC_3H_7)_4$ is used as a starter. The mixed solution is dried at a temperature of 150 °C (hereinafter indicated in
30 celsius) after carrying out spin coating, then pre-baking is carried out at a temperature of 400 °C for 30 seconds under dried air atmosphere. Thermal treatment at a temperature over 700 °C is carried out under O_2 atmosphere after carrying out the processes described for 5 times. Thus, the
35 ferroelectric film 8 having a thickness of 250 nm is formed. In this embodiment, the PZT film is formed at a ratio of x equals 0.52 in $PbZr_xTi_{1-x}O_3$ (hereinafter the material is

indicated as PZT (52 • 48)).

Further, a layer of palladium oxide is formed on the ferroelectric film as the upper electrode 15 by reactive sputtering method (Fig. 3D). The upper electrode 15 is
5 formed with a thickness of 200 nm. Thus, the ferroelectric capacitor is completed. Any one of WOx, TiOx, TaOx, IrO₂, PtO₂, ReOx, RuOx, OsOx can be used for the palladium oxide.

In the case of forming a layer made of ferroelectric substance on one of the oxidation layers, orientation of the
10 ferroelectric substance is degraded. In order to maintain the orientation, the layer made of ferroelectric substance can be formed on a conductive layer formed on the oxidation layer. The conductive layer may be selected from of at least one of the following: a W layer, a Ti layer, a Ta
15 layer, an Ir layer, a Pt layer, an Ru layer, an Re layer, an Os layer and the like. Further, leakage of the ferroelectric substance can be decreased by providing the conductive layer.

Fig. 4 shows the structure of a ferroelectric
20 capacitor fabricated in accordance with another embodiment of the present invention. In this embodiment, a layer made of titanium (having a thickness of 5 nm) is provided between the lower electrode 12 and the silicon oxidation layer 4 as a contact layer 30. In general, palladium oxide and silicon
25 oxide do not contact tightly with each other. Therefore, there is a probability of degradation of ferroelectricity occurring due to partial delamination of a layer consisting of an alloy of palladium oxide and silicon oxide. To resolve the degradation, the titanium layer 30 which can be
30 contacted tightly with the silicon oxide layer 4 is provided in this embodiment, so that the ferroelectricity is improved. The titanium layer can be formed by sputtering.

Although the titanium layer is used as the contact
layer 30 in the embodiment described above, any other
35 materials which improve contact can be utilized. For instance, a layer made of platinum can be used for the contact layer.

Though the PZT film is used as the ferroelectric film 8 in the embodiment described above, any other materials can be utilized as long as the materials are ferroelectric oxide. For instance, $\text{Ba}_4\text{Ti}_3\text{O}_{12}$ can be used for the ferroelectric film.

Fig. 5 shows the structure of a ferroelectric capacitor fabricated in accordance with yet another embodiment of the present invention. A dielectric layer 90 having high dielectric constant is used for the ferroelectric film 8 in this embodiment. The lower electrode 12 made of palladium oxide is provided on the silicon oxide layer 4, and a high dielectric thin film made of SrTiO_3 , $(\text{Sr}, \text{Ba})\text{TiO}_3$ having perovskite structure is formed thereon as the dielectric layer 90. In this embodiment, ferroelectricity is improved in the same manner as in the embodiment using the ferroelectric substance. In other words, it is clear that the advantages offered by using the ferroelectric layer can also be obtained by utilizing a dielectric layer having high dielectric constant.

Fig. 6 shows the structure of a ferroelectric capacitor fabricated in accordance with yet another embodiment of the present invention. In this embodiment, the silicon oxidation layer 4, the lower electrode 12, the ferroelectric film (ferroelectric layer) 8 and the upper electrode 15 are provided on the silicon substrate 2. The lower electrode 12 consists of a palladium layer 11 and a palladium oxide layer 13 formed thereon. Also, the upper electrode 15 consists of a palladium layer 7 and a palladium oxide layer 9 formed thereon.

Fig. 7 is an enlarged view of the vicinity of the lower electrode 12. Since the palladium layer 11 has columnar crystals, the oxygen contained in the ferroelectric film 8 passes through the palladium layer 11. A palladium oxide layer 13 is formed on the upper surface of the palladium layer 11 in this embodiment. Therefore, it is possible to prevent shortage of oxygen contained in the ferroelectric film 8 by forming the palladium oxide layer 13

as described above. The upper electrode 15 obtains the same advantage which the lower electrode 12 offers as described above.

Since both of the palladium oxide layers are formed
5 in the lower electrode 12 and the upper electrode 15 respectively in this embodiment, it is possible to obtain a ferroelectric capacitor having excellent ferroelectricity as well as having less influences of aging. Certain advantages as described above can be observed when either of the lower
10 electrode 12 or the upper electrode 15 is formed by the structure described above.

Fig. 8A, Fig. 8B, Fig. 8C and Fig. 8D show successive stages in the fabrication of the ferroelectric capacitor described above. The silicon oxidation layer 4 is
15 formed by carrying out thermal oxidation of a surface of the silicon substrate 2 (Fig. 8A). In this embodiment, the silicon oxidation layer 4 is formed with a thickness of 600 nm. The palladium oxide layer 11 is formed on the silicon oxide layer 4 by utilizing palladium as a target (Fig. 8B).
20 The palladium oxide layer 13 is formed by carrying out a thermal treatment at a temperature of 800 °C for one minute under O₂ atmosphere. The palladium layer 11 and the palladium layer 13 thus formed are defined as the lower electrode 12. The lower electrode 12 is formed with a
25 thickness of 200 nm.

A PZT film is formed on the lower electrode 12 as the ferroelectric film 8 by sol-gel method (Fig. 8C). A mixed solution of $\text{Pb}(\text{CH}_3\text{COO})_2 \cdot 3\text{H}_2\text{O}$, $\text{Zr}(\text{t-OC}_4\text{H}_9)_4$ and $\text{Ti}(\text{i-OC}_3\text{H}_7)_4$ is used as a starter. The mixed solution is
30 dried at a temperature of 150 °C (hereinafter indicated in celsius) after carrying out spin coating, then pre-baking is carried out at a temperature of 400 °C for 30 seconds under dried air atmosphere. Thermal treatment at a temperature over 700 °C is carried out under O₂ atmosphere after carrying
35 out the processes described above for 5 times. Thus, the ferroelectric film 8 having a thickness of 250 nm is formed. In this embodiment, the PZT film is formed at a ratio of x

equals 0.52 in $\text{PbZr}_x\text{Ti}_{1-x}\text{O}_3$ (hereinafter the material is indicated as PZT (52 • 48)).

Further, the palladium 7 is formed on the ferroelectric film 8 by sputtering method. Then, the
5 palladium oxide layer 9 is formed on a surface of the palladium layer 7 by carrying out a thermal treatment at a temperature of 800 °C for one minute under O_2 atmosphere (Fig. 8D). The palladium layer 7 and the palladium oxide layer 9 thus formed are defined as the upper electrode 15.
10 The upper electrode 15 is formed with a thickness of 200 nm. Thus, the ferroelectric capacitor is completed.

It is also preferable to form the contact layer 30 in the ferroelectric capacitor as described in Fig. 4.

The process which oxidizes a surface of the
15 palladium described above can be applied not only to the ferroelectric film, but also to the dielectric layer having high dielectric constant described above, so that the same advantages can be expected.

As described above, though leakage of oxygen can be
20 prevented by oxidizing the surface of the palladium layer, orientation of the ferroelectric layer is degraded by formation of the palladium oxide on its surface. This problem can be resolved by formation of at least one conductive layer on the palladium oxide layer 13, selected
25 from a W layer, Ti layer, Ta layer, Ir layer, Pt layer, Ru layer, Re layer, Os layer or the like, as mentioned above. The problem can also be resolved by forming the lower electrode as follows.

At first, a platinum layer 80 (thin film conductive
30 substance) is formed very thinly on the palladium layer 11 as shown in Fig. 9. The platinum layer 80 is formed in a thickness of 30 nm. Thereafter, a thermal treatment is carried out. The platinum layer is not oxidized because the platinum layer 80 exposed on the surface does not react to
35 oxygen. Also, leakage of oxygen is shut out by formation of palladium oxygen between crystals of the palladium layer 11 located under the platinum layer 80 as a result of

oxidization of the crystals, because the platinum layer 80 is formed thinly. Therefore, the lower electrode 12 which can shut out leakage of oxygen whilst maintaining good orientation can be formed.

5 The palladium layer 11, being formed the thin platinum layer 80 and then being oxidized can also be used as the lower electrode 12 by itself. The palladium layer 11 can be used as the conductive layer having good orientation in the embodiment of improving orientation by providing a
10 conductive layer (a palladium layer, a platinum layer and the like) having good orientation in the palladium layer formed by sputtering.

 Also, all of the embodiments described in the above can be applied not only to a ferroelectric capacitor using
15 the ferroelectric film but also to a capacitor using a dielectric layer having high dielectric constant. Exactly the same advantage offered by applying the present invention to the ferroelectric film can be obtained when the present invention is applied to the dielectric layer having high
20 dielectric constant.

 While the invention has been described in its preferred embodiments, it is to be understood that the words which have been used are words of description rather than limitation and that changes within the purview of the
25 appended claims may be made without departing from the true scope and spirit of the invention in its broader aspects.

CLAIMS:

1. A ferroelectric capacitor comprising:

a lower electrode having an oxidation layer including at
5 least one layer selected from a WOx layer, a TiOx layer, a
TaOx layer, an IrO₂ layer, a PtO₂ layer, an RuOx layer, an
ReOx layer, a PdOx layer and an OsOx layer,
a dielectric layer comprising either a ferroelectric
substance or a dielectric substance having a high dielectric
10 constant, the dielectric layer being formed on the lower
electrode, and
an upper electrode formed on the dielectric layer.

2. A ferroelectric capacitor in accordance with claim 1,
15 wherein the lower electrode comprises a conductive layer
which includes at least one layer selected from a W layer, a
Ti layer, a Ta layer, an Ir layer, a Pt layer, an Ru layer,
an Re layer, a Pd layer and an Os layer on the oxidation
layer, and wherein a ferroelectric layer is formed on the
20 conductive layer.

3. A ferroelectric capacitance in accordance with claim 1
or claim 2, wherein the lower electrode is formed on a
silicon oxidation layer located on a substrate, and wherein
25 the lower electrode has a contact layer in contact with the
silicon oxidation layer.

4. A ferroelectric capacitor comprising:

a lower electrode,
30 a dielectric layer comprising either a ferroelectric
substance or a dielectric substance having a high dielectric
constant, the dielectric layer being formed on the lower
electrode, and
an upper electrode formed on the dielectric layer and
35 including at least one layer selected from a WOx layer, a
TiOx layer, a TaOx layer, an IrO₂ layer, a PtO₂ layer, an
RuOx layer, an ReOx layer, a PdOx layer and an OsOx layer.

5. A ferroelectric capacitor in accordance with claim 4, wherein the lower electrode is formed on a silicon oxidation layer located on a substrate, and wherein the lower electrode has a contact layer in contact with the silicon oxidation layer.

6. A ferroelectric capacitor comprising:

a lower electrode having an oxidation layer including at least one layer selected from a WOx layer, a TiOx layer, a TaOx layer, an IrO₂ layer, a PtO₂ layer, an RuOx layer, an ReOx layer, a PdOx layer and an OsOx layer,

a dielectric layer comprising either a ferroelectric substance or a dielectric substance having a high dielectric constant, the dielectric layer being formed on the lower electrode, and

an upper electrode having an oxidation layer including at least one layer selected from a WOx layer, a TiOx layer, a TaOx layer, an IrO₂ layer, a PtO₂ layer, an RuOx layer, an ReOx layer, a PdOx layer and an OsOx layer.

7. A ferroelectric capacitor in accordance with claim 6, wherein the lower electrode comprises a conductive layer which includes at least one layer selected from a W layer, a Ti layer, a Ta layer, an Ir layer, a Pt layer, an Ru layer, an Re layer, a Pd layer and an Os layer on the oxidation layer, and wherein a ferroelectric layer is formed on the conductive layer.

8. A ferroelectric capacitor in accordance with claim 6 or claim 7, wherein the lower electrode is formed on a silicon oxidation layer located on a substrate, and wherein the lower electrode has a contact layer in contact with the silicon oxidation layer.

9. A method for manufacturing a ferroelectric capacitor comprising the steps of:

forming at least one oxidation layer selected from a WOx

layer, a TiOx layer, a TaOx layer, an IrO₂ layer, a PtO₂ layer, an RuOx layer, an ReOx layer, a PdOx layer and an OsOx layer on a substrate as a lower electrode by sputtering,

5 forming either a ferroelectric film or a dielectric layer having a high dielectric constant on the lower electrode as a dielectric layer, and

 forming an upper electrode on the dielectric layer.

10 10. A method of manufacturing a ferroelectric capacitor comprising the steps of:

forming at least one layer selected from a W layer, a Ti layer, a Ta layer, an Ir layer, a Pt layer, an Ru layer, an Re layer, a Pd layer and an Os layer on a substrate as a

15 base layer by sputtering,

 oxidizing a surface of the base layer,

 forming either a ferroelectric film or a dielectric layer having a high dielectric constant on the base layer as a dielectric layer, a surface of the base layer being

20 oxidized, and

 forming an upper electrode on the dielectric layer.

11. A method of manufacturing a ferroelectric capacitor comprising the steps of:

25 forming either a ferroelectric film or a dielectric layer having a high dielectric constant on a lower electrode as a dielectric layer, and

 forming at least one oxidation layer selected from a WOx layer, a TiOx layer, a TaOx layer, an IrO₂ layer, a PtO₂ layer, an RuOx layer, an ReOx layer, a PdOx layer and an OsOx layer on the dielectric layer as an upper electrode by sputtering.

12. A method of manufacturing a ferroelectric capacitor comprising the steps of:

35 forming a lower electrode on a substrate,

 forming either a ferroelectric film or a dielectric

layer having a high dielectric constant on the lower electrode as a dielectric layer,

forming at least one layer selected from a W layer, a Ti layer, a Ta layer, an Ir layer, a Pt layer, an Ru layer, an Re layer, a Pd layer and an Os layer on the dielectric layer as a base layer by sputtering, and
oxidizing a surface of the base layer.

13. A method of manufacturing a ferroelectric capacitor comprising the steps of:

forming at least one layer selected from a W layer, a Ti layer, a Ta layer, an Ir layer, a Pt layer, an Ru layer, an Re layer, a Pd layer and an Os layer on a substrate as a base layer by sputtering,

forming at least one layer selected from a W layer, a Ti layer, a Ta layer, an Ir layer, a Pt layer, an Ru layer, an Re layer, a Pd layer and an Os layer on a surface of the base layer as a conductive layer,

forming a thin conductive layer on a surface of the conductive layer,

oxidizing the conductive layer on the surface of which is covered with the thin conductive layer,

forming either a ferroelectric film or a dielectric layer having a high dielectric constant on the conductive layer as a dielectric layer, the conductive layer being oxidized, and

forming an upper electrode on the dielectric layer.

14. A method for manufacturing a ferroelectric capacitor in accordance with claim 10, claim 12 or claim 13, wherein the step of oxidization is carried out within the step of forming the dielectric layer.

15. A method for manufacturing a ferroelectric capacitor in accordance with claim 13, wherein the thin conductive layer is made of Pt.

FIG. 1

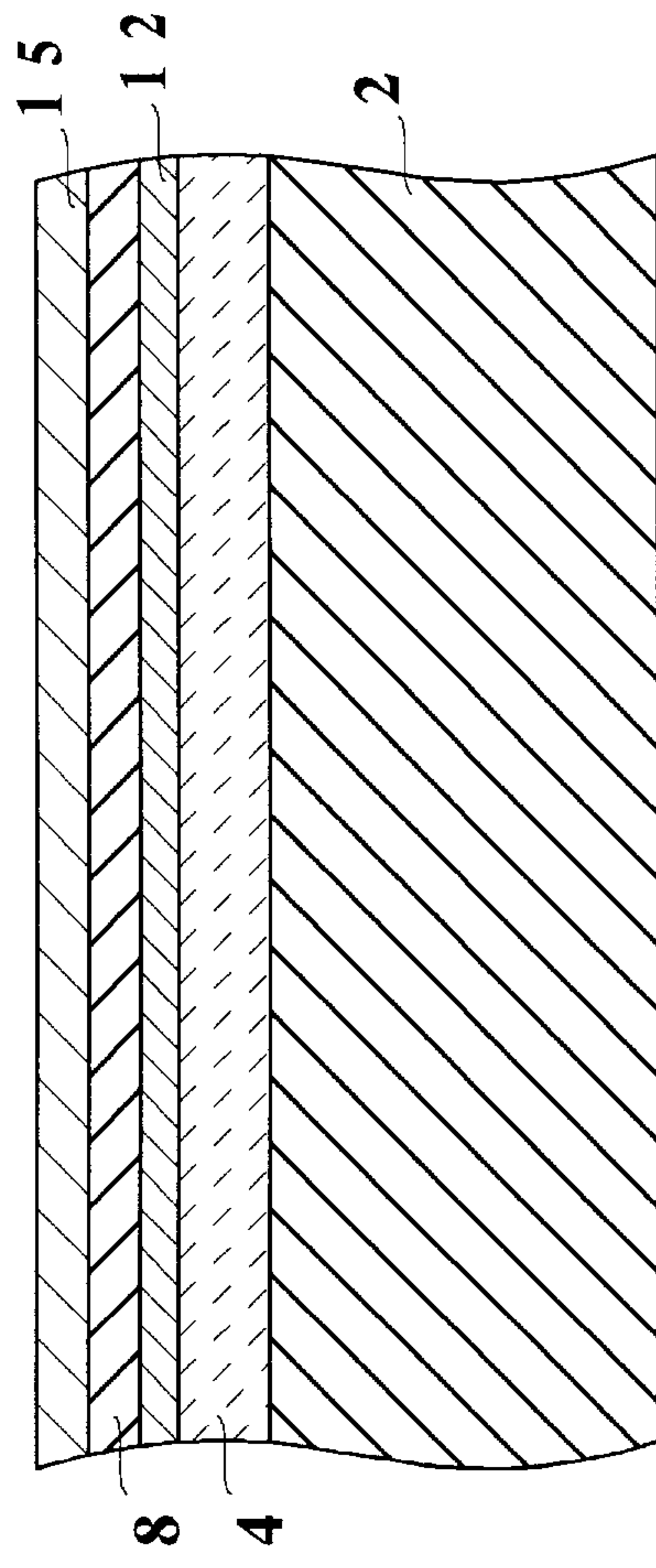


FIG. 2

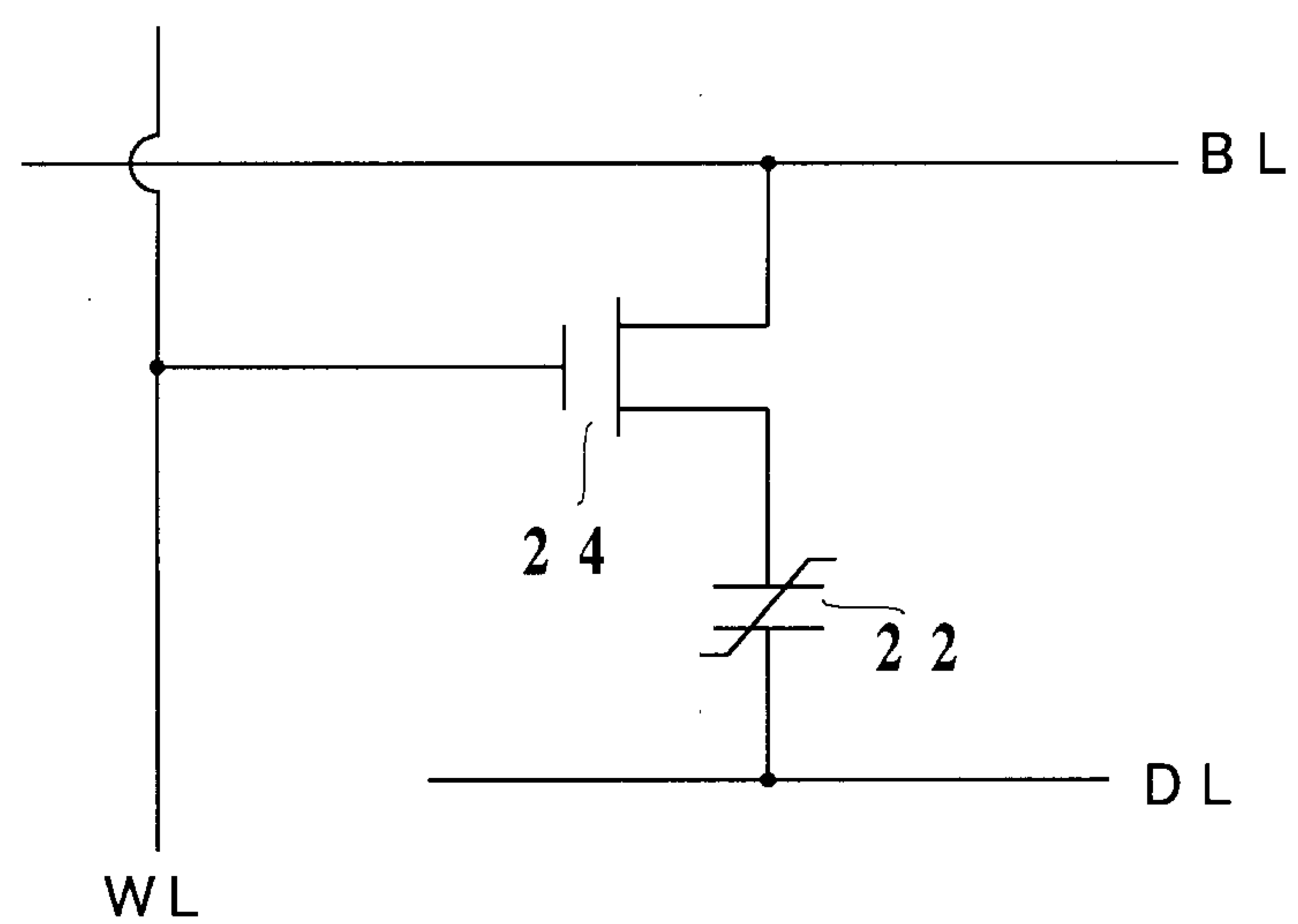


FIG. 3 A

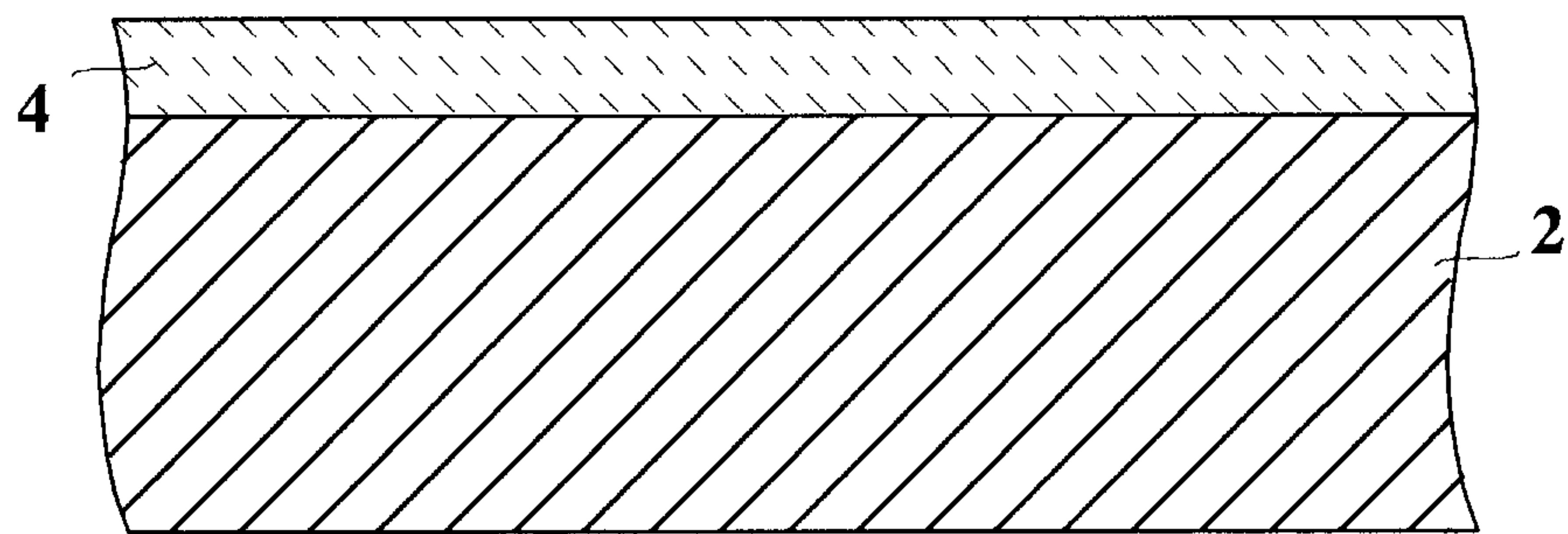


FIG. 3 B

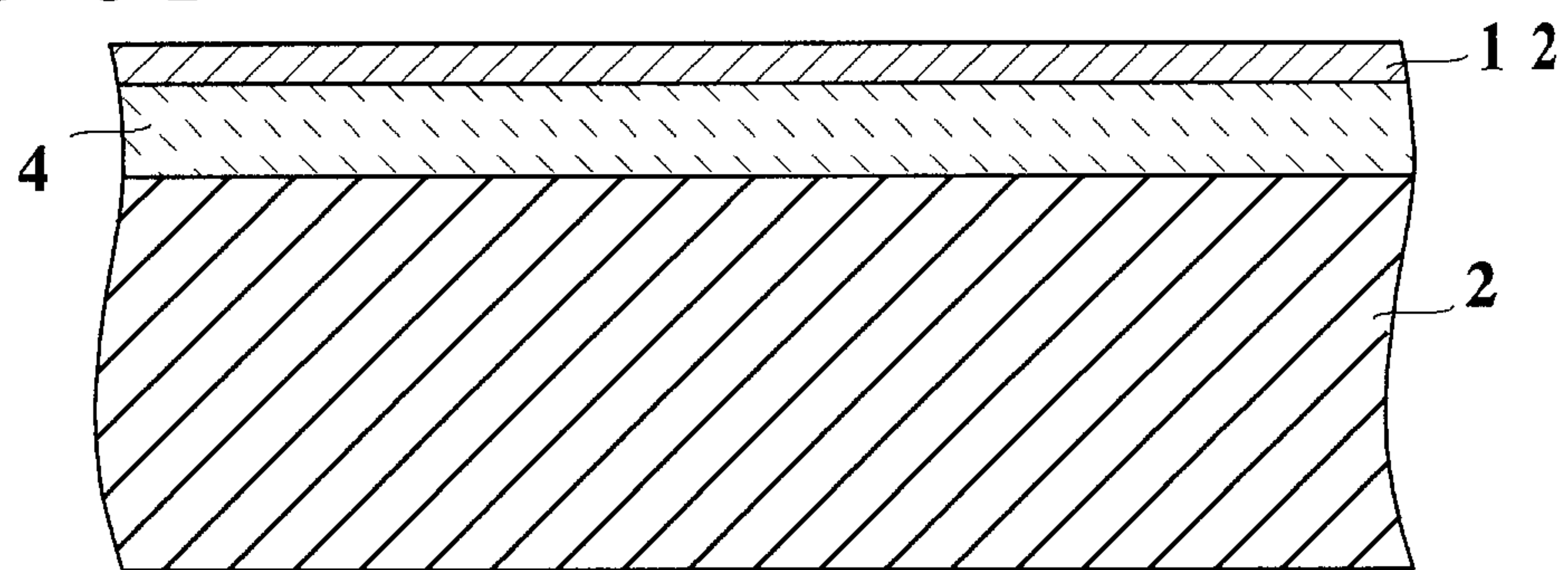


FIG. 3 C

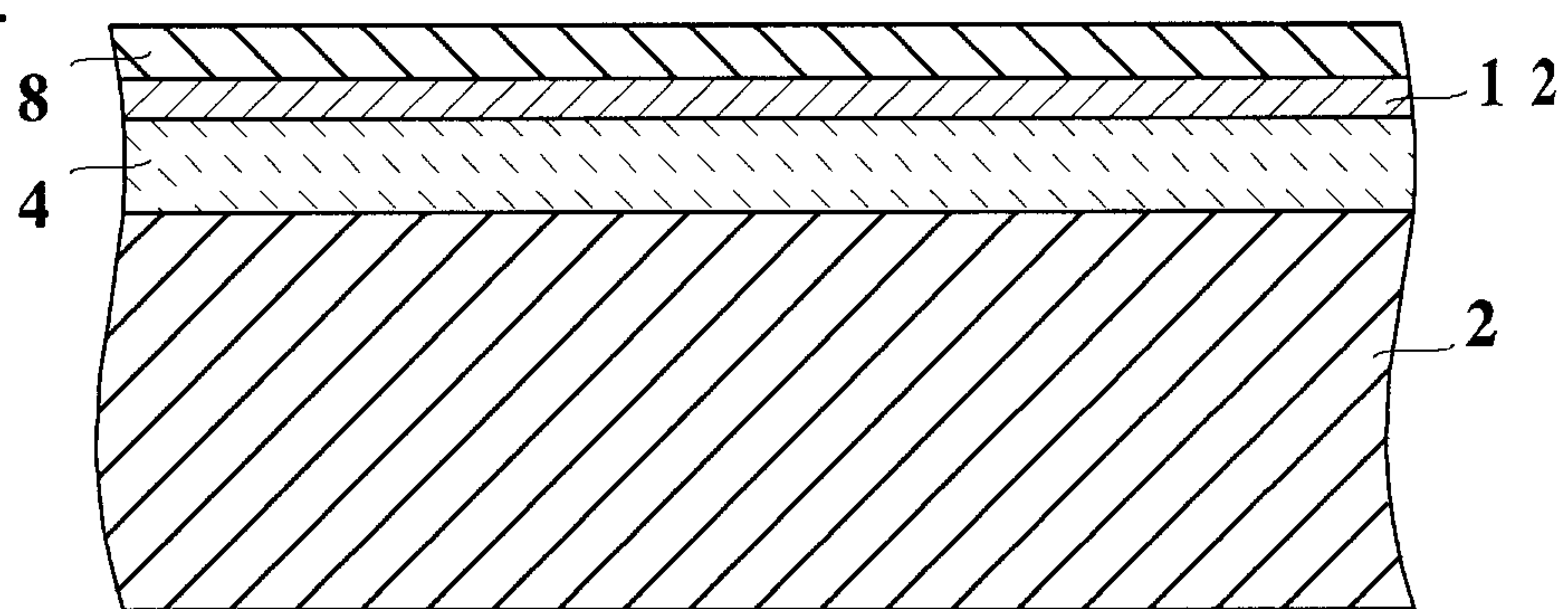
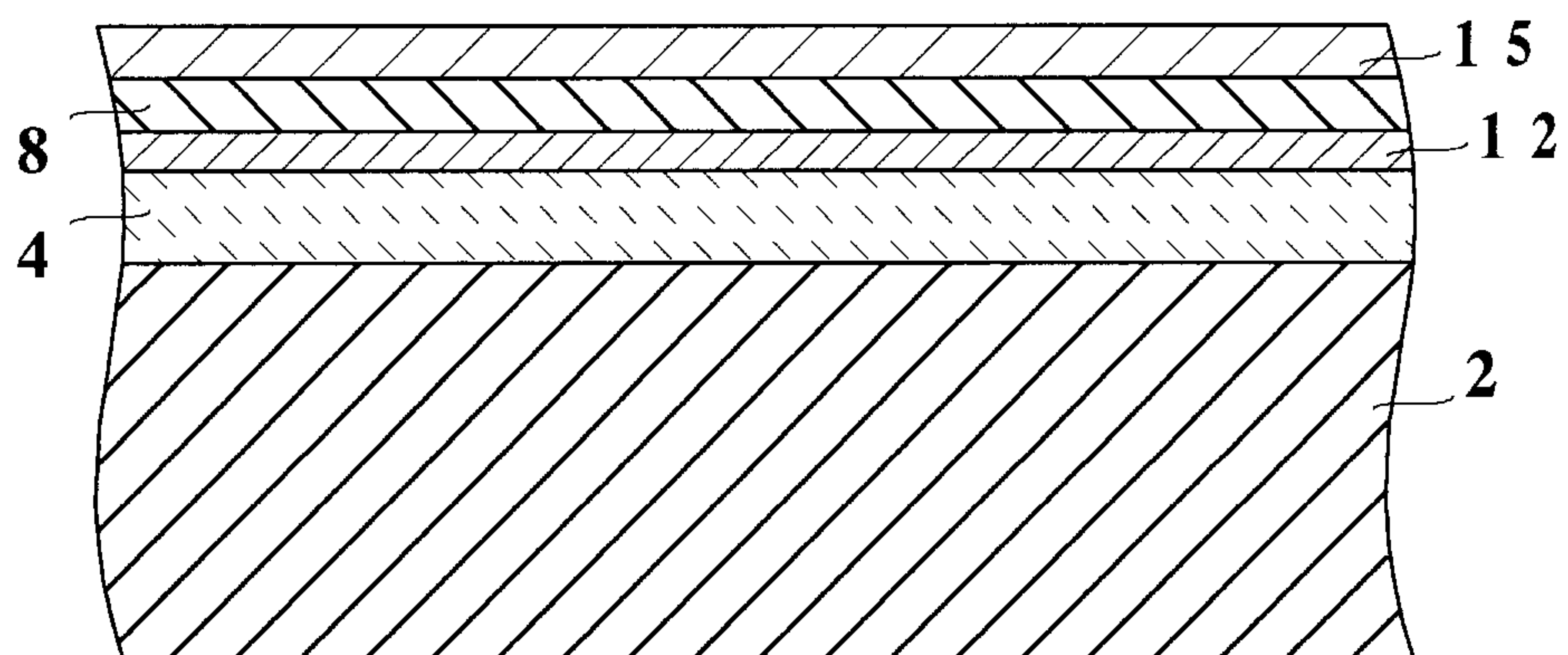
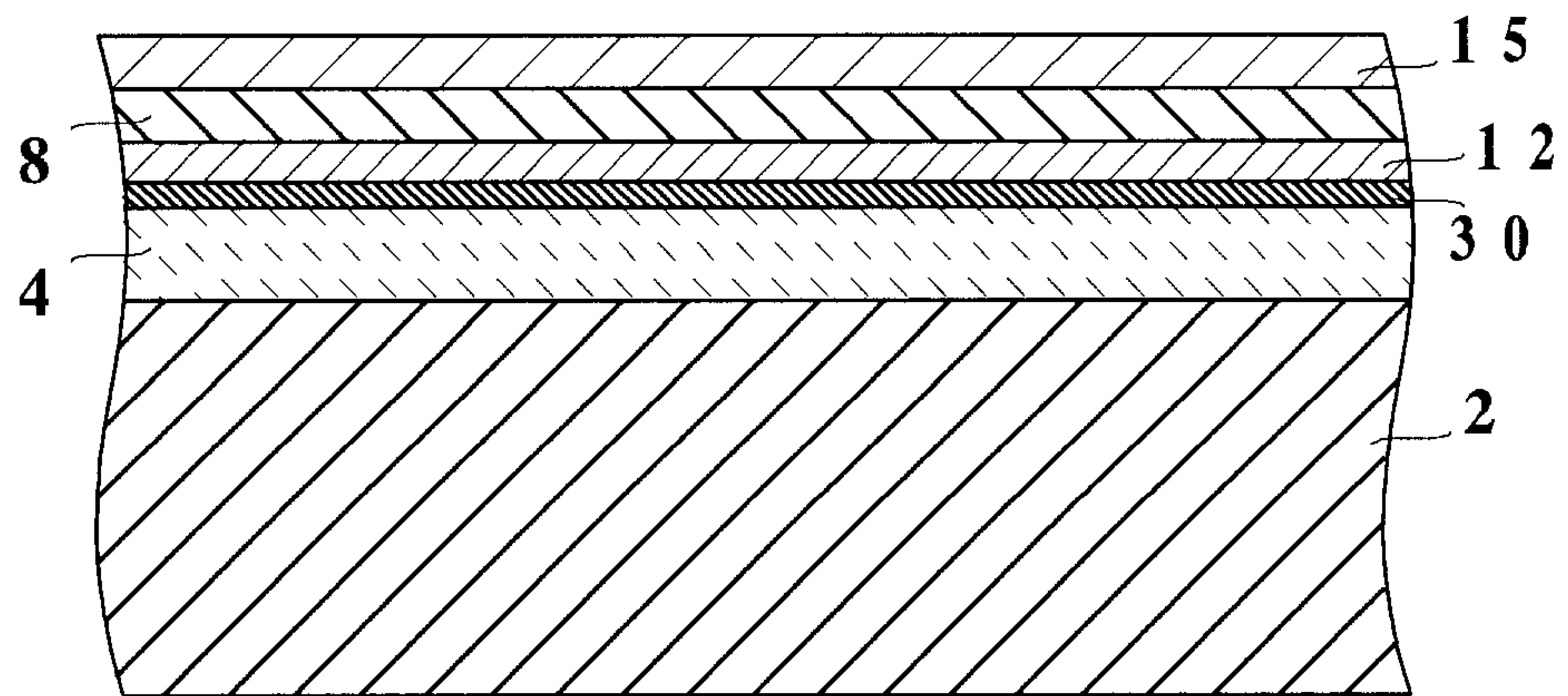


FIG. 3 D



F I G. 4



F I G. 5

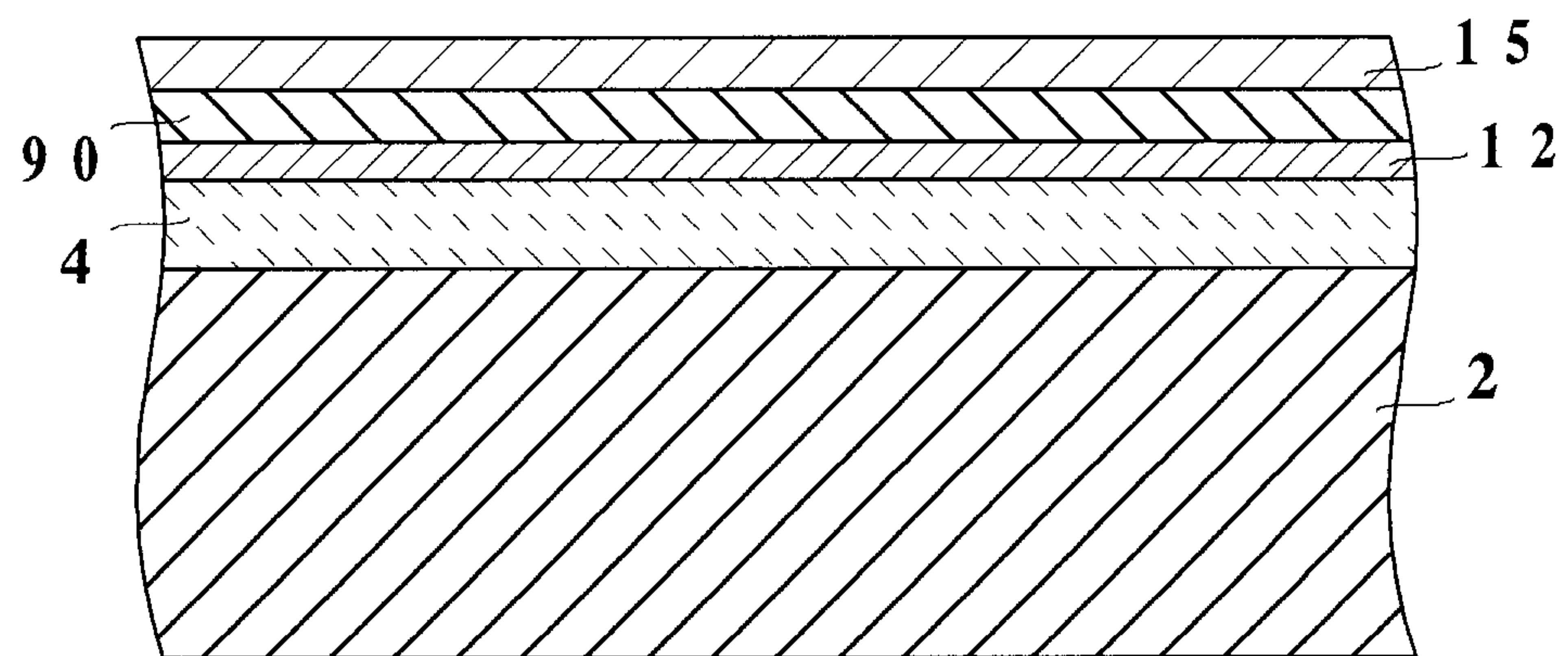
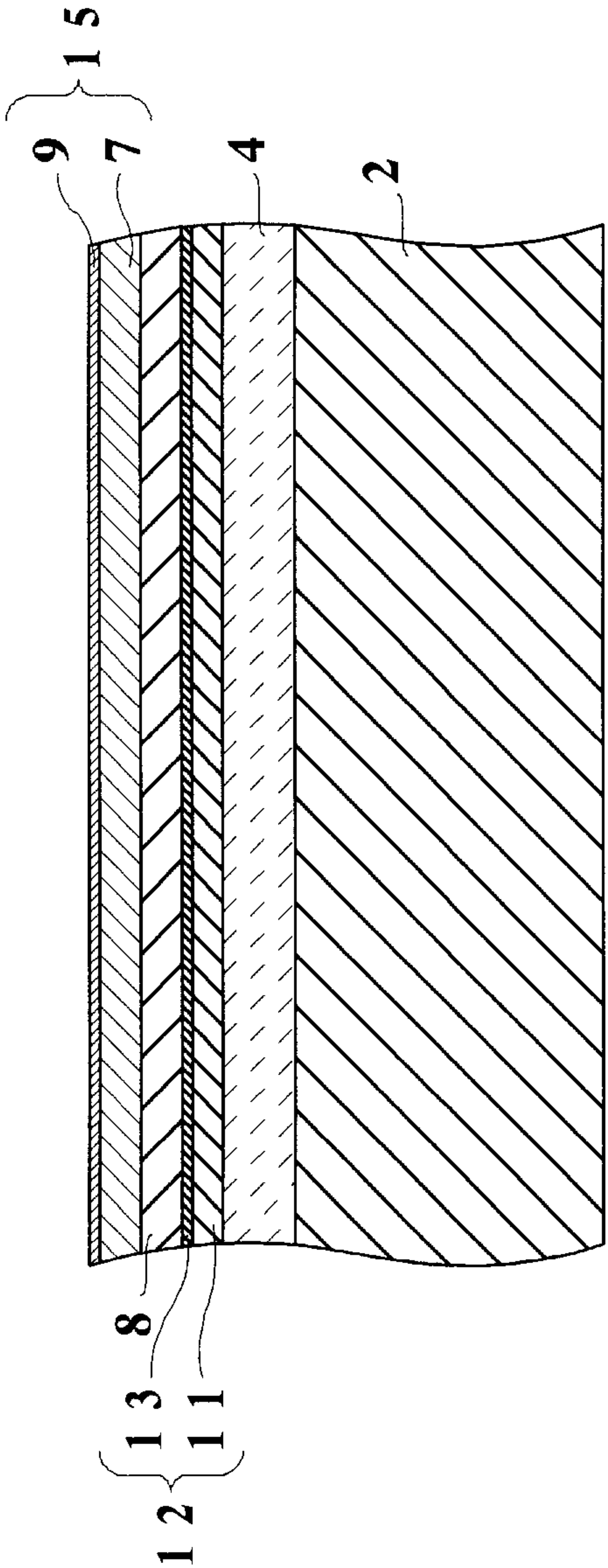


FIG. 6



F I G . 7

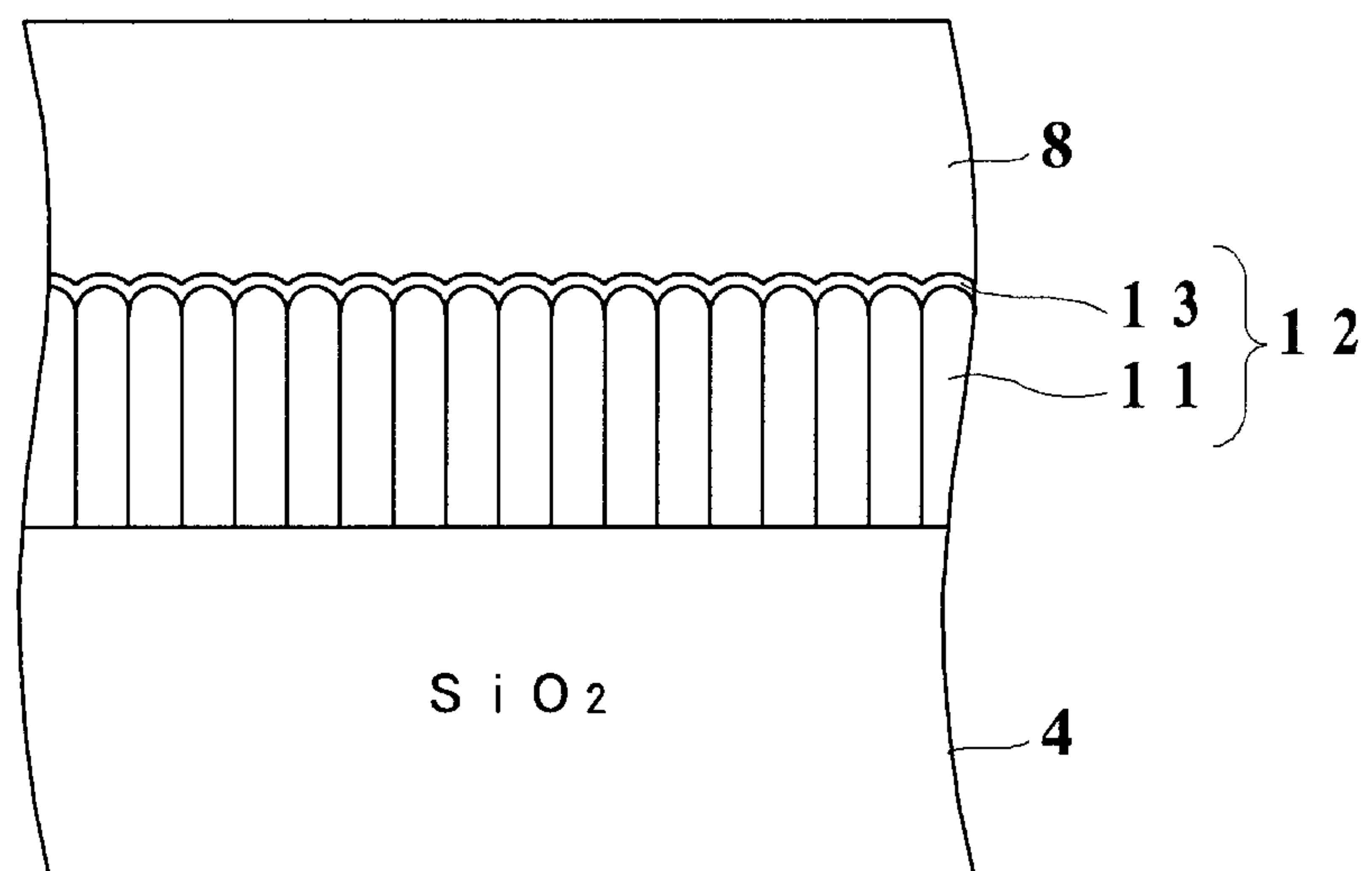


FIG. 8 A

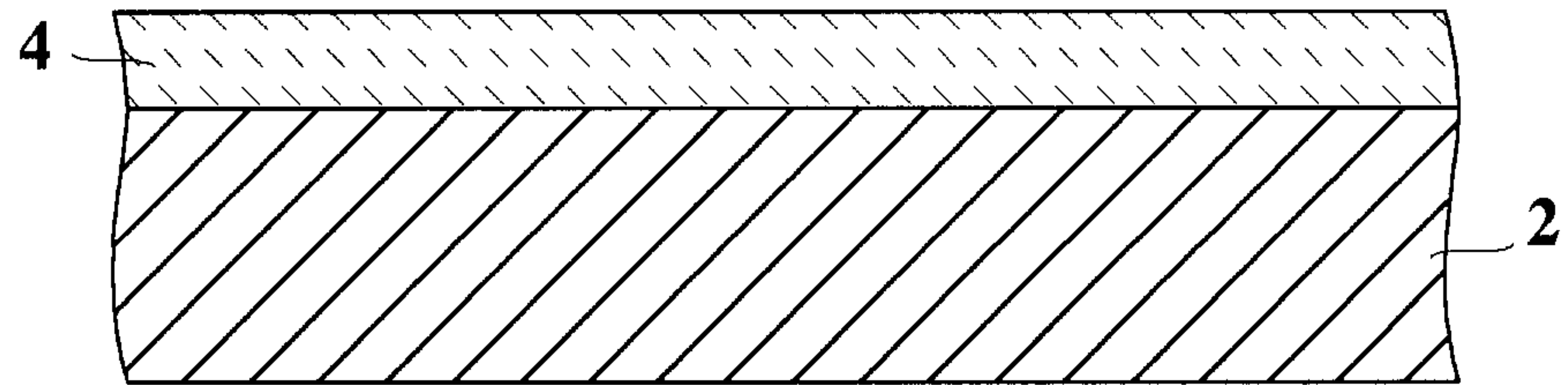


FIG. 8 B

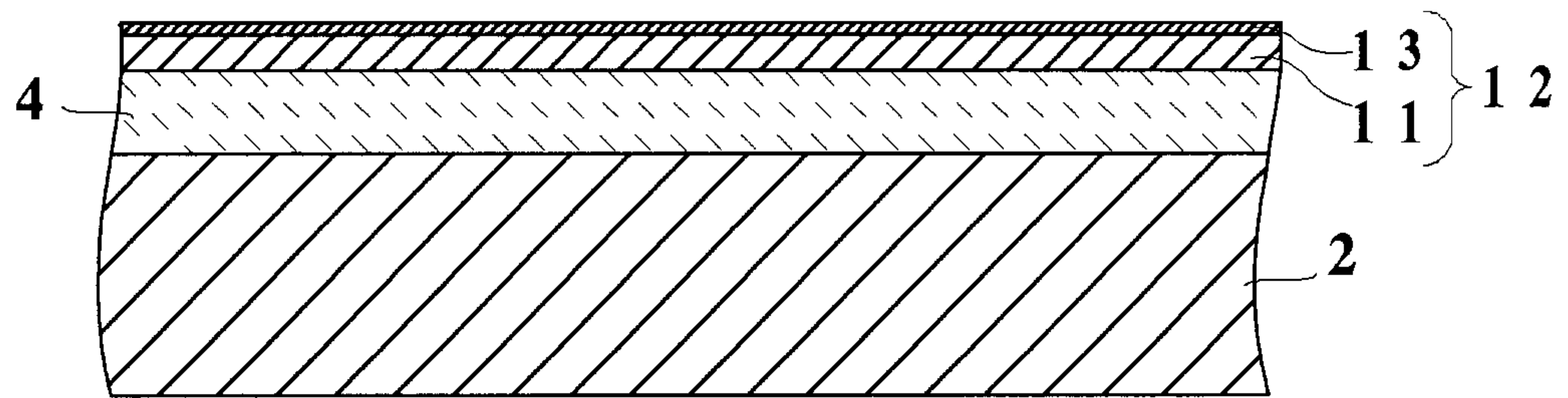


FIG. 8 C

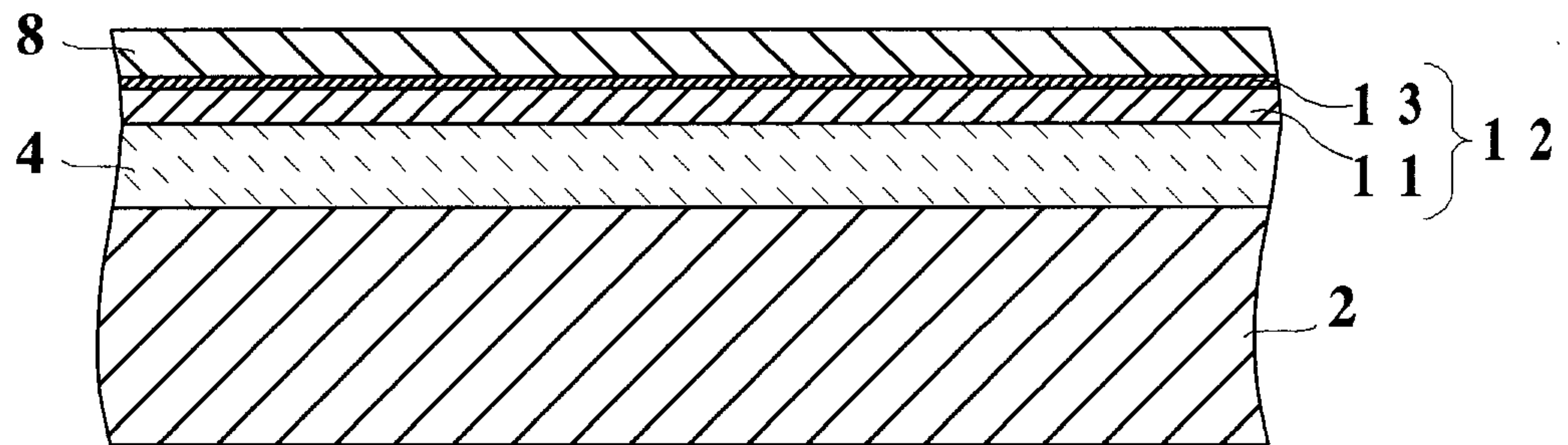


FIG. 8 D

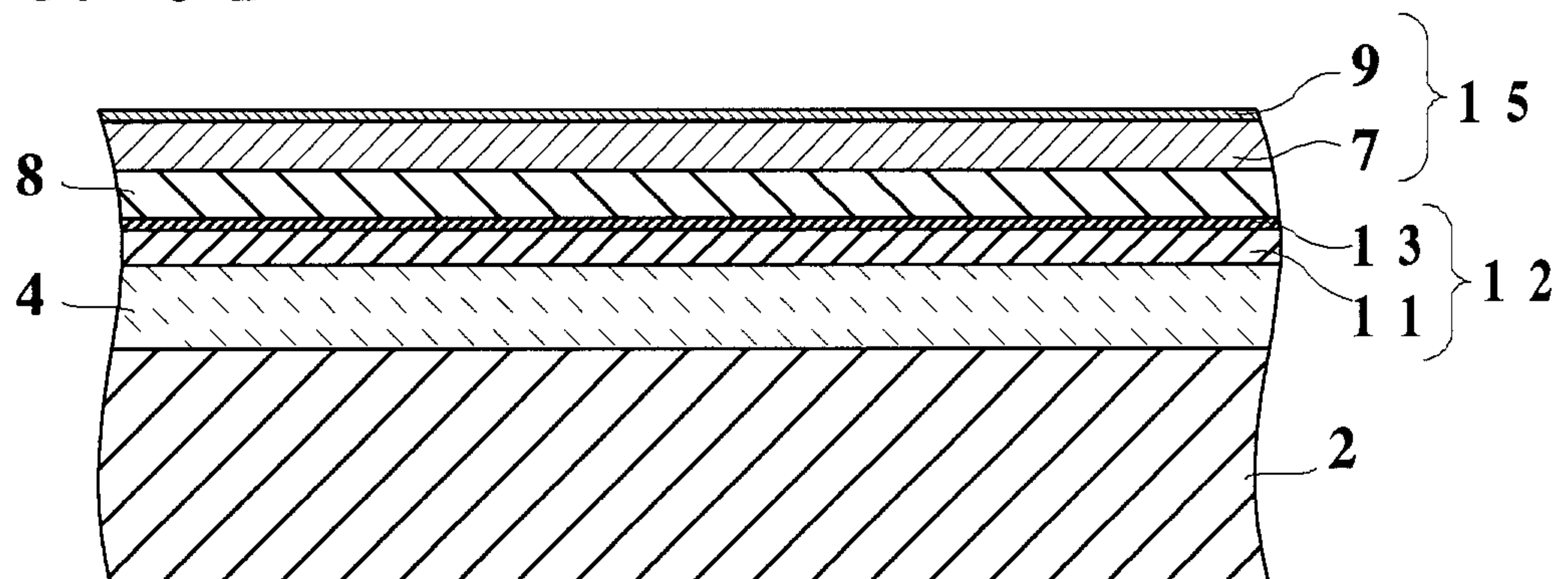


FIG. 9B

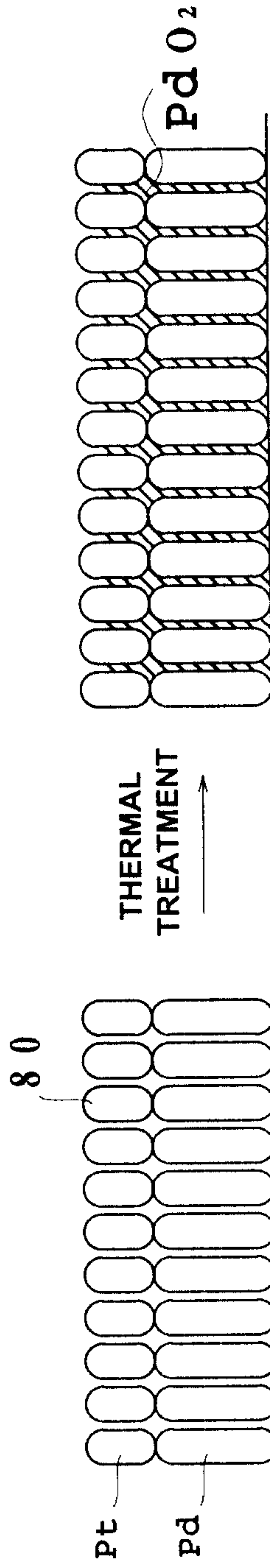


FIG. 10 (Prior Art)

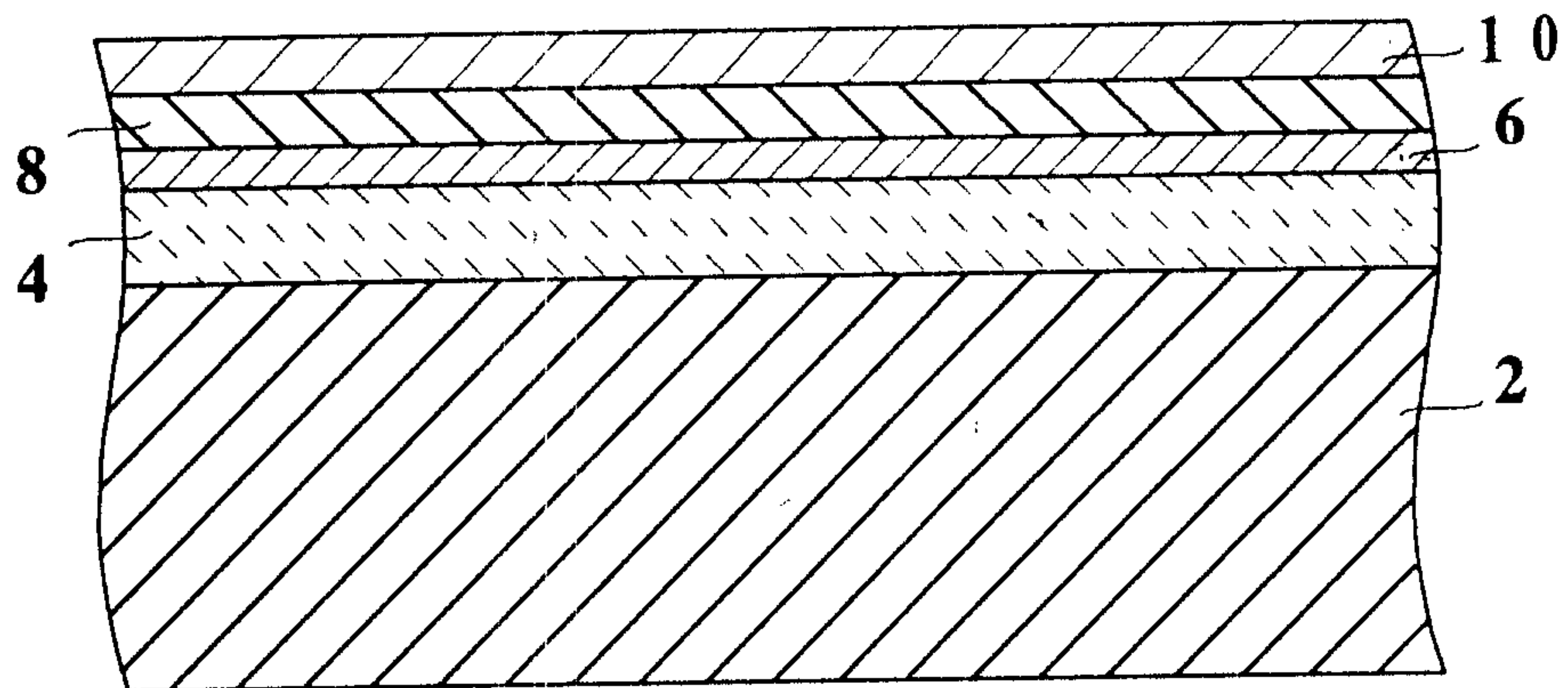


FIG. 11 (Prior Art)

