UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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TAIWAN SEMICONDUCTOR MANUFACTURING CO., LTD,
Petitioner,

v.

GODO KAISHA IP BRIDGE 1,
Patent Owner.

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Case IPR2017-01843
Patent 7,893,501

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# PATENT OWNER'S DEMONSTRATIVES

**IP Bridge Exhibit 2233**
**TSMC v. Godo Kaisha IP Bridge 1**
**IPR2017-01843**

**1**. A semiconductor device, comprising a MISFET, wherein

the MISFET includes:

an active region made of a semiconductor substrate;

a gate insulating film formed on the active region;

a gate electrode formed on the gate insulating film;

source/drain regions formed in regions of the active region located on both sides of the gate electrode; and

a silicon nitride film formed over from side surfaces of the gate electrode to upper surfaces of the source/drain regions, wherein:

the silicon nitride film is not formed on an upper surface of the gate electrode, and

the gate electrode protrudes upward from a surface level of parts of the silicon nitride film located at both side surfaces of the gate electrode.

’501 patent at Claim 1

**1**. A semiconductor device, comprising a MISFET, wherein

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the silicon nitride film is not formed on an upper surface of the gate electrode, and

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’501 patent at Claim 1

**A. “silicon nitride film”**

As demonstrated below, the BRI of “silicon nitride film” is a “thin coating of one or more layers of silicon nitride.” Ex.-2208(Glew-Decl.), ¶61.

POR at 28

1. A semiconductor device, comprising a MISFET, wherein
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'501 patent at Claim 1

**A. "silicon nitride film"**

As demonstrated below, the BRI of "silicon nitride film" is a "thin coating of one or more layers of silicon nitride." Ex.-2208(Glew-Decl.), ¶61.

POR at 28

Misra includes spacers on the sides of the gate like Figure 1 of the '501 patent. (*E.g.*, *compare* Misra at Fig. 7 (including spacers 23) (Ex-1204) *with* '501 patent at Fig. 1 (including spacers 7) (Ex-1201).) A POSITA would have understood that the gate electrode 28b protrudes upward from a surface level of the silicon nitride film (plasma enhanced nitride layer 20) located at the sides of the gate electrode, as claimed, regardless of whether spacers 23 are constructed out of silicon nitride. This is because plasma enhanced nitride layer 20 and the spacers 23 are separate structures (even if they are made of the same material). The plasma enhanced nitride layer 20 and the spacers 23 are separate structures because they are formed through different process steps and serve separate functions.

Petition at 42

**1.** A semiconductor device, comprising a MISFET, wherein
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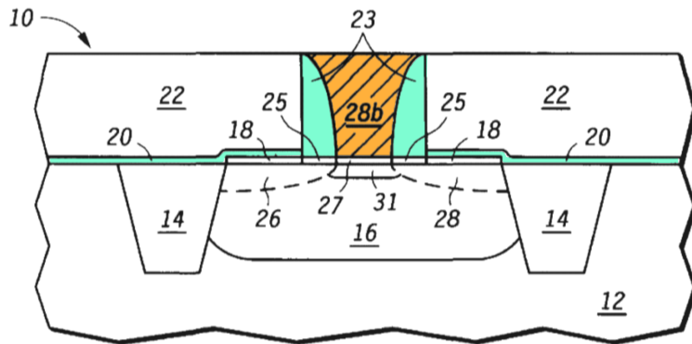
’501 patent at Claim 1



Misra (Ex.-1204), Fig. 7 (annotated)

POR at 6

**A. “silicon nitride film”**

As demonstrated below, the BRI of “silicon nitride film” is a “thin coating of one or more layers of silicon nitride.” Ex.-2208(Glew-Decl.), ¶61.

POR at 28

Misra includes spacers on the sides of the gate like Figure 1 of the ’501 patent. (*E.g.*, *compare* Misra at Fig. 7 (including spacers 23) (Ex-1204) *with* ’501 patent at Fig. 1 (including spacers 7) (Ex-1201).) A POSITA would have understood that the gate electrode 28b protrudes upward from a surface level of the silicon nitride film (plasma enhanced nitride layer 20) located at the sides of the gate electrode, as claimed, regardless of whether spacers 23 are constructed out of silicon nitride. This is because plasma enhanced nitride layer 20 and the spacers 23 are separate structures (even if they are made of the same material). The plasma enhanced nitride layer 20 and the spacers 23 are separate structures because they are formed through different process steps and serve separate functions.

Petition at 42

# BRI Of "Film" Is A Thin Coating Of One Or More Layers

a silicon nitride film formed over from side surfaces of the gate electrode to upper surfaces of the source/drain regions, wherein:

'501 patent at Claim 1

**A. "silicon nitride film"**

As demonstrated below, the BRI of "silicon nitride film" is a "thin coating of one or more layers of silicon nitride." Ex.-2208(Glew-Decl.), ¶61.

POR at 28

Furthermore, each of the internal stress films **8***a* and **8***b* does not have to be a single layer but may include multiple layers, as long as each of the internal stress films **8***a* and **8***b* can apply a stress to the substrate as a whole.

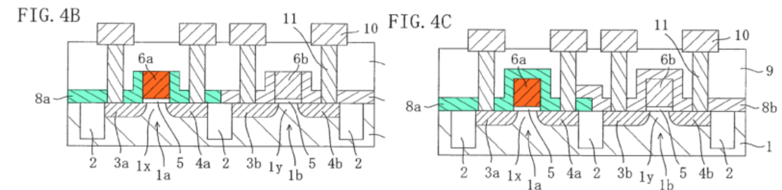
'501 patent at 5:60-63 (cited POR at 30)

**film** (film) *n.* **1.** A thin skin or membrane. **2.** A thin opaque abnormal coating on the cornea of the eye. **3.** A thin covering or coating: *a film of dust.* **4.** A thin flexible transparent sheet,

American Heritage College Dictionary
Third Edition: Film, Ex. 2228

**2. The '501-Patent Describes a Silicon Nitride Film As a Thin Coating of One Or More Layers Of Silicon Nitride**

The '501-patent uses "film" in its ordinary manner. The Figures depict the silicon nitride film 8a (green below) as a thin coating or covering, and the written description repeatedly describes the silicon nitride film as coating or covering one or more surfaces. Ex.-2208(Glew-Decl.), ¶¶63-64; '501-patent at 2:1-2 ("capable of ***covering***"), 2:10-11 ("***Covering*** both side surfaces … of a gate electrode"), 2:15-19, 2:26-30, 6:64-67 ("***covers*** respective upper surfaces of the gate electrodes"), 8:13-17 ("a silicon nitride film ***covers***"), 8:49-53, 9:56-58, 11:2-4, 11:47-52, 12:32-35, 15:20-26. The '501-patent also describes other "films" in the same manner. '501-patent at 3:36-37 (sidewall 7—"made of … film"—"***covering*** a side surface of the gate electrode"), 3:48-49, 3:59-60, 5:27-28 ("substrate ***covered*** by the interlevel insulating film"), 7:16-17, 10:7-8, 11:13-15, 12:42-44.




'501-patent (Ex.-1201), Figures 4B and 4C (annotated)

POR at 29

# Under Patent Owner's BRI Of "Film" All Grounds Fail

1. A semiconductor device, comprising a MISFET, wherein
the MISFET includes:
an active region made of a semiconductor substrate;
a gate insulating film formed on the active region;
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source/drain regions formed in regions of the active region located on both sides of the gate electrode; and
a silicon nitride film formed over from side surfaces of the gate electrode to upper surfaces of the source/drain regions, wherein:
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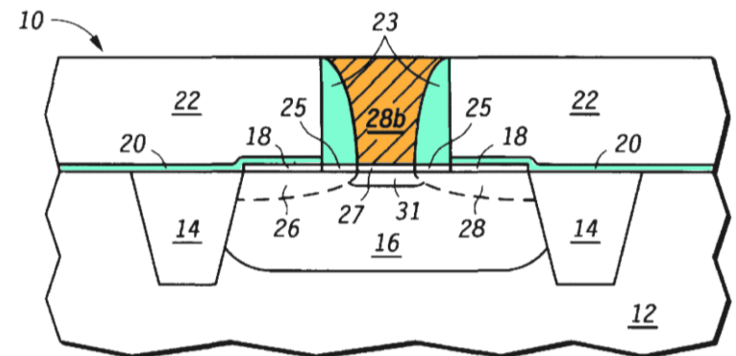
As demonstrated below, the BRI of "silicon nitride film" is a "thin coating of one or more layers of silicon nitride." Ex.-2208(Glew-Decl.), ¶61.

POR at 28



Misra (Ex.-1204), Fig. 7 (annotated)

POR at 6

# Petitioner's Narrow Interpretation Of "Film" Is Not Remotely The BRI

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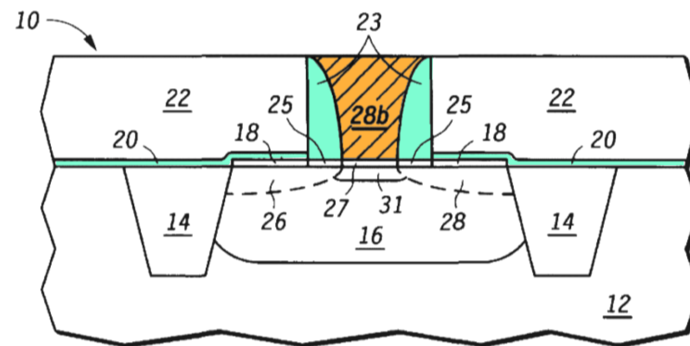
'501 patent at Claim 1

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POR at 6

Misra includes spacers on the sides of the gate like Figure 1 of the '501 patent. (*E.g.*, *compare* Misra at Fig. 7 (including spacers 23) (Ex-1204) *with* '501 patent at Fig. 1 (including spacers 7) (Ex-1201).) A POSITA would have understood that the gate electrode 28b protrudes upward from a surface level of the silicon nitride film (plasma enhanced nitride layer 20) located at the sides of the gate electrode, as claimed, regardless of whether spacers 23 are constructed out of silicon nitride. This is because plasma enhanced nitride layer 20 and the spacers 23 are separate structures (even if they are made of the same material). The plasma enhanced nitride layer 20 and the spacers 23 are separate structures because they are formed through different process steps and serve separate functions.

Petition at 42

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Shanfield Opening Decl., Ex. 1202, at ¶115

# Petitioner's Narrow Interpretation Of "Film" No Intrinsic Support

Misra includes spacers on the sides of the gate like Figure 1 of the '501 patent. (*E.g.*, *compare* Misra at Fig. 7 (including spacers 23) (Ex-1204) *with* '501 patent at Fig. 1 (including spacers 7) (Ex-1201).) A POSITA would have understood that the gate electrode 28b protrudes upward from a surface level of the silicon nitride film (plasma enhanced nitride layer 20) located at the sides of the gate electrode, as claimed, regardless of whether spacers 23 are constructed out of silicon nitride. This is because plasma enhanced nitride layer 20 and the spacers 23 are separate structures (even if they are made of the same material). The plasma enhanced nitride layer 20 and the spacers 23 are separate structures because they are formed through different process steps and serve separate functions.

42

U.S. Patent 7,893,501
Petition for *Inter Partes* Review

(*Compare* Misra at Fig. 2; 5:20-22 *with* Misra at Fig. 5; 6:34-40 (disclosing the formation of the plasma-enhanced nitride layer 20 and the spacers 23 at different steps in the process); *compare* Misra at 5:24-29 (disclosing plasma enhanced nitride layer 20 being used as an etch stop layer for forming contact openings) *with* Misra at 6:37-45 (disclosing spacers 23 being used as a mask for implanting a threshold adjust doped region 31 within the channel) (Ex-1204).) (Shanfield Decl. ¶115 (Ex-1202).)

Petition at 42-43

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Shanfield Opening Decl., Ex. 1202, at ¶115

Furthermore, each of the internal stress films **8*a*** and **8*b*** does not have to be a single layer but may include multiple layers, as long as each of the internal stress films **8*a*** and **8*b*** can apply a stress to the substrate as a whole.

'501 patent at 5:60-63 (cited POR at 30)

# Petitioner's Narrow Interpretation Of "Film" Ignores The Specification

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Shanfield Opening Decl., Ex. 1202, at ¶115

# Shanfield Testified Petitioner's Narrow Interpretation Of "Film" Is Inconsistent With Specification

Furthermore, each of the internal stress films **8***a* and **8***b* does not have to be a single layer but may include multiple layers, as long as each of the internal stress films **8***a* and **8***b* can apply a stress to the substrate as a whole.

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Petition at 42

Shanfield Opening Decl., Ex. 1202, at ¶115

10 Q. Why would it not matter if there were
11 separate processes used to make layers of a stress
12 film, but it would matter generally with respect to
13 determining whether or not layers constitute a film
14 with respect to the claims of the '501 patent?
15 **A. The '501 patent specifically brings out**
16 **that example of multiple layers of film providing**
17 **stress as being considered a stress-inducing film.**
18 **So for that specific context, if that**
19 **film provides stress, then by the language -- how I**
20 **read the language of the '501 patent, it's**
21 **considered one film. But not in general.**
22 Q. So why would a different set of criteria
23 apply for determining what is a film and is not a
24 film based on what the function of that film is?

1 **A. It's simply that it was explicitly**
2 **mentioned in the '501 patent for this particular**
3 **situation, that particular context. And in general,**
4 **a person of skill in the art would not regard even**
5 **that situation as the same film particularly.**
6 **But since the patent mentions it, it's**
7 **understood that that's to be viewed as -- as taught**
8 **by the '501, that's to be viewed as one film.**
9 **In general, a person of skill in the art**
10 **is not going to view films that are deposited with**
11 **separate processes that are adjacent with different**
12 **functions as the same film. They're not going to**
13 **view it that way. So I think it's understandable**
14 **that the patent would bring that point out for this**
15 **particular situation.**

Shanfield Reply Depo, Ex. 2232, at 161:10-162:15 (cited at Patent Owner's Observations, Paper 30, #16)

Misra includes spacers on the sides of the gate like Figure 1 of the '501 patent. (*E.g.*, *compare* Misra at Fig. 7 (including spacers 23) (Ex-1204) *with* '501 patent at Fig. 1 (including spacers 7) (Ex-1201).) A POSITA would have understood that the gate electrode 28b protrudes upward from a surface level of the silicon nitride film (plasma enhanced nitride layer 20) located at the sides of the gate electrode, as claimed, regardless of whether spacers 23 are constructed out of silicon nitride. This is because plasma enhanced nitride layer 20 and the spacers 23 are separate structures (even if they are made of the same material). The plasma enhanced nitride layer 20 and the spacers 23 are separate structures because they are formed through different process steps and serve separate functions.

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Shanfield Opening Decl., Ex. 1202 at ¶115

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'501 patent at 5:60-63 (cited POR at 30)

15 Q. So in the context of the '501 patent
16 claims, if two layers are fully one on top of the
17 other and they are formed by the same process to
18 create the same structure to perform the same
19 function, it is your opinion that those would be the
20 same film?
21 **A. Could you repeat that again. I'm sorry.**
22 **It's got a lot of qualifications to it.**
23 **MR. HRYCYSZYN:** Could you read that.
24 (Record read as requested.)

1 **THE WITNESS:** That's not really what I
2 said. And I'm reflecting what I believe the
3 '501 patent is describing, which is you can have
4 multiple layers. And as I read it, it could be in a
5 separate process step. But if they apply stress to
6 the substrate as a whole, then it can be viewed as a
7 film, an internal stress film, in the specification.
8 And I think they're expressing the point
9 that I understand, and I think a person of skill in
10 the art would understand, that your structure is
11 intended to create a stress field in the substrate
12 underneath.
13 **BY MR. HRYCYSZYN:**
14 Q. So let me ask it a little bit of a
15 different way. If two layers are fully formed on
16 top of one another and they are formed by the same
17 process to create the same structure and perform the
18 same function, in the context of the '501 patent,
19 would you consider those to be the same film?
20 **A. The '501 patent talks about an internal**
21 **stress film and internal stress films, plural. So**
22 **I'd like to use their term: "internal stress film."**
23 **And in that case, my understanding of the**
24 **specification is that as long as the films are on**

1 **top of each other and applies stress to the**
2 **substrate as a whole, that can be viewed as an**
3 **internal stress film. You know, again, that's their**
4 **terminology.**
5 **So the rest of the detail isn't being**
6 **addressed in their specification statement. They**
7 **simply say two films on top of each other, but**
8 **entirely on top of each other, that apply stress to**
9 **the substrate as a whole can be viewed as an**
10 **internal stress film.**
11 Q. And in that context, in the context of the
12 answer you just gave, it doesn't matter if they're
13 created by the same process; is that accurate?
14 **A. I think that's true, yes.**

Shanfield Reply Depo., Ex. 2232, at 33:15-35:14 (Patent Owner's Observations, Paper No. 30, #16)

# Shanfield Incorrectly Testified That Claim 1 Requires The Silicon Nitride Film Impart Stress

**2**. The semiconductor device of claim **1**, wherein the silicon nitride film is for generating a stress in a substantially parallel direction to the gate length direction in a channel region located in the active region under the gate electrode.

’501 patent at Claim 2

**1**. A semiconductor device, comprising a MISFET, wherein

the MISFET includes:

an active region made of a semiconductor substrate;

a gate insulating film formed on the active region;

a gate electrode formed on the gate insulating film;

source/drain regions formed in regions of the active region located on both sides of the gate electrode; and

a silicon nitride film formed over from side surfaces of the gate electrode to upper surfaces of the source/drain regions, wherein:

the silicon nitride film is not formed on an upper surface of the gate electrode, and

the gate electrode protrudes upward from a surface level of parts of the silicon nitride film located at both side surfaces of the gate electrode.

’501 patent at Claim 1

To be clear, Patent Owner does ***not*** agree with Shanfield’s testimony under cross-examination that claim 1 requires that the silicon nitride film induce stress.

Patent Owner’s Mot. to Exclude, Paper No. 31 at 5

U.S. Patent 7,893,501
Declaration of Stanley R. Shanfield, Ph.D.

89. Claim 1 recites "a silicon nitride film formed over from side surfaces of the gate electrode to upper surfaces of the source/drain regions." ('501 patent, claim 1 (Ex-1201).) Misra in view of Tsai discloses this element.

90. For example, Misra discloses a plasma-enhanced nitride layer 20 (silicon nitride film) (blue) formed over from side surfaces of metallic gate electrode 28b to upper surfaces of source and drain electrodes 26 and 28 and silicide region 18 (the source/drain regions):

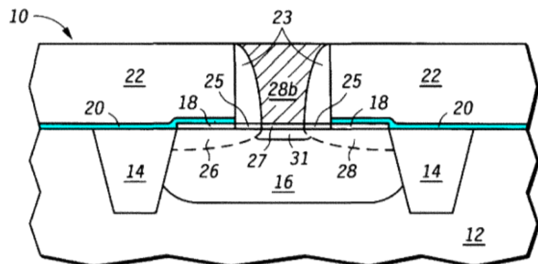



*FIG. 7*

(Misra at Fig. 7 (Ex-1204); *see also, e.g.*, *id.* at 5:20-23 (disclosing "a **thin plasma-enhanced nitride (PEN or like material) layer 20** is deposited overlying the trench isolation regions 14 and the silicide layer 18"), 5:24-27 (**"Plasma enhanced nitride layer 20 is provided for use as an etch stop layer** when

Shanfield Opening Decl., Ex. 1202, at 41

3 Q. So let me ask my question again. Can a
4 silicon nitride film be composed of more than one
5 layer in the context of the '501 patent if it
6 functions as an etch stop layer?
7 **A. So the silicon nitride layer in the**
8 **'501 patent is an internal stress film. And my**
9 **point is, if it's an etch stop layer in this**
10 **context, not a film that applies stress to the**
11 **whole -- the substrate as a whole because it's very**
12 **thin, that's part of the intent of making it so thin**
13 **so that it doesn't affect the stress fields or any**
14 **electrical properties. It's just an etch stop layer.**
15 **The internal stress films that are being**
16 **talked about here are much thicker. They're**
17 **intended to create stress in the substrate as a**
18 **whole.**

Shanfield Reply Depo., Exhibit 2232, at 45:3-18
(Patent Owner's Observations, Paper No. 30, #9)

20 Q. So it is your understanding that Claim 1 of
21 the '501 patent requires that the silicon nitride
22 film induce stress; is that accurate?
23 **A. Yes.**

Shanfield Reply Depo., Exhibit 2232, at 160:20-23
(Patent Owner's Observations, Paper No. 30, #9)

14 Q. So is it your opinion that outside that
15 statement in the '501 patent specification, a POSA
16 would not understand that a silicon nitride film can
17 have multiple layers?
18 **A. It doesn't say anything about outside the**
19 **context of a stress film, as far as I know. I mean,**
20 **this statement is talking about the films of concern**
21 **in the '501 patent, which are these stress films.**
22 **And it's explaining what applies there.**
23 **I hadn't given thought to films that**
24 **might have other functions that, for example --**
1 **well, I won't even give an example -- that have**
2 **other functions, nor is there any particular**
3 **clarification of that in the '501 patent because it**
4 **isn't relevant to it.**
5 Q. So in the context of the '501 patent claims,
6 can you think of any other circumstances other than
7 stress films applying stress as a whole to the
8 substrate in which multiple layers can make up a
9 silicon nitride film?
10 **A. I can think of other circumstances.**
11 **I'm not sure it's of any importance to the '501**
12 **teachings, but I can.**
13 Q. And what are those circumstances?
14 **A. For example, the interlayer dielectric**
15 **could have multiple layers and be considered an**
16 **interlayer dielectric even though it's consisting of**
17 **multiple layers. I think a person of skill in the**
18 **art would probably view it that way. But how that**
19 **matters for the '501, I don't know. I don't think**
20 **it does.**
21 Q. Why don't you think it matters for the '501?
22 **A. Because the '501 takes the trouble to**
23 **explain what multiple layers might mean, how that**
24 **can be viewed as an internal stress film in itself**
1 **when it's talking about internal stress films and**
2 **not when it's talking about interlayer dielectrics.**
3 **So it gives me the sense that that's where the**
4 **teachings need to be made and need to be discussed**
5 **in detail.**

Shanfield Reply Depo., Exhibit 2232 at 48:14-50:5
(Patent Owner's Observations, Paper No. 30, #15)

13 Q. So a person of ordinary skill in the art
14 would understand that in the context of the
15 '501 patent claims, a silicon nitride film could be
16 made out of multiple layers even if it did not apply
17 stress to the substrate as a whole?
18 **A. I didn't opine on that point nor do I**
19 **think -- I mean, I can't think of a circumstance**
20 **that would matter in the '501.** So what a person of

Shanfield Reply Depo., Exhibit 2232 at 50:13-20
(Patent Owner's Observations, Paper No. 30, #15)

# Petitioner's Improper Coaching

14 Q. I'm going to represent to you that as a
15 legal matter, a dependent claim recites additional
16 limitations that are not present in the independent
17 claim from which it depends.
18 Do you have that understanding in mind?
19 **MR. HRYCYSZYN:** Objection, beyond the
20 scope. Objection, coaching.
21 **THE WITNESS:** Okay. I didn't know that.

* * * *

[omitted objections and call to the Board]

11 Q. So, Dr. Shanfield, with the representation
12 I just made to you in mind about how independent and
13 dependent claims are interpreted, could you look at
14 dependent Claim 2.
15 **A. Yes.**
16 **MR. HRYCYSZYN:** Objection, beyond the
17 scope. Same objections as before as to the improper
18 question.
19 **BY MR. SMITH:**
20 Q. Does dependent Claim 2 add a requirement
21 that the silicon nitride film is for generating a
22 stress?
23 **MR. HRYCYSZYN:** Objection, beyond the
24 scope. Objection, leading, instructing the witness.

1 **THE WITNESS:** Yes.
2 **BY MR. SMITH:**
3 Q. Do you see that Claim 2 depends from
4 Claim 1?
5 **MR. HRYCYSZYN:** Objection, beyond the
6 scope.
7 **THE WITNESS:** Yes, I do.
8 **BY MR. SMITH:**
9 Q. I believe you testified earlier that
10 Claim 1 does not recite any stress limitations;
11 is that correct?

12 **A. That is correct.**
13 **MR. HRYCYSZYN:** Objection, leading.
14 Objection, improper.
15 **BY MR. SMITH:**
16 Q. And with the understanding that we
17 discussed earlier, is there anything you would like
18 to clarify with your testimony regarding whether
19 Claim 1 requires silicon nitride film to induce
20 stress?
21 **MR. HRYCYSZYN:** So --
22 **THE WITNESS:** Yes. Now that I
23 understand --
24 **MR. HRYCYSZYN:** Can we wait so I can get

1 my objections on the record. So same set of
2 objections we had earlier. I can restate them or if
3 we can agree they apply here.
4 So Josh is reminding me that I should
5 restate them. So objection, coaching the witness.
6 Objection, leading. Objection, coaching and
7 instructing the witness.
8 **THE WITNESS:** Yes. I do want to
9 clarify. Now that I understand the legal issue,
10 Claim 1 does not require that -- it does not have
11 any language in it that requires the film to have
12 stress, as I said before. And what that means
13 legally is that it's not required in meeting the
14 limitations of Claim 1.
15 **MR. HRYCYSZYN:** Objection, move to
16 strike.

Shanfield Reply Depo., Ex. 2232 at 167:14-21; 170:11-172:16
(Patent Owner's Observations, Paper No. 30, #1)

17 Q. So the information that Mr. Smith provided
18 you during his redirect questioning changed your
19 testimony; is that accurate?
20 **A. No.**
21 Q. So it didn't change --
22 **A. It changed what I knew about the relation**
23 **between dependent and independent claims. And that**
24 **has -- As I said, that was not related to my**

Shanfield Reply Depo., Ex. 2232 at 175:17-24
(Patent Owner's Observations, Paper No. 30, #1)

4 Q. So before Mr. Smith instructed you on
5 certain legal principles, you had testified that
6 Claim 1 required that the silicon nitride film
7 induced stress, right?
8 **A. I mistakenly made that statement because I**
9 **thought legally that there was a legal requirement**
10 **that the independent -- the dependent claims read**
11 **back into the independent claim the limitations in**
12 **the dependent claims.**
13 **Since, I've heard that the dependent**
14 **claims are usually narrower. That was a mistake.**
15 **So that particular statement, I changed. It's a**
16 **legal opinion.**

Shanfield Reply Depo., Ex. 2232 at 176:4-16
(Patent Owner's Observations, Paper No. 30, #1)

Page 173

1 **THE WITNESS:** And I'll add that the
2 legal aspect of this is something I was confused
3 about and needed to be instructed on.

# Shanfield Testified A Spacer Is Not A "Film"

5 Q. If element 20 is silicon nitride and
6 element 23 is silicon nitride, are those two layers
7 a film?
8 MR. SMITH: Objection.
9 A. They're two separate films.
10 Q. Why don't those two layers make a film?
11 MR. SMITH: Objection.
12 A. They serve separate functions. Layer 23
13 doesn't have to be silicon nitride. It's a
14 different film, a different material -- I'm sorry;
15 and I'm not sure I'd even consider 23 a film in the
16 sense of the way a person of ordinary skill in the
17 art would view it. It's a spacer, not a film,
18 where layer 20 is clearly a film.

* * * *

4 Q. In your opinion, can a spacer be a film?
5 MR. SMITH: Objection.
6 A. Well, I'm offering my opinion in the view
7 of someone of skill in the art. I also view it the
8 same way. So I -- I would never describe -- you're
9 asking me personally -- a -- a spacer as a film?
10 It's awkward and doesn't make sense.

Shanfield Opening Depo., Ex. 2210 at 289:5-18, 298:4-10 (cited POR at 10)

23 Q. You testified that element 23 is not a
24 film.
1 Is there any other reason that it would
2 not satisfy that limitation?
3 MR. SMITH: Objection.
4 A. I'd have to give that some thought. I
5 can't answer on the spot. It would take some
6 consideration. I'd need to review, again, what the
7 '501 embodiments involved to understand what else
8 it doesn't -- and essentially it comes down to
9 the -- my understanding -- my understanding of what
10 a person of skill in the art would know element 23
11 is in Misra. And that's that it's a sidewall
12 spacer.
13 So at that point it's not sensical to try
14 and select other aspects of the phrase that it
15 doesn't fit. It simply doesn't fit that -- that
16 claim element, as I am interpreting it, based on
17 all this background that I've described -- like the
18 specification and what I understand someone of
19 ordinary skill in the art would know.
20 A person of ordinary skill in the art
21 would look at element 23 and say, Those are
22 sidewall spacers. And when they read source -- I'm
23 sorry -- "silicon nitride film formed over from the
24 side surfaces of the gate electrode to the upper
1 surfaces of the source-drain," the side spacers
2 just don't meet the meaning of that.

Shanfield Opening Depo., Ex. 2210 at 374:23-376:2 (cited Paper No. 27 at 1)

# “[A] POSA would have understood that “films” and spacers are not mutually exclusive, and indeed it was common … to have a “film” act as a spacer.” (POR at 76)

Extrinsic evidence confirms that numerous references disclose a film that serves as a spacer (purple below) and has a shape similar to spacer 7 of the ’501-patent (purple below), and those references refer to the spacer as a “film.” Ex.-2208(Glew-Decl.), ¶¶81-86; *e.g.*, Ex.-2217 at 6:47-50; Ex.-2218, ¶88 (identifying

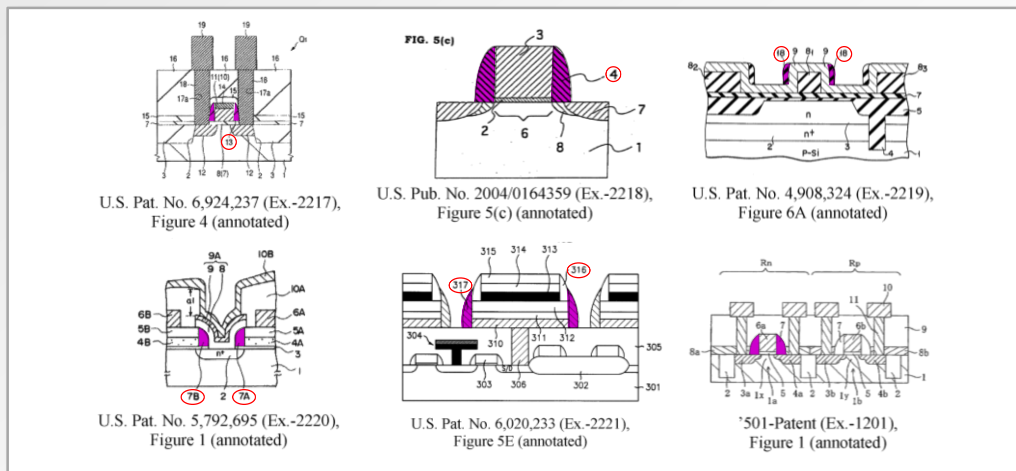
POR at 36

78. Dr. Shanfield testified that a POSA “would not ever” call element 7 of the ’501 patent or element 23 of Misra a film or “consider [them] a film.” Ex.-2210 at 311:14-313:5; *see also id.* at 289:10-18, 296:22-298:16 (asserting that spacers are “a separate entity from film”). I disagree. The specification of the ’501 patent and multiple semiconductor references confirm that a POSA would have understood that element 7 of the ’501 patent and spacers 23 of Misra are both a film and that it was common in the art for a “film” to serve as a spacer.

Glew Decl., Ex. 2208 at ¶78 (cited at POR at 75)

energy of 2 keV and a dose of $1\times10^{15}/cm^2$. Thereafter, an insulating film which is for forming a sidewall and has a thickness of about 50 nm is deposited on the substrate and then a sidewall **7** is formed on side surfaces of the gate electrodes **6***a* and **6***b* by etch back. Next, using the gate

‘501 patent at 6:41-45 (cited POR 36)



U.S. Pat. No. 6,924,237 (Ex.-2217), Figure 4 (annotated)

U.S. Pub. No. 2004/0164359 (Ex.-2218), Figure 5(c) (annotated)

U.S. Pat. No. 4,908,324 (Ex.-2219), Figure 6A (annotated)

U.S. Pat. No. 5,792,695 (Ex.-2220), Figure 1 (annotated)

U.S. Pat. No. 6,020,233 (Ex.-2221), Figure 5E (annotated)

’501-Patent (Ex.-1201), Figure 1 (annotated)

POR at 37

# Misra's Layers 20 And 23 Are Contiguous And Form A Film Of Silicon Nitride

18 Q. So is element 20 touching element 23?
19 MR. SMITH: Objection.
20 **A. You'll have to give me a minute to look**
21 **through the process sequence to see exactly what**
22 **that interface looks like.**
23 **Is that all right?**

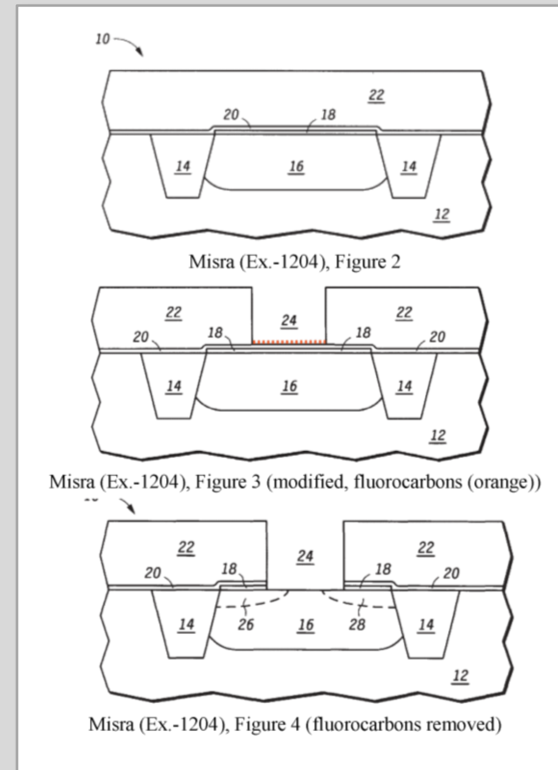
* * * *

1 Q. So do you agree that element 20 would be
2 exposed to the opening 24, as shown in figure 4?
3 MR. SMITH: Objection.
4 **A. No.**
5 Q. Why not?
6 **A. It has this polymer from the etch,**
7 **residual polymer.**

* * * *

13 Q. So your opinion is that none of element 20
14 would be present in opening 24 because of the fine
15 layer of atomic contamination; is that correct?
16 MR. SMITH: Objection.
17 **A. I didn't say that.**
18 **You asked me what that interface looked**
19 **like. I said it's got a layer of -- it's not**
20 **contamination. It's the fluorocarbon products from**
21 **the NF3 etch.**

Shanfield Opening Depo., Ex. 2210 at 259:18-23, 261:1-7, 261:13-21 (cited POR at 48)



Misra (Ex.-1204), Figure 2

Misra (Ex.-1204), Figure 3 (modified, fluorocarbons (orange))

Misra (Ex.-1204), Figure 4 (fluorocarbons removed)

POR at 50

As Dr. Glew explains, a POSA would have understood that Misra's $NF_3$ etch ***cannot produce fluorocarbon film*** because it does not contain carbon. Ex.-2208(Glew-Decl.), ¶114; Ex.-1204 at 5:52-58; Ex.-2224 at 2107; Ex.-2223 at 49. Moreover, even though the fluorocarbon etch for silicon oxide 22 produces fluorocarbons, the ***subsequent $NF_3$ etch removes any fluorocarbons***. Ex.-2208(Glew-Decl.), ¶¶115-116; Ex.-2222 at 45, 55; Ex.-2223 at 47.

POR at 49

# Cross Examination Revealed Shanfield Understands That "Film" Has A Broader Meaning In The Art

14 Can you tell me what characteristics "a
15 gate insulating film" shares with "a silicon
16 nitride film," as used in claim 1.
17 **MR. SMITH:** Objection.
18 **A. (Witness reviews document.) One**
19 **characteristic of those two films is their thin**
20 **layers.**

Shanfield Opening Depo., Ex. 2210 at 306:14-20
(cited POR at 33)

# Cross Examination Revealed Shanfield Understands That "Film" Has A Broader Meaning In The Art

12 Q. So the interpretation of "film" in the
13 '501 patent does not require that it is continuous.
14 MR. SMITH: Objection.
15 A. I don't know what you mean by
16 "continuous." It's not a claim term. I don't have
17 any opinion on that, so I can't comment.

* * * *

19 Q. Would a POSA interpret "a silicon nitride
20 film" as requiring a continuous structure?
21 MR. SMITH: Objection.
22 A. Why would they care? There's no term
23 "continuous" being used. So I don't think they'd
24 worry about it. It wouldn't be an issue.

Shanfield Depo., Ex. 2210 at 342:12-17; 343:19-24
(cited POR at 51)

# Cross Examination Revealed Shanfield Understands That "Film" Has A Broader Meaning In The Art

8 Q. Do you have any experience with chemical
9 vapor deposition?
10 A. Yes.
11 Q. At a high level, how does that process
12 work?
13 A. If you're referring to plasma enhanced
14 chemical vapor deposition, I can explain that.
15 That would be probably most relevant here.
16 Q. Yes, at a high level, please.
17 A. It's depositing a thin film of something
18 that -- of semiconductor material that you're
19 interested in covering a surface with. It's done
20 with plasma so that it can be done at low
21 temperature -- lower temperature than if it was
22 just pure chemical reaction.
23 The kinds of materials that might be
24 deposited on -- in thin film would be -- it's
1 typically a dielectric like silicon nitride,
2 silicon oxynitride, silicon oxide. "Thin films"
3 refer to one or multiple layers of coverage over a
4 surface.
5 It's widely used in the semiconductor
6 industry and has been perfected in terms of
7 providing extremely high uniformity, uniform etch
8 properties, and other characteristics that you care
9 about in a thin film.

Shanfield Opening Depo., Ex. 2209, at 54:8-55:9 (cited POR at 47)

Shanfield admitted that layers 20, 23 are formed through a process where "[t]hin films refer ***to one or multiple layers of coverage over a surface***." Ex.-2209 at 54:8-55:9 (defining thin films); *see also* Ex.-2210 at 214:6-24, 268:5-269:1 (a POSA would understand that layer 20 is deposited using a PECVD), 269:22-270:6 (same for spacers 23), 271:24-272:4 (same).

POR at 47

**1**. A semiconductor device, comprising a MISFET, wherein

the MISFET includes:

an active region made of a semiconductor substrate;

a gate insulating film formed on the active region;

a gate electrode formed on the gate insulating film;

source/drain regions formed in regions of the active region located on both sides of the gate electrode; and

a silicon nitride film formed over from side surfaces of the gate electrode to upper surfaces of the source/drain regions, wherein:

the silicon nitride film is not formed on an upper surface of the gate electrode, and

the gate electrode protrudes upward from a surface level of parts of the silicon nitride film located at both side surfaces of the gate electrode.

’501 patent at Claim 1

**A. “silicon nitride film”**

As demonstrated below, the BRI of “silicon nitride film” is a “thin coating of one or more layers of silicon nitride.” Ex.-2208(Glew-Decl.), ¶61.

POR at 28

# '501 Patent's Prosecution History Confirms Plain Meaning of The Protruding Gate Electrode Limitation

15. (Currently Amended) A semiconductor device, comprising a MISFET, wherein the MISFET includes:

an active region made of a semiconductor substrate;

a gate insulating film formed on the active region;

a gate electrode formed on the gate insulating film;

source/drain regions formed in regions of the active region located on both sides of the gate electrode; and

a silicon nitride film formed over from side surfaces of the gate electrode to upper surfaces of the source/drain regions, wherein:

the silicon nitride film is not formed on an upper surface of the gate electrode, and

~~the gate insulating film is formed only under a lower surface of the gate electrode, and~~

~~the source/drain regions include lightly doped impurity regions formed in regions of the active region located on both sides of the gate electrode, and heavily doped impurity regions formed in regions of the active region respectively extending outwardly from the lightly doped impurity regions to be in contact with the lightly doped impurity regions and having a higher impurity concentration than that of the lightly doped impurity regions~~

the gate electrode protrudes upward from a surface level of parts of the silicon nitride film located at both side surfaces of the gate electrode.

8/6/2010 Amendment, Ex.1203, at 2

**Rejection under 35 U.S.C. § 103**

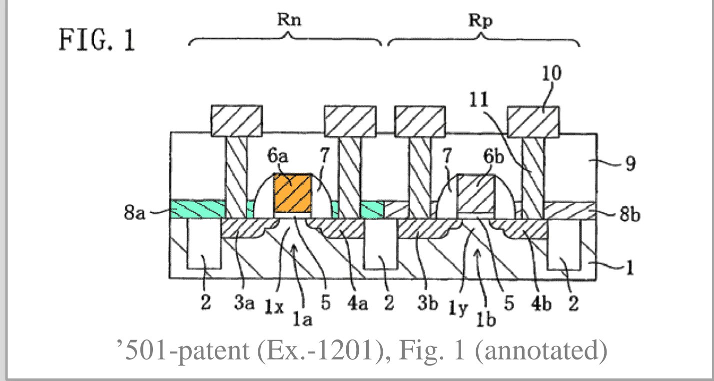
Claims 15-21, 23-34 and 36 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Xiang et al. (US 6,437,404) and Matsuda et al. (US 6,870,230). Claims 22 and 35 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Xiang et al. and Matsuda et al., and further in view of Tatsuta (US 5,023,676). These rejections are traversed for at least the following reasons.

Applicants respectfully submit that, at a minimum, none of the cited references discloses or suggests that "*the gate electrode protrudes upward from a surface level of parts of the silicon nitride film located at both side surfaces of the gate electrode*," as recited by amended claim 15. In the present subject matter, as shown in, for example, FIGS. 1 and 4A, the gate electrode 6a, 6b protrudes upward from a surface level of parts of the silicon nitride film 8a, 8b located at both side surfaces of the gate electrode 6a, 6b. In other words, a height of the gate electrode from the surface of the substrate is higher than a height of the silicon nitride film disposed at the sides of the gate electrode.

8/6/2010 Amendment, Ex.1203, at 8 (cited in POR at 3)

Applicants respectfully submit that, at a minimum, none of the cited references discloses or suggests that "*the gate electrode protrudes upward from a surface level of parts of the silicon nitride film located at both side surfaces of the gate electrode*," as recited by amended claim 15. In the present subject matter, as shown in, for example, FIGS. 1 and 4A, the gate electrode 6a, 6b protrudes upward from a surface level of parts of the silicon nitride film 8a, 8b located at both side surfaces of the gate electrode 6a, 6b. In other words, a height of the gate electrode from the surface of the substrate is higher than a height of the silicon nitride film disposed at the sides of the gate electrode.

8/6/2010 Amendment, Ex.1203, at 8 (cited in POR at 3)

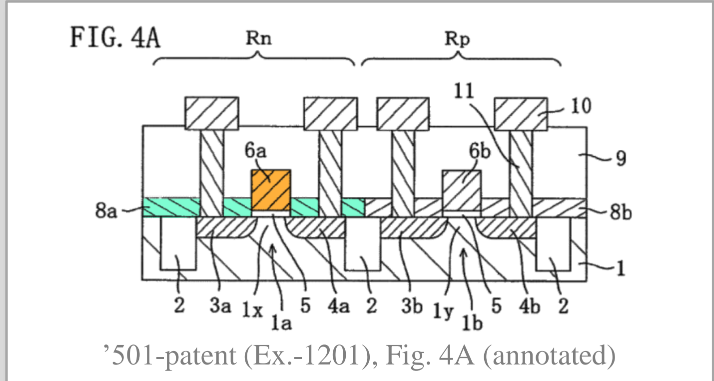


'501-patent (Ex.-1201), Fig. 1 (annotated)

POR at 60

Next, in the process step of FIG. **2**C, after the resist film **12** has been removed, the silicon nitride film **8***x* is etched back, part of the silicon nitride film **8***x* located on the gate electrode **6***a* is removed and the thickness of the silicon nitride film **8***x* is further reduced. Thus, a first-type internal stress film **8***a* is

'501 patent at 7:5-9 (cited in POR at 59)

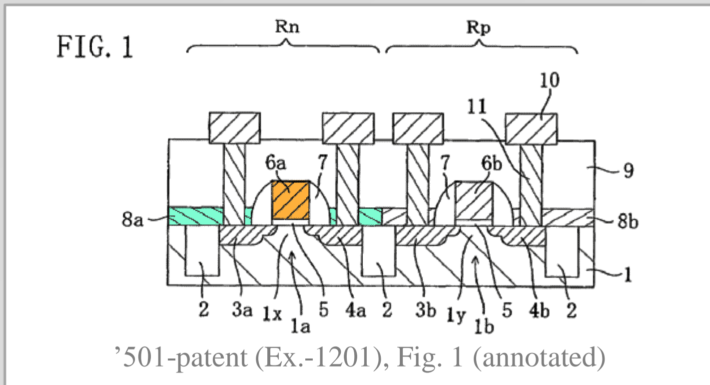


'501-patent (Ex.-1201), Fig. 4A (annotated)

POR at 60

Next, in the process step of FIG. **5**B, after the resist film **12** has been removed, the silicon nitride film **8***x* is etched back, part of the silicon nitride film **8***x* located on the gate electrode **6***a* is removed and the thickness of the silicon nitride film **8***x* is further reduced. Thus, a first-type internal stress film **8***a*

'501 patent at 9:62-66 (cited in POR at 59)

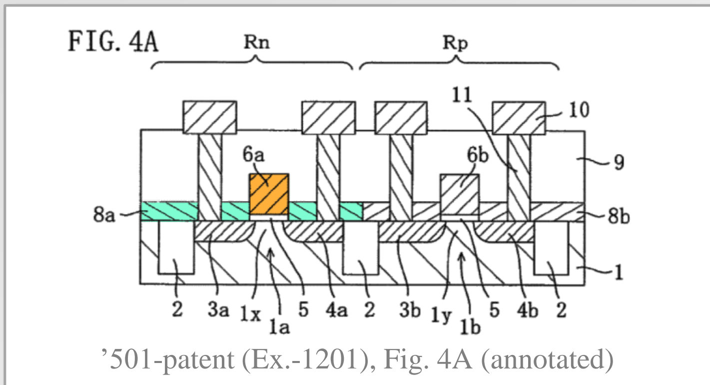


’501-patent (Ex.-1201), Fig. 1 (annotated)

POR at 60

Next, in the process step of FIG. **2**C, after the resist film **12** has been removed, the silicon nitride film **8***x* is etched back, part of the silicon nitride film **8***x* located on the gate electrode **6***a* is removed and the thickness of the silicon nitride film **8***x* is further reduced. Thus, a first-type internal stress film **8***a* is

’501 patent at 7:5-9 (cited in POR at 59)

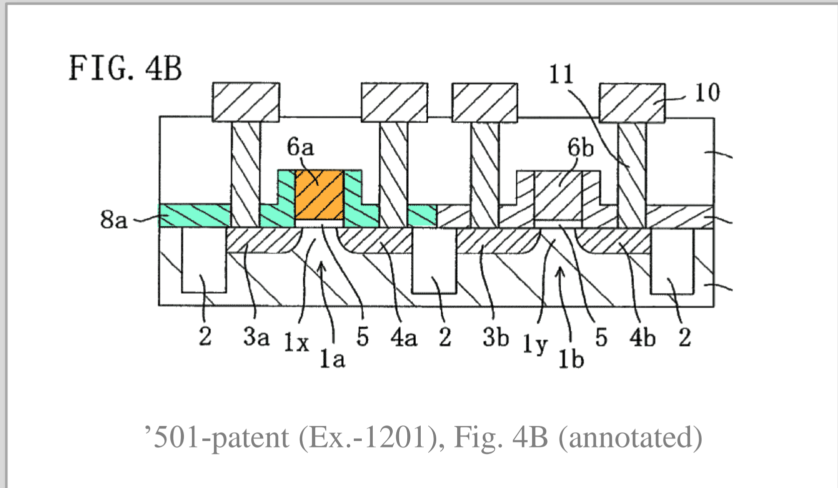


’501-patent (Ex.-1201), Fig. 4A (annotated)

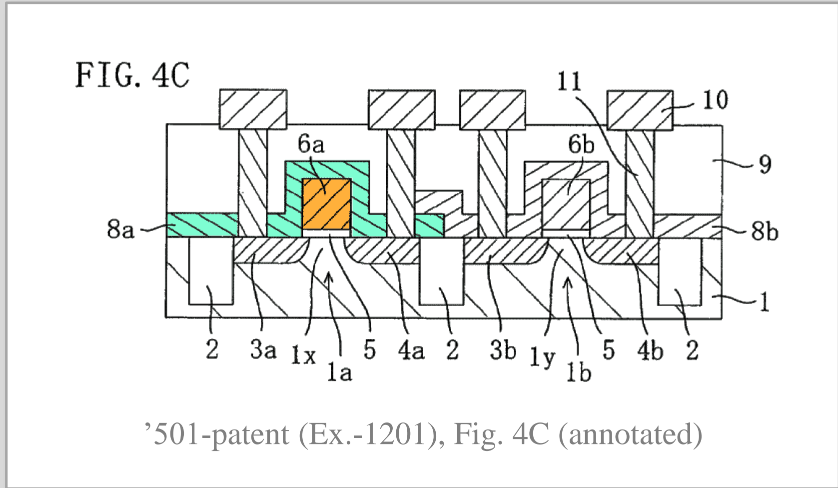
POR at 60

Next, in the process step of FIG. **5**B, after the resist film **12** has been removed, the silicon nitride film **8***x* is etched back, part of the silicon nitride film **8***x* located on the gate electrode **6***a* is removed and the thickness of the silicon nitride film **8***x* is further reduced. Thus, a first-type internal stress film **8***a*

’501 patent at 9:62-66 (cited in POR at 59)



’501-patent (Ex.-1201), Fig. 4B (annotated)

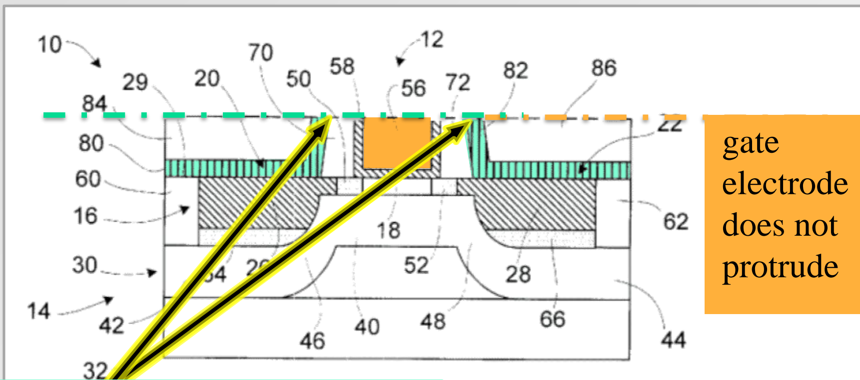


’501-patent (Ex.-1201), Fig. 4C (annotated)

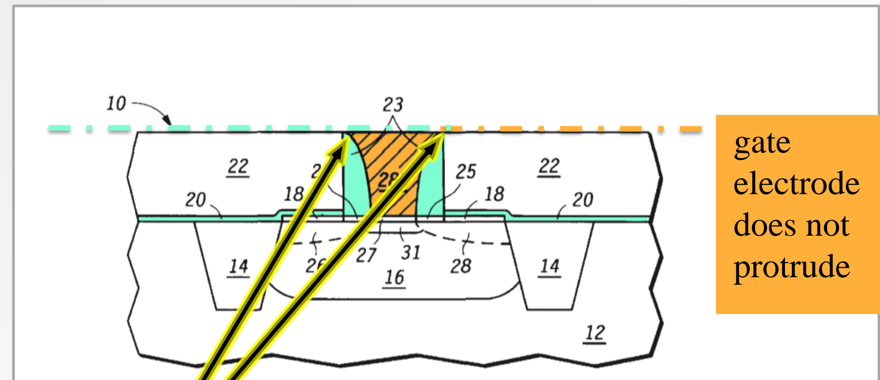
POR at 29

In contrast, as shown in FIG. 1 of Xiang, it is clear that the upper surface of the gate electrode 56 is at the same level as that of an upper end surface of the etch stop layer 80, 82 (i.e., the alleged silicon nitride film) located at both side surfaces of the gate electrode 56. As such, in Xiang, the gate electrode 56 does not protrude from a surface level of the parts of the silicon nitride film 80, 82 located at the both side surfaces of the gate electrode 56.

8/6/2010 Amendment, Ex.1203, at 9 (cited in POR at 3)




Xiang (Ex.-2202), Fig. 1 (annotated)

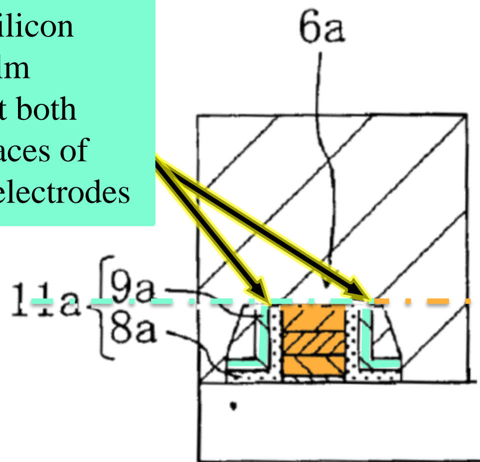



Misra (Ex.-1204), Fig. 7 (annotated)

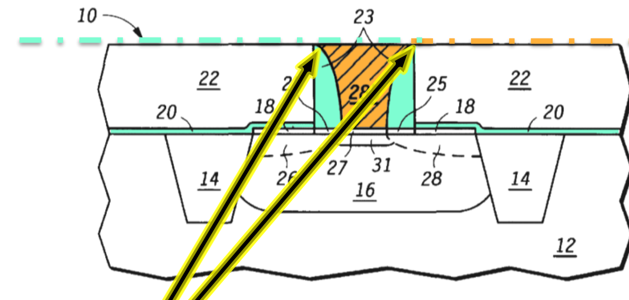
POR at 64

In Matsuda, as shown in FIG. 9A, it is also clear that the upper surface of the gate electrode 6a is at the same level as that of an upper end surface of the parts of the protective insulating film 9a (i.e., the alleged silicon nitride film) located at both side surfaces of the gate electrode 6a. As such, it is clear that Matsuda also fails to disclose or suggest that the gate electrode protrudes upward from a surface level of parts of the silicon nitride film located at both side surfaces of the gate electrode.

8/6/2010 Amendment, Ex.1203, at 9 (cited in POR at 3)

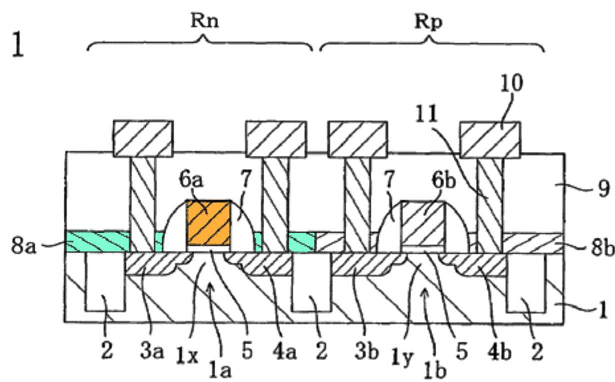



Matsuda (Ex.-2203), Fig. 9A (annotated)

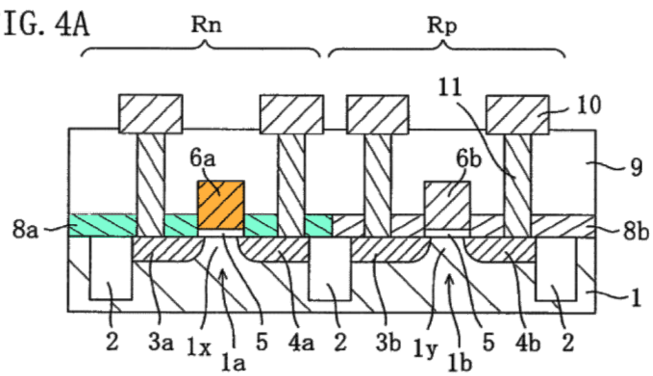



Misra (Ex.-1204), Fig. 7 (annotated)

POR at 64

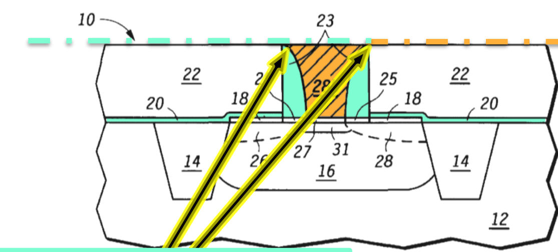



’501-patent (Ex.-1201), Fig. 1 (annotated)




’501-patent (Ex.-1201), Fig. 4A (annotated)

POR at 60

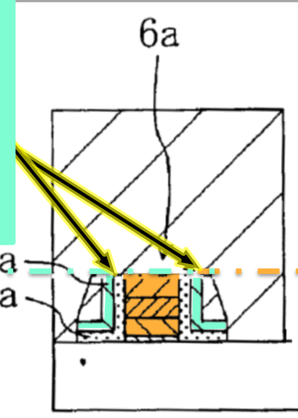



gate electrode does not protrude

surface level of silicon nitride film located at both side surfaces of the gate electrodes

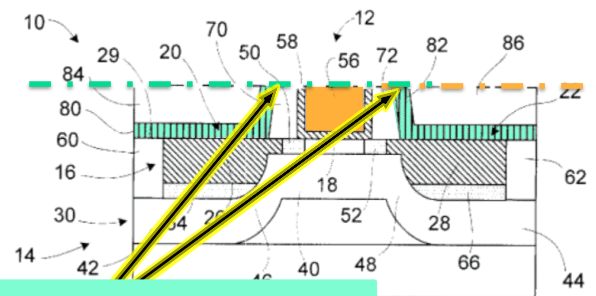
Misra (Ex.-1204), Fig. 7 (annotated)

surface level of alleged silicon nitride film located at both side surfaces of the gate electrodes




gate electrode does not protrude

Matsuda (Ex.-2203), Fig. 9A (annotated)




gate electrode does not protrude

surface level of alleged silicon nitride film located at both side surfaces of the gate electrodes

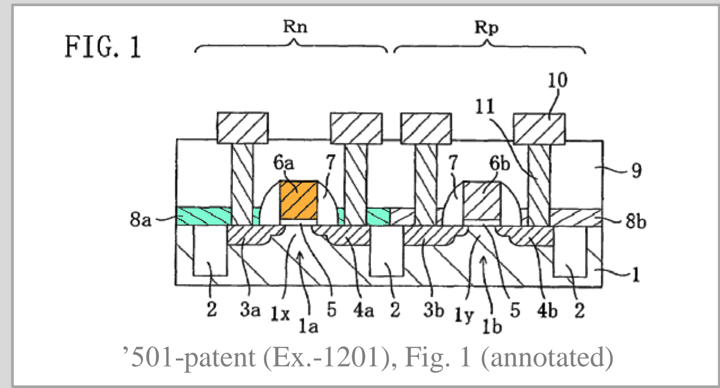
Xiang (Ex.-2202), Fig. 1 (annotated)

Demonstrative Exhibit

POR at 64, 65

The allegedly distinguishing feature of the claims of the '501 patent is gate 6a protruding above the silicon nitride film 8a.[2] (*See* Summary of the Prosecution History below.) The specification of '501 patent, however, does not even mention the protruding gate electrode, let alone identify any purported advantages. (Shanfield Decl. ¶49 (Ex-1202).)

Petition at 9

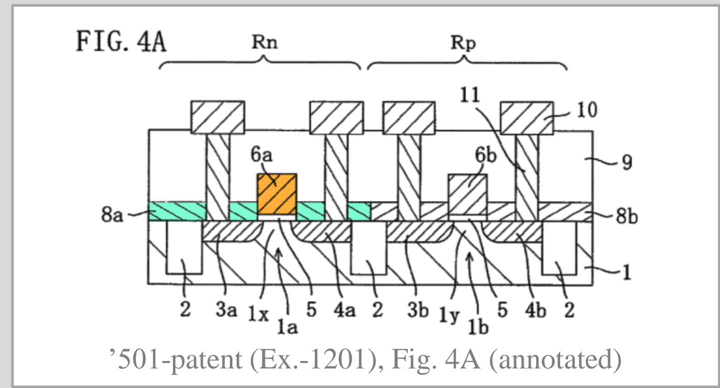


'501-patent (Ex.-1201), Fig. 1 (annotated)

POR at 60

Next, in the process step of FIG. **2**C, after the resist film **12** has been removed, the silicon nitride film **8***x* is etched back, part of the silicon nitride film **8***x* located on the gate electrode **6***a* is removed and the thickness of the silicon nitride film **8***x* is further reduced. Thus, a first-type internal stress film **8***a* is

'501 patent at 7:5-9 (cited at POR at 60)



'501-patent (Ex.-1201), Fig. 4A (annotated)

POR at 60

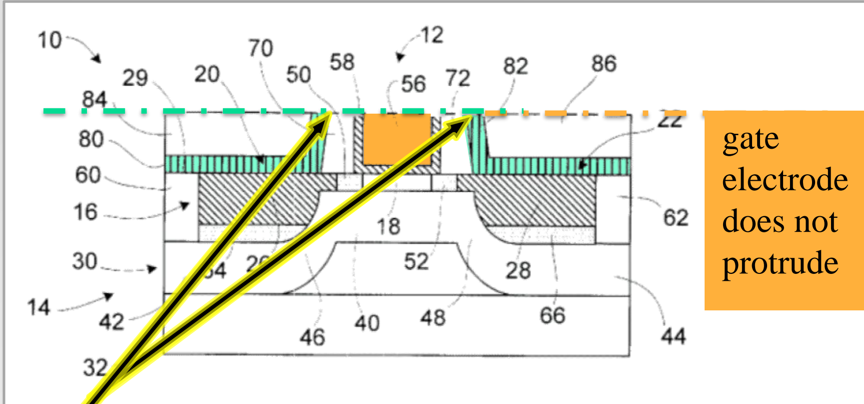
Next, in the process step of FIG. **5**B, after the resist film **12** has been removed, the silicon nitride film **8***x* is etched back, part of the silicon nitride film **8***x* located on the gate electrode **6***a* is removed and the thickness of the silicon nitride film **8***x* is further reduced. Thus, a first-type internal stress film **8***a*

'501 patent at 9:62-66 (cited at POR at 60)

# Shanfield Testified He Did Not Consider If Petitioner's Narrow Interpretation Of "Film" Is Consistent With The Prosecution History

In contrast, as shown in FIG. 1 of Xiang, it is clear that the upper surface of the gate electrode 56 is at the same level as that of an upper end surface of the etch stop layer 80, 82 (i.e., the alleged silicon nitride film) located at both side surfaces of the gate electrode 56. As such, in Xiang, the gate electrode 56 does not protrude from a surface level of the parts of the silicon nitride film 80, 82 located at the both side surfaces of the gate electrode 56.

8/6/2010 Amendment, Ex.-1203 at 9 (cited in POR at 3)




Xiang (Ex.-2202), Fig. 1 (annotated)

POR at 64

Shanfield admitted that he did not even consider whether Petitioner's claim interpretations were so broad that they read directly onto the very references distinguished over during prosecution. Ex.-2210 at 389:8-390:2 ("I've offered no opinion about whether Xiang meets or doesn't meet the claim elements in ***my interpretation of them*** … I haven't done [] an analysis on Xiang."). It was legal error for Shanfield to not ensure that the claim interpretation he and the Petitioner advanced was consistent with the prosecution history. *See Hospira, Inc. v. Genentech, Inc.*, IPR2017-00731, Paper No. 29 at 8 (Oct. 26, 2017) ("Under the broadest-reasonable-interpretation standard, we ***must*** consult the patent's prosecution history in proceedings … "***Any explanation, elaboration, or qualification*** presented by the inventor … ***is relevant***, for the role of claim construction is to capture the scope of the actual invention that is disclosed, described, and patented.").

POR at 15

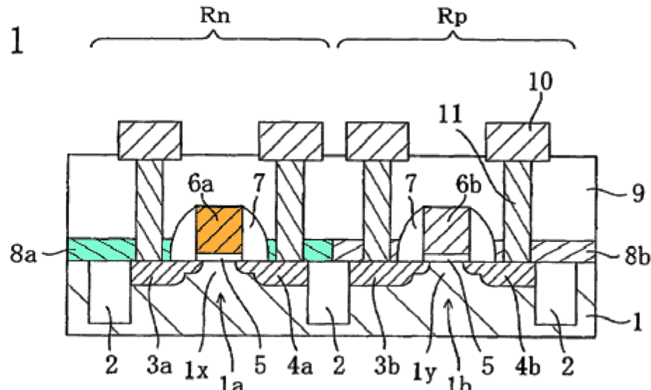
# Benefits Of The Claimed Protruding Gate Electrode Limitation

1. A semiconductor device, comprising a MISFET, wherein
the MISFET includes:
an active region made of a semiconductor substrate;
a gate insulating film formed on the active region;
a gate electrode formed on the gate insulating film;
source/drain regions formed in regions of the active region located on both sides of the gate electrode; and
a silicon nitride film formed over from side surfaces of the gate electrode to upper surfaces of the source/drain regions, wherein:
the silicon nitride film is not formed on an upper surface of the gate electrode, and
the gate electrode protrudes upward from a surface level of parts of the silicon nitride film located at both side surfaces of the gate electrode.

’501 patent at Claim 1

2. The semiconductor device of claim 1, wherein the silicon nitride film is for generating a stress in a substantially parallel direction to the gate length direction in a channel region located in the active region under the gate electrode.

’501 patent at Claim 2



'501-patent (Ex.-1201), Fig. 1 (annotated)

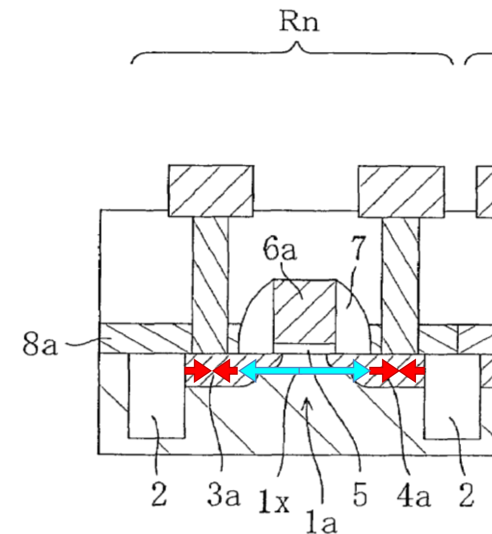
POR at 60

direction to a boundary surface. Specifically, the first-type internal stress film **8***a* applies a compressive stress to the source region **3***a* and the drain region **4***a* in the active region **1***a* of the nMISFET in the parallel direction to the principal surface. As a result, a tensile stress is applied to a region of the substrate located between the source region **3***a* and the drain region **4***a*, i.e., the channel region **1***x* in the gate length direction (the direction in which electrons move when the nMISFET is in an operation state). Then, with this tensile stress, electrons are influenced by the piezo resistivity effect, so that the mobility of electrons is increased. Herein, "substantially

'501 patent at 4:42-52 (cited in POR at 20)

to balance out the forces. As shown conceptually in the figure below, applying compressive stresses to the source and drain regions (red arrows) creates the desired tensile stress (blue arrows) in the channel region between the source and the drain regions.

Glew Decl., Ex. 2208, at ¶ 36 (cited in POR at 19)



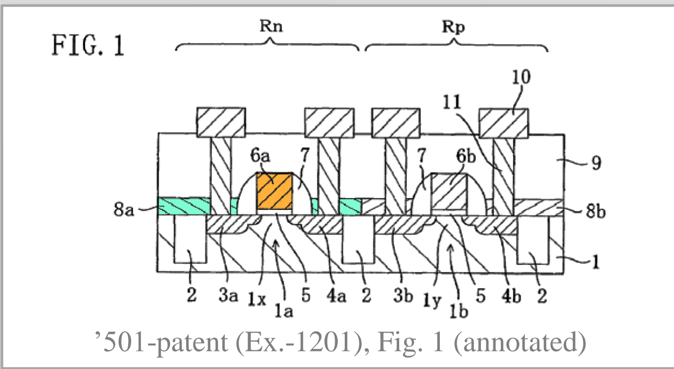
'501 Patent, Ex.-1201, Portion of Fig. 1 (annotated)

Glew Decl., Ex. 2208, at ¶ 36 (cited in POR at 19)

38. Due to the piezo resistivity effect, the applied stress in channel regions 1x and 1y increases carrier (*e.g.*, electron, hole) mobility within the channel regions. *Id.* at 4:50-52, 5:49-51. In particular, applying stress to a semiconductor

Glew Decl., Ex. 2208, at ¶ 38 (cited in POR at 19)

Demonstrative Exhibit

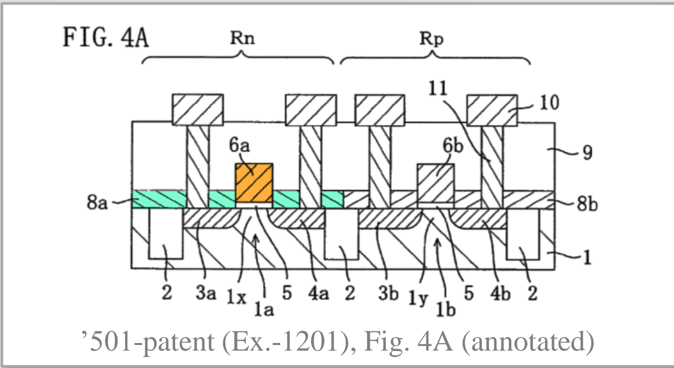


’501-patent (Ex.-1201), Fig. 1 (annotated)

POR at 60

FET is in an operation state). Then, with this tensile stress, electrons are influenced by the piezo resistivity effect, so that the mobility of electrons is increased. Herein, “substantially

’501 patent at 4:50-52 (cited in POR at 19)

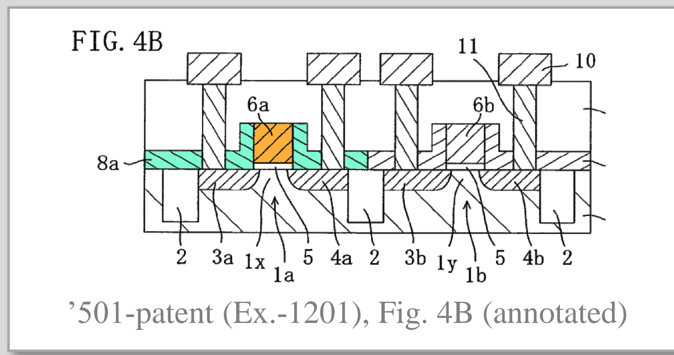


’501-patent (Ex.-1201), Fig. 4A (annotated)

POR at 60

that of the semiconductor device of the first embodiment. In this modified example, no sidewall exists in forming an internal stress film, so that a space between respective parts of the source/drain regions **3***a* and **4***a* being in contact with the first-type internal stress film **8***a* is small. Thus, a stress applied to each of the channel regions **1***x* and **1***y* is increased, so that the effect of improving the carrier mobility becomes larger than that of the first embodiment.

’501 patent at 8:1-9 (cited at POR at 20)



’501-patent (Ex.-1201), Fig. 4B (annotated)

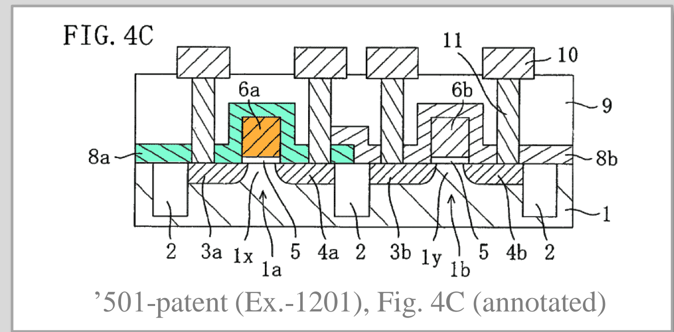
POR at 29

In this modified example, in addition to the effect of the first modified example, the following effect can be obtained.

* * * *

surface and the mobility of electrodes in the nMISFET is further improved.

’501 patent at 8:22-33 (Cited at POR 22)



’501-patent (Ex.-1201), Fig. 4C (annotated)

POR at 29

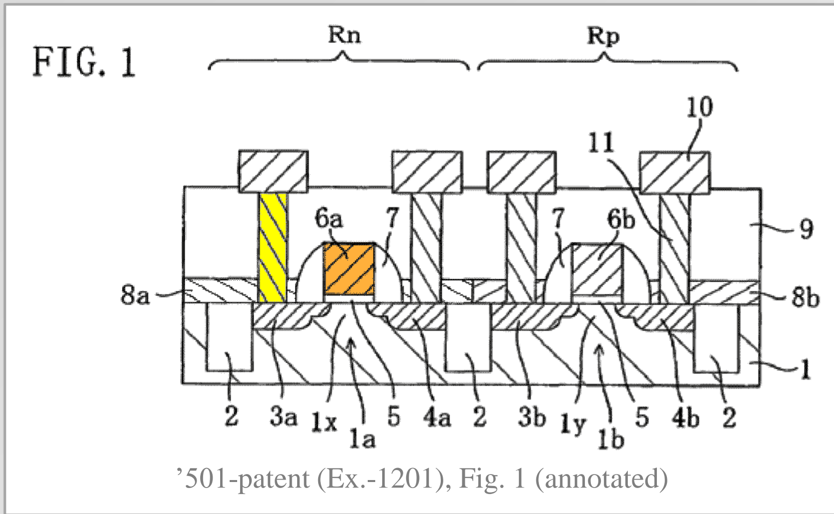
In this modified example, in addition to the effect of the second modified example, the following effect can be

* * * *

principal surface and the mobility of electrons in the nMISFET is further improved.

’501 patent at 8:59-9:3 (Cited at POR at 22)

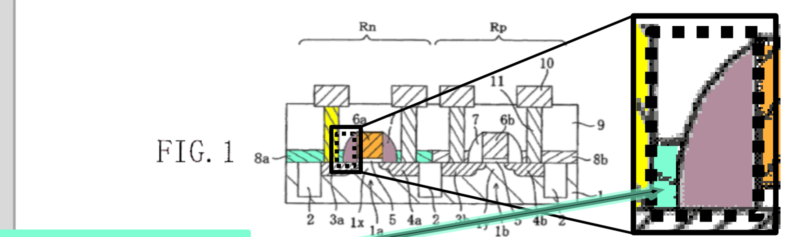
Demonstrative Exhibit



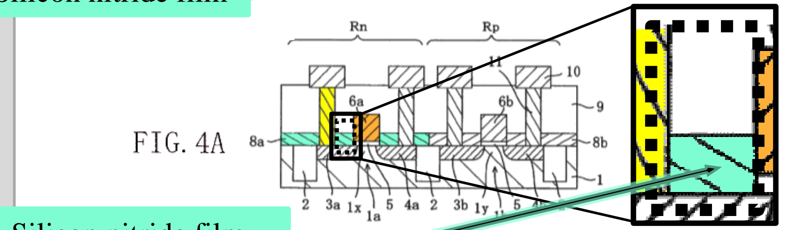

’501-patent (Ex.-1201), Fig. 1 (annotated)

parts of a circuit due to their proximity. Ex.-2205 at 1:60-64, 4:73-5:20. It was well known in MOS transistors that parasitic capacitance exists between the gate electrode (orange below) and the contacts (one highlighted in yellow) for the source/drain regions, and should preferably be minimized.

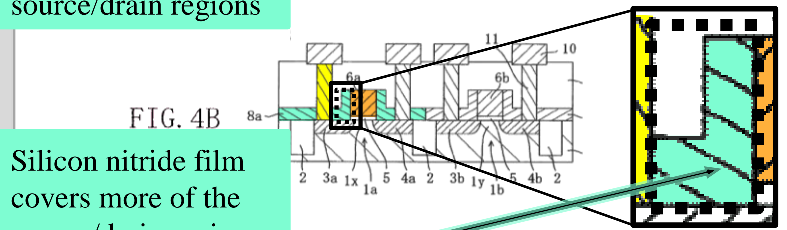
POR at 23-24




Silicon nitride film




Silicon nitride film covers more of the source/drain regions




Silicon nitride film covers more of the source/drain regions and the side surface of the gate electrode

’501 patent (Ex.-1201), Figures 1, 4A, and 4B (annotated)

Glew Decl., Ex. 2208, ¶ 50 (cited in POR at 25)

50. For example, in comparing the embodiments in Figures 1, 4A, and 4B (illustrated below), a POSA would have recognized that the embodiments in Figures 1 and 4A have lower ***parasitic capacitance*** between the gate electrode and the contact 11 as compared to the embodiment in Figure 4B, because the embodiment in Figure 4B has more silicon nitride in the area between the gate and the electrode which increases the effective dielectric constant in that area.

Glew Decl., Ex. 2208, ¶ 50 (cited in POR at 25)

# Under Patent Owner's BRI Of "Film" All Grounds Fail

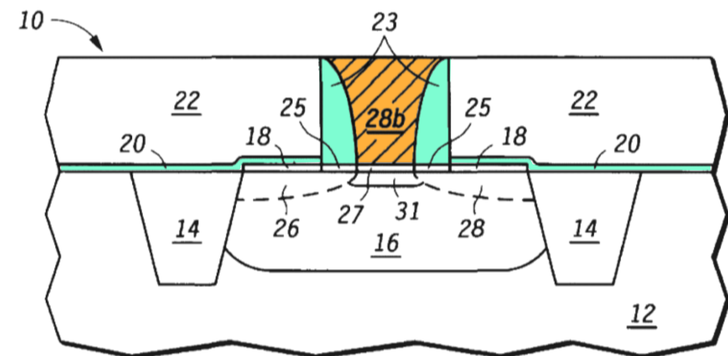
1. A semiconductor device, comprising a MISFET, wherein
the MISFET includes:
an active region made of a semiconductor substrate;
a gate insulating film formed on the active region;
a gate electrode formed on the gate insulating film;
source/drain regions formed in regions of the active region located on both sides of the gate electrode; and
a silicon nitride film formed over from side surfaces of the gate electrode to upper surfaces of the source/drain regions, wherein:
the silicon nitride film is not formed on an upper surface of the gate electrode, and
the gate electrode protrudes upward from a surface level of parts of the silicon nitride film located at both side surfaces of the gate electrode.

'501 patent at Claim 1

**A. "silicon nitride film"**

As demonstrated below, the BRI of "silicon nitride film" is a "thin coating of one or more layers of silicon nitride." Ex.-2208(Glew-Decl.), ¶61.

POR at 28



Misra (Ex.-1204), Fig. 7 (annotated)

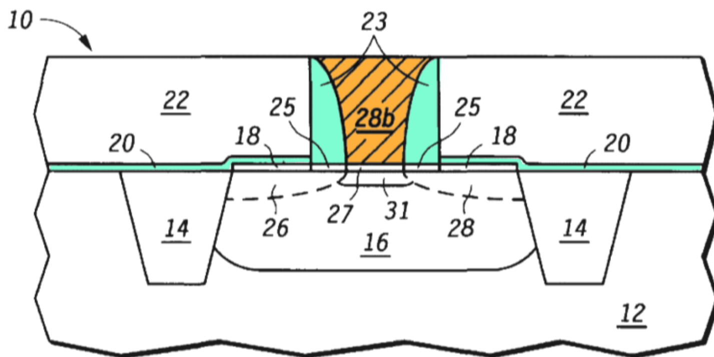
POR at 6

**1.** A semiconductor device, comprising a MISFET, wherein
the MISFET includes:
an active region made of a semiconductor substrate;
a gate insulating film formed on the active region;
a gate electrode formed on the gate insulating film;
source/drain regions formed in regions of the active region located on both sides of the gate electrode; and
a silicon nitride film formed over from side surfaces of the gate electrode to upper surfaces of the source/drain regions, wherein:
the silicon nitride film is not formed on an upper surface of the gate electrode, and
the gate electrode protrudes upward from a surface level of parts of the silicon nitride film located at both side surfaces of the gate electrode.

'501 patent at Claim 1

Patent Owner, however, mischaracterizes Petitioner's argument. Nowhere does Petitioner argue that the claims *exclude* a silicon nitride film having multiple layers. Petitioner simply argues that a silicon nitride film *need not* include *every* silicon nitride structure in a prior art device. *See* Pet. 42–43. As discussed in more detail below (Section II.E), Petitioner relies on Misra's plasma-enhanced nitride layer 20 (in combination with Tsai) as teaching the claimed "silicon nitride film" and relies on Misra's spacers 23 (that Patent Owner alleges *must* be considered part of the silicon nitride film) as teaching the claimed "sidewall formed on the side surface of the gate electrode" (claim 7). *See* Pet. 29, 51–52. Although we agree with Patent Owner that the Specification discloses that the claimed silicon nitride film *may include* multiple layers, we disagree that the claim requires that the

Institution Decision, Paper No. 10 at 8




Misra (Ex.-1204), Fig. 7 (annotated)

POR at 6

At Institution, the Board noted that a silicon nitride film "*need not* include *every* silicon nitride structure in a prior art device." Decision at 8 (emphasis in original). Patent Owner agrees that ***every*** silicon nitride structure need not be considered part of the same film. But the plain meaning of "film," and more importantly its usage in the '501 specification, ***do require*** that contiguous layers of the same silicon nitride material that—like Misra/Tsai's layers 20, 23—together coat one or more surfaces of a device are part of the same film. Ex.-2208(Glew-Decl.), ¶¶99-102.

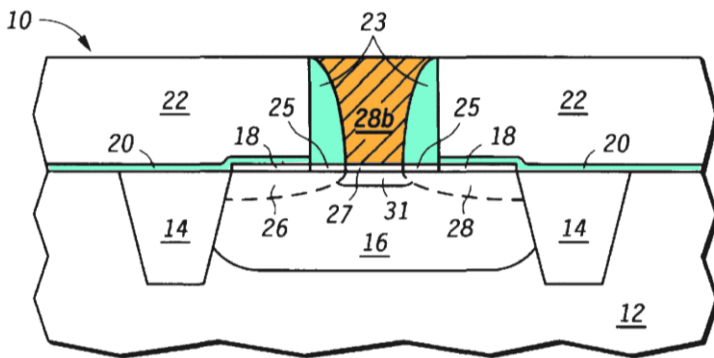
POR at 8

1. A semiconductor device, comprising a MISFET, wherein
the MISFET includes:
an active region made of a semiconductor substrate;
a gate insulating film formed on the active region;
a gate electrode formed on the gate insulating film;
source/drain regions formed in regions of the active region located on both sides of the gate electrode; and
a silicon nitride film formed over from side surfaces of the gate electrode to upper surfaces of the source/drain regions, wherein:
the silicon nitride film is not formed on an upper surface of the gate electrode, and
the gate electrode protrudes upward from a surface level of parts of the silicon nitride film located at both side surfaces of the gate electrode.

'501 patent at Claim 1

Patent Owner's arguments in this regard are premised primarily on its contention that the claimed "silicon nitride film" must encompass *all* silicon nitride structures in a prior art device. *See id.* at 12–20, 61–76. For the reasons discussed above (*supra* Section II.A), we are not persuaded based on the current record that this is required by the claims. Instead, we are persuaded by Petitioner's showing that gate electrode 28b (i.e., the claimed gate electrode) "protrudes upward from a surface level" of plasma-enhanced nitride layer 20 (i.e., the claimed silicon nitride film). *See* Pet. 41–43.

Institution Decision, Paper No. 10 at 18




Misra (Ex.-1204), Fig. 7 (annotated)

POR at 6

At Institution, the Board characterized Patent Owner's argument as requiring that the gate electrode protrude from "*all* silicon nitride structures in a prior art device." Decision at 18 (emphasis in original). Respectfully, that is ***not*** Patent Owner's position. Patent Owner's position is simply this—the plain language of the claims requires that the gate electrode protrude from a silicon nitride film ***"formed over from" and "located at" the side surfaces of the gate electrode***, and in view of the specification and prosecution history, the ***only*** reasonable interpretation of the claims is that the silicon nitride structure located closest to the side surfaces of the gate electrode (such as layer 23 in Misra) cannot fully cover the side surfaces of the gate electrode. Ex.-2208(Glew-Decl.), ¶¶148-161.

POR at 11

# Even if Misra/Tsai's Silicon Nitride Layers 20, 23 Are Considered Distinct Films, Misra/Tsai Still Does Not Satisfy The Limitations Of Claim 1 (POR at 71)

To the extent Patent Owner argues that the gate must protrude above ***every*** silicon nitride structure in the device, this argument should be rejected. Under the broadest reasonable interpretation, a POSITA would have understood that the claim merely requires the "gate electrode protrudes upward from a surface level of parts of the silicon nitride film located at both side surfaces of the gate electrode" and does ***not*** require the gate to protrude above ***every*** silicon nitride structure in the device. Not only that, but the claim only requires the gate electrode protrude upward from "***parts*** of the silicon nitride film," not even the entire film. (Shanfield Decl. ¶116 (Ex-1202).)

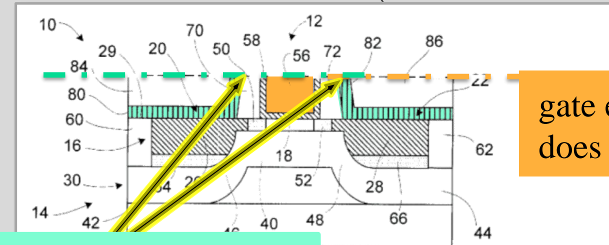
Petition at 43

the gate electrode protrudes upward from a surface level of parts of the silicon nitride film located at both side surfaces of the gate electrode.

'501 patent at Claim 1

the alleged silicon nitride film) located at both side surfaces of the gate electrode 56. As such, in Xiang, the gate electrode 56 does not protrude from a surface level of the parts of the silicon nitride film 80, 82 located at the both side surfaces of the gate electrode 56.

Ex.1203 at 9 (cited in POR at 3)

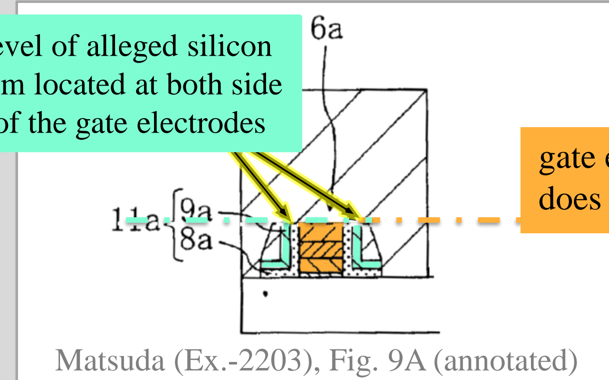



Xiang (Ex.-2202), Fig. 1 (annotated)

POR at 64

electrode 6a. As such, it is clear that Matsuda also fails to disclose or suggest that the gate electrode protrudes upward from a surface level of parts of the silicon nitride film located at both side surfaces of the gate electrode.

Ex.1203 at 9 (cited in POR at 3)




Matsuda (Ex.-2203), Fig. 9A (annotated)

POR at 65

# Petitioner's Reply Improperly Changed Petitioner's Theory Of Unpatentability (Paper No. 27, at 52)

For example, Misra discloses a sidewall (spacer 23) (purple) formed on the side surface of the gate electrode (gate electrode 28b) (orange), wherein the silicon

* * * *

(Misra at Fig. 7; 6:37-40 ("After formation of the sacrificial oxide 25, silicon nitride is deposited and reactive ion etched to form **silicon nitride spacers 23** on top of the sacrificial oxide 25.") (Ex-1204).) The silicon nitride film (plasma

Petition, Paper No. 2 at 51-52

patent at Fig. 1 (including spacers 7) (Ex-1201).) A POSITA would have understood that the gate electrode 28b protrudes upward from a surface level of the silicon nitride film (plasma enhanced nitride layer 20) located at the sides of the gate electrode, as claimed, regardless of whether spacers 23 are constructed out of silicon nitride. This is because plasma enhanced nitride layer 20 and the spacers 23 are separate structures (even if they are made of the same material). The

Petition, Paper No. 2 at 42

U.S. Patent 7,893,501
IPR2017-01843
Petitioner's Reply to Patent Owner's Response

II. PATENT OWNER DOES NOT DISPUTE MISRA'S THERMALLY GROWN SIDEWALL EMBODIMENTS DISCLOSE THE CLAIMED

**PETITIONER'S REPLY TO PATENT OWNER'S RESPONSE**

42. As discussed in the sections that follow, PO fails to rebut Petitioner's

PO offers no response for Misra's embodiments where spacers 23 are made of other materials such as silicon oxide. Ex. 1232, ¶9.

other materials such as silicon oxide. Ex. 1232, ¶9.

Misra expressly states that the spacers 23 may be replaced with other

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ot

**Ex. 1204, 6:54-58**

added). In other words, the spacers 23 are made of a thermally grown silicon dioxide rather than silicon nitride. Ex. 1232, ¶10.

- 4 -

Petitioner's Reply to POR, Paper No. 22 at 4

Demonstrative Exhibit

18 Q. Now, let me draw your attention to
19 Column 6, lines 54 to 58 of Misra. Do you see the
20 sentence in Misra at Column 6, lines 54 to 58?
21 **A. Yes.**
22 Q. In your opening declaration, Exhibit 1202,
23 did you cite to any part of Column 6, lines 54 to
24 58, of Misra?
1 **A. Well, to do a thorough job, I'll have to**
2 **spend a lot more time. But it doesn't look like I**
3 **did, yes.**
4 Q. If we give you 10 to 15 minutes, do you
5 think you can confirm that?
6 **A. That might be enough time.**
7 **So I don't see it in there.**

Shanfield Reply Depo., Ex. 2232 at 36:18-37:7 (Patent Owner's Observations, Paper No. 30, #17)

21 Q. Did you opine in your declaration that a
22 POSA would modify element 23 in Misra to be a
23 material other than silicon nitride?
24 **MR. SMITH:** Objection.
1 **A. I don't think I did, but I'm responding to**
2 **your question about what material the spacers could**
3 **be and explaining that there are other choices than**
4 **silicon nitride.**

Shanfield Opening Depo., Ex. 2210 at 287:21-288:4 (Paper No. 27 at 1)

3 Q. So in your opening declaration,
4 Exhibit 1202, you did not provide an opinion that
5 Misra discloses use of a material other than silicon
6 nitride for spacer 23; is that right?
7 **A. No, I didn't. For the reasons I just**
8 **explained.**

Shanfield Reply Depo., Ex. 2232 at 38:3-8 (Patent Owner's Observations, Paper No. 30, #18)

U.S. Patent 7,893,501
IPR2017-01843
Petitioner's Reply to Patent Owner's Response

**PETITIONER'S REPLY TO PATENT OWNER'S RESPONSE**

Petitioner additionally showed that Misra discloses the "protruding gate" limitation "regardless of whether spacers 23 are constructed out of silicon nitride." Petition

PO offers no response for Misra's embodiments where spacers 23 are made of other materials such as silicon oxide. Ex. 1232, ¶9.

incorrect premise that spacers 23 are *necessarily* made of silicon nitride – they are not. PO offers no response for Misra's embodiments where spacers 23 are made of other

**Ex. 1204, 6:54-58**

mater

deposition ***may be replaced*** or composited ***with a sidewall thermal growth***, some silicides do not oxidize effectively and may at least some deposition process to obtain adequate source/drain to gate isolation." Ex. 1204, 6:54-58 (emphasis added). In other words, the spacers 23 are made of a thermally grown silicon dioxide rather than silicon nitride. Ex. 1232, ¶10.

- 4 -

Petitioner's Reply to POR, Paper No. 22 at 4

**ARIOSA DIAGNOSTICS v. VERINATA HEALTH, INC.**
Cite as 805 F.3d 1359 (Fed. Cir. 2015)

* * * *

iosa, at *10. Ariosa argues that the Board erred in failing to consider some embodiments of Dhallan—those which do not require a restriction-enzyme digestible primer—embodiments that, they argue, could be combined with Binladen. The Board declined to consider those embodiments because the cited "portions of Dhallan were not identified or discussed in the Petition or the accompanying Declarations." *Ariosa*, at *10. In any event, the Board added, Ariosa's explanation was lacking even as to those portions. *Id.*

We see no error in the Board's rejection of Ariosa's reliance, in its Reply submissions, on previously unidentified portions of a prior-art reference to make a meaningfully distinct contention. Ariosa's Peti-

*Ariosa Diagnostics v. Verinata Health, Inc.*, 805 F.3d 1359, 1367 (Fed. Cir. 2015) (cited in Patent Owner's Identification of New Arguments in Petitioner's Reply, Paper No. 27 at 2)

1. The Reply at 2-3 and 4-6 does not raise a new argument. Rather, it points out the failure of the Patent Owner's response to address Dr. Shanfield's responses to *Patent Owner's* questions about what materials Misra uses for the sidewalls.

Petitioner's Resp. to Patent Owner's Identification of New Arguments in Petitioner's Reply, Paper No. 28 at 1

**ARIOSA DIAGNOSTICS v. VERINATA HEALTH, INC.**
**Cite as 805 F.3d 1359 (Fed. Cir. 2015)**

* * * *

*iosa*, at *10. Ariosa argues that the Board erred in failing to consider some embodiments of Dhallan—those which do not require a restriction-enzyme digestible primer—embodiments that, they argue, could be combined with Binladen. The Board declined to consider those embodiments because the cited "portions of Dhallan were not identified or discussed in the Petition or the accompanying Declarations." *Ariosa*, at *10. In any event, the Board added, Ariosa's explanation was lacking even as to those portions. *Id.*

We see no error in the Board's rejection of Ariosa's reliance, in its Reply submissions, on previously unidentified portions of a prior-art reference to make a meaningfully distinct contention. Ariosa's Peti-

Ariosa, 805 F.3d at 1367 (cited in Patent Owner's Identification of New Arguments in Petitioner's Reply, Paper No. 27 at 2)

21 Q. Did you opine in your declaration that a
22 POSA would modify element 23 in Misra to be a
23 material other than silicon nitride?
24 MR. SMITH: Objection.
1 **A. I don't think I did, but I'm responding to**
2 **your question about what material the spacers could**
3 **be and explaining that there are other choices than**
4 **silicon nitride.**

Shanfield Reply Depo., Ex. 2210 at 287:21-288:4 (cited Paper No. 27 at 1)

3 Q. So in your opening declaration,
4 Exhibit 1202, you did not provide an opinion that
5 Misra discloses use of a material other than silicon
6 nitride for spacer 23; is that right?
7 **A. No, I didn't. For the reasons I just**
8 **explained.**

Shanfield Reply Depo., Ex. 2232 at 38:3-8 (Patent Owner's Observations, Paper No. 30, #18)

18 Q. Now, let me draw your attention to
19 Column 6, lines 54 to 58 of Misra. Do you see the
20 sentence in Misra at Column 6, lines 54 to 58?
21 **A. Yes.**
22 Q. In your opening declaration, Exhibit 1202,
23 did you cite to any part of Column 6, lines 54 to
24 58, of Misra?
1 **A. Well, to do a thorough job, I'll have to**
2 **spend a lot more time. But it doesn't look like I**
3 **did, yes.**
4 Q. If we give you 10 to 15 minutes, do you
5 think you can confirm that?
6 **A. That might be enough time.**
7 **So I don't see it in there.**

Shanfield Reply Depo., Ex. 2232 at 36:18-37:7 (Patent Owner's Observations, Paper No. 30, #17)

Misra includes spacers on the sides of the gate like Figure 1 of the '501 patent. (*E.g.*, *compare* Misra at Fig. 7 (including spacers 23) (Ex-1204) *with* '501 patent at Fig. 1 (including spacers 7) (Ex-1201).) A POSITA would have understood that the gate electrode 28b protrudes upward from a surface level of the silicon nitride film (plasma enhanced nitride layer 20) located at the sides of the gate electrode, as claimed, regardless of whether spacers 23 are constructed out of silicon nitride. This is because plasma enhanced nitride layer 20 and the spacers 23 are separate structures (even if they are made of the same material). The plasma enhanced nitride layer 20 and the spacers 23 are separate structures because they are formed through different process steps and serve separate functions.

Petition at 42

115. Misra includes spacers on the sides of the gate like Figure 1 of the '501 patent. (*E.g.*, *compare* Misra at Fig. 7 (including spacers 23) (Ex-1204) *with* '501 patent at Fig. 1 (including spacers 7) (Ex-1201).) A POSITA would have understood that the gate electrode 28b protrudes upward from a surface level of the silicon nitride film (plasma enhanced nitride layer 20) located at the sides of the gate electrode, as claimed, regardless of whether spacers 23 are constructed out of silicon nitride. This is because plasma enhanced nitride layer 20 and the spacers 23 are separate structures (even if they are made of the same material). The plasma enhanced nitride layer 20 and the spacers 23 are separate structures because they are formed through different process steps and serve separate functions.

Shanfield Opening Decl., Ex. 1202 at ¶115

21 Q. Did you opine in your declaration that a
22 POSA would modify element 23 in Misra to be a
23 material other than silicon nitride?
24 MR. SMITH: Objection.
1 **A. I don't think I did, but I'm responding to**
2 **your question about what material the spacers could**
3 **be and explaining that there are other choices than**
4 **silicon nitride.**

Shanfield Reply Depo., Ex. 2210 at 287:21-288:4
(cited Paper No. 27 at 1)

3 Q. So in your opening declaration,
4 Exhibit 1202, you did not provide an opinion that
5 Misra discloses use of a material other than silicon
6 nitride for spacer 23; is that right?
7 **A. No, I didn't. For the reasons I just**
8 **explained.**

Shanfield Reply Depo., Ex. 2232 at 38:3-8
(cited Paper Owner's Observations, Paper No. 30, #18)

# Petitioner's Coaching During Deposition

Godo Kaisha IP Bridge 1 ("Patent Owner") moves to exclude portions of the deposition transcript of Petitioner's expert ("Shanfield") because, during redirect (and re-redirect), Petitioner's counsel blatantly led and coached Shanfield to change the testimony he offered under cross-examination. Ex. 2232 at 144:1-12, 145:1-147:8, 167:14-173:3, 173:10-178:4. The testimony Petitioner elicited through improper leading and coaching should be excluded pursuant to Fed. R. Evid. 611(c). *E.g.*, *Universal Remote Control v. Universal Elecs.*, IPR2014-01146 Paper No. 36 at 6-7 (PTAB Dec. 10, 2015) (excluding re-direct examination, finding the questions were leading because they "contained contextual cues sufficient to suggest the answer that counsel desired to elicit.").

Demonstrative Exhibit

Patent Owner's Motion to Exclude,
Paper No. 31 at 1

# Petitioner's Leading Questions

1 Q. Do Claims 2, 3, and 20 recite stress
2 limitations?
3 **MR. HRYCYSZYN: Objection, leading.**
4 **THE WITNESS:** Yes, they do, of course.
5 They talk about [as read], a stress includes the
6 direction tilted by an angle less than 10 degrees in
7 a substantially parallel direction.
8 **BY MR. SMITH:**
9 Q. Does Claim 1 require that a silicon nitride
10 film be a stress film?
11 **MR. HRYCYSZYN: Objection, leading.**
12 **THE WITNESS:** No, it doesn't.
13 **BY MR. SMITH:**
14 Q. Earlier you were asked about the silicon
15 nitride film that's described in the '501 patent,
16 and you offered testimony that "that isn't what's
17 being referred to here as the silicon nitride film
18 located at both side surfaces of the gate electrode.
19 That's not an etch stop layer. It is referring to,
20 what's talked about in the specification, which is
21 layers that deliver stress to the substrate as a
22 whole."
23 Do you recall that testimony?
24 **A. Yes, I do.**

1 Q. Were you referring to what's required by
2 the claims, or were you referring to the description
3 of the stress film embodiment in the specification?
4 **MR. HRYCYSZYN: Objection, leading.**
5 **THE WITNESS:** I was referring to the
6 embodiment in the specification.
7 **BY MR. SMITH:**
8 Q. Do any of the challenged claims --
9 Do you have Claim 1 in mind?
10 **A. Yes.**
11 Q. Could the silicon nitride film in Claim 1
12 be a silicon nitride etch stop layer?
13 **A. Yes, it could.**
14 **MR. HRYCYSZYN: Objection, leading.**
15 Dr. Shanfield, if you could just slow
16 down and give me a chance to hear the question and
17 object to it on the record.

Shanfield Reply Depo., Ex. 2232 at 144:1-145:17
(Paper No. 31 at 1)

20 Q. So it is your understanding that Claim 1 of
21 the '501 patent requires that the silicon nitride
22 film induce stress; is that accurate?
23 **A. Yes.**

Shanfield Reply Depo., Ex. 2232 at 160:20-23
(Paper No. 31 at 2)

# Petitioner's Leading Questions Enabled Shanfield to Answer Questions He Previously Could Not Answer

15 Q. Do you see dependent claim 2 in the '501
16 patent, Doctor Shanfield?
17 **A. Yes.**
18 Q. Does this description -- strike that.
19 Does the paragraph starting at column 3,
20 line 60 apply to the silicon nitride film described
21 in claim 2?
22 **MR. SMITH:** Objection.
23 **A. I haven't considered claim 2 in -- in my**
24 **analysis. I would need to spend time thinking**
1 **about it in the context of what it's describing.**
2 Q. Does claim 2 require that the silicon
3 nitride film generate a stress in the substrate?
4 **MR. SMITH:** Objection. Scope.
5 **A. As I explained, I hadn't considered claim**
6 **2, and I can't immediately answer. I would need to**
7 **do some analysis.**

Shanfield Opening Depo., Ex. 2210 at 230:15-231:7
(Paper No. 31 at 5)

1 Q. Do Claims 2, 3, and 20 recite stress
2 limitations?
3 **MR. HRYCYSZYN:** Objection, leading.
4 **THE WITNESS:** Yes, they do, of course.
5 They talk about [as read], a stress includes the
6 direction tilted by an angle less than 10 degrees in
7 a substantially parallel direction.
8 **BY MR. SMITH:**
9 Q. Does Claim 1 require that a silicon nitride
10 film be a stress film?
11 **MR. HRYCYSZYN:** Objection, leading.
12 **THE WITNESS:** No, it doesn't.

Shanfield Reply Depo., Ex. 2232 at 144:1-12
(Paper No. 31 at 1)

Demonstrative Exhibit

# Petitioner's Improper Coaching

14 Q. I'm going to represent to you that as a
15 legal matter, a dependent claim recites additional
16 limitations that are not present in the independent
17 claim from which it depends.
18 Do you have that understanding in mind?
19 MR. HRYCYSZYN: Objection, beyond the
20 scope. Objection, coaching.
21 THE WITNESS: Okay. I didn't know that.

* * * *

[omitted objections and call to the Board]

11 Q. So, Dr. Shanfield, with the representation
12 I just made to you in mind about how independent and
13 dependent claims are interpreted, could you look at
14 dependent Claim 2.
15 A. Yes.
16 MR. HRYCYSZYN: Objection, beyond the
17 scope. Same objections as before as to the improper
18 question.
19 BY MR. SMITH:
20 Q. Does dependent Claim 2 add a requirement
21 that the silicon nitride film is for generating a
22 stress?
23 MR. HRYCYSZYN: Objection, beyond the
24 scope. Objection, leading, instructing the witness.

1 THE WITNESS: Yes.
2 BY MR. SMITH:
3 Q. Do you see that Claim 2 depends from
4 Claim 1?
5 MR. HRYCYSZYN: Objection, beyond the
6 scope.
7 THE WITNESS: Yes, I do.
8 BY MR. SMITH:
9 Q. I believe you testified earlier that
10 Claim 1 does not recite any stress limitations;
11 is that correct?

12 A. That is correct.
13 MR. HRYCYSZYN: Objection, leading.
14 Objection, improper.
15 BY MR. SMITH:
16 Q. And with the understanding that we
17 discussed earlier, is there anything you would like
18 to clarify with your testimony regarding whether
19 Claim 1 requires silicon nitride film to induce
20 stress?
21 MR. HRYCYSZYN: So --
22 THE WITNESS: Yes. Now that I
23 understand --
24 MR. HRYCYSZYN: Can we wait so I can get

1 my objections on the record. So same set of
2 objections we had earlier. I can restate them or if
3 we can agree they apply here.
4 So Josh is reminding me that I should
5 restate them. So objection, coaching the witness.
6 Objection, leading. Objection, coaching and
7 instructing the witness.
8 THE WITNESS: Yes. I do want to
9 clarify. Now that I understand the legal issue,
10 Claim 1 does not require that -- it does not have
11 any language in it that requires the film to have
12 stress, as I said before. And what that means
13 legally is that it's not required in meeting the
14 limitations of Claim 1.
15 MR. HRYCYSZYN: Objection, move to
16 strike.

Shanfield Reply Depo., Ex. 2232 at 167:14-21; 170:11-172:16 (Paper No. 31 at 1)

17 Q. So the information that Mr. Smith provided
18 you during his redirect questioning changed your
19 testimony; is that accurate?
20 A. No.
21 Q. So it didn't change --
22 A. It changed what I knew about the relation
23 between dependent and independent claims. And that
24 has -- As I said, that was not related to my

Shanfield Reply Depo., Ex. 2232 at 175:17-24 (Paper No. 31 at 1)

4 Q. So before Mr. Smith instructed you on
5 certain legal principles, you had testified that
6 Claim 1 required that the silicon nitride film
7 induced stress, right?
8 A. I mistakenly made that statement because I
9 thought legally that there was a legal requirement
10 that the independent -- the dependent claims read
11 back into the independent claim the limitations in
12 the dependent claims.
13 Since, I've heard that the dependent
14 claims are usually narrower. That was a mistake.
15 So that particular statement, I changed. It's a
16 legal opinion.

Shanfield Reply Depo., Ex. 2232 at 176:4-16 (Paper No. 31 at 1)

Page 173

1 THE WITNESS: And I'll add that the
2 legal aspect of this is something I was confused
3 about and needed to be instructed on.

Shanfield Reply Depo., Ex. 2232 at 173:1-3 (Paper No. 31 at 8)

# Summary

1. Shanfield Decl., Ex. 1202, ¶115 is verbatim Petition at 42
2. "Separate structures because … different process steps and serve separate function." Shanfield Decl., Ex. 1202, ¶115
3. Shanfield Decl., Ex. 1202, ¶115 does not consider '501 Patent at 5:60-63.
4. "In that context … it doesn't matter if they're created by the same process." Shanfield Reply Depo., Ex. 2232, at 33:15-35:14
5. "Claim 1 … requires … stress." Shanfield Reply Depo., Exhibit 2232, at 160:20-23
6. "[Shanfield] hadn't given thought to films that might have other functions." Shanfield Reply Depo., Exhibit 2232 at 48:14-50:5.
7. "Relation between dependent and independent claims" – "needed to be instructed on." Shanfield Reply Depo., Ex. 2232 at 175:17-24, 173:1-3
8. "Did not even consider whether … interpretations … read … onto Xiang" POR 15. Shanfield Depo., Ex.2210, at 389:8-390:2

| Shanfield | POR |
|---|---|
| "23 … It's a spacer, not a film." Shanfield Opening Depo., Ex. 2210, at 289:5-18 | "Extrinsic evidence confirms … a film that serves as a spacer … refer[ed] to … as a "film."" POR at 36 (Ex.-2208(Glew-Decl.), ¶¶81-86). |
| "Layer 20 and spacers 23 … not …in contact because the NF3 etch … produce[s] fluorocarbon film between the two." POR 48 (Shanfield Depo., Ex. 2210 at 261:13-21, 267:7-11, 272:15-273:24). | "Misra's NF3 etch cannot produce fluorocarbon film … removes any fluorocarbons." POR 49 |

# Conclusion

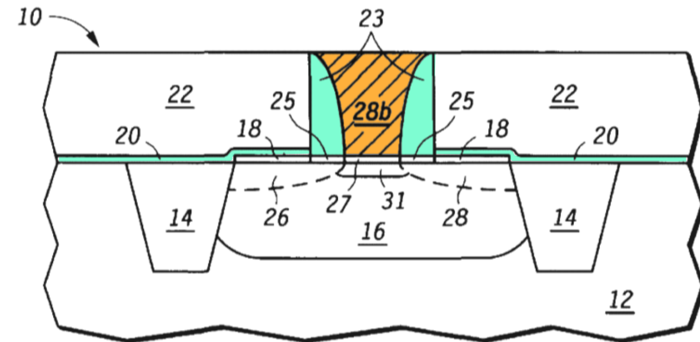
1. A semiconductor device, comprising a MISFET, wherein
the MISFET includes:
an active region made of a semiconductor substrate;
a gate insulating film formed on the active region;
a gate electrode formed on the gate insulating film;
source/drain regions formed in regions of the active region located on both sides of the gate electrode; and
a silicon nitride film formed over from side surfaces of the gate electrode to upper surfaces of the source/drain regions, wherein:
the silicon nitride film is not formed on an upper surface of the gate electrode, and
the gate electrode protrudes upward from a surface level of parts of the silicon nitride film located at both side surfaces of the gate electrode.

’501 patent at Claim 1

**A. “silicon nitride film”**

As demonstrated below, the BRI of “silicon nitride film” is a “thin coating of one or more layers of silicon nitride.” Ex.-2208(Glew-Decl.), ¶61.

POR at 28




Misra (Ex.-1204), Fig. 7 (annotated)

POR at 6

Misra includes spacers on the sides of the gate like Figure 1 of the ’501 patent. (*E.g.*, *compare* Misra at Fig. 7 (including spacers 23) (Ex-1204) *with* ’501 patent at Fig. 1 (including spacers 7) (Ex-1201).) A POSITA would have understood that the gate electrode 28b protrudes upward from a surface level of the silicon nitride film (plasma enhanced nitride layer 20) located at the sides of the gate electrode, as claimed, regardless of whether spacers 23 are constructed out of silicon nitride. This is because plasma enhanced nitride layer 20 and the spacers 23 are separate structures (even if they are made of the same material). The plasma enhanced nitride layer 20 and the spacers 23 are separate structures because they are formed through different process steps and serve separate functions.

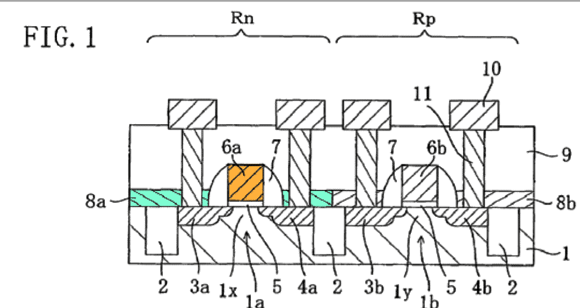
Petition at 42

Demonstrative Exhibit

# Misra Is Not "Nearly Identical" To Figure 1 Of The '501 Patent (POR 54)

Misra includes spacers on the sides of the gate like Figure 1 of the '501 patent. (*E.g.*, *compare* Misra at Fig. 7 (including spacers 23) (Ex-1204) *with* '501 patent at Fig. 1 (including spacers 7) (Ex-1201).) A POSITA would have understood that the gate electrode 28b protrudes upward from a surface level of the silicon nitride film (plasma enhanced nitride layer 20) located at the sides of the gate electrode, as claimed, regardless of whether spacers 23 are constructed out of silicon nitride. This is because plasma enhanced nitride layer 20 and the spacers 23 are separate structures (even if they are made of the same material). The plasma enhanced nitride layer 20 and the spacers 23 are separate structures because they are formed through different process steps and serve separate functions.

Petition at 42

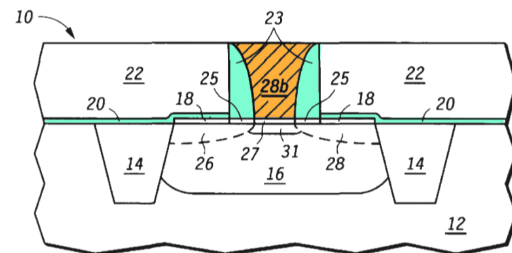



'501-patent (Ex.-1201), Fig. 1 (annotated)

POR at 55

example shown in FIG. **4**B has a structure in which instead of the **sidewall 7** of the first embodiment, which is made of a silicon oxide film, the first-type internal stress film **8*a*** made of a silicon nitride film covers a side surface of the gate electrode

'501 patent at 8:10-13 (cited at POR 55)




Misra (Ex.-1204), Fig. 7 (annotated)

POR at 56

opening 24. The sacrificial thermal oxide **25** is typically grown to a thickness of roughly 100 angstroms. After formation of the sacrificial oxide **25**, silicon nitride is deposited and reactive ion etched to form silicon nitride spacers **23** on top of the sacrificial oxide **25**. The etch used

Misra, Ex. 1204 at 6:37-40 (cited at Petition at 53)

Demonstrative Exhibit

17 Q. So you understand the last limitation of
18 Claim 1 and the reference to silicon nitride, when
19 that is read in the context of the '501 patent as a
20 whole, to require a silicon nitride film that
21 applies a stress to the substrate as a whole?

* * * *

5 Q. I'd like it in your own words.
6 **A. The film that is being referred to in the**
7 **last element of Claim 1 in the '501 patent, the**
8 **specification is talking about stress-inducing film.**
9 **And that's how it would be read by someone of skill**
10 **in the art.**
11 **The claim language doesn't prohibit a**
12 **zero stress film. But it wouldn't apply to the**
13 **teachings of the '501, in my opinion.**
14 Q. So is it fair to say that a silicon nitride
15 film can be made out of multiple layers and meet the
16 limitations of the Claim 1 of the '501 patent, even
17 if those layers do not deliver stress to the
18 substrate as a whole?
19 **MR. SMITH:** Objection.
20 **THE WITNESS:** It's inconsistent with the
21 teachings of the '501 patent. Since the
22 specification discusses stress-inducing films for
23 pages, it's clear that's what's being referred to.
24 So a person of skill in the art would
1 interpret that silicon nitride film as delivering
2 nonnegligible stress to the substrate.

Shanfield Reply Depo., Exhibit 2232 at 56:17-21; 57:5-58:2
(Patent Owner's Observations, Paper No. 30, #1)

20 Q. So it is your understanding that Claim 1 of
21 the '501 patent requires that the silicon nitride
22 film induce stress; is that accurate?
23 **A. Yes.**

Shanfield Reply Depo., Exhibit 2232 at 160:20-23
(Patent Owner's Observations, Paper No. 30, #1)

20. The '501 patent simply states that "***each*** of the internal stress films 8a and 8b does not have to be a single layer but may include multiple layers, as long as each of the internal stress films 8a and 8b can apply a stress to the substrate as a whole." Ex. 1201, 5:60-63 (emphasis added). This description merely recognizes that a film *can* have multiple layers deposited on top of each other. Nowhere does the '501 patent state that two adjacent films, such as films 8a and 8b, would be considered "layers" of a single film, much less than any two adjacent structures made of the same material are somehow "layers" of a single film. In my opinion, such an interpretation is plainly not the reasonable. The '501 patent itself merely recognizes that the film 8a could be deposited with a single layer or it could be deposited in multiple layers (and the same for goes for the separate, adjacent film 8b). This does not mean that other, partially adjacent, or even fully adjacent, structures necessarily become part of the same film simply as a result of being adjacent.

Shanfield Reply Decl., Exhibit 1232 at ¶ 20

22 Q. Does that claim language require that the
23 silicon nitride film apply stress?
24 **MR. SMITH:** Objection.
1 **THE WITNESS:** No. The claim language
2 doesn't require stress.
3 **BY MR. HRYCYSZYN:**
4 Q. Do you understand the claim to require that
5 film apply stress?
6 **MR. SMITH:** Objection.
7 **THE WITNESS:** There are two parts to my
8 answer to that. The context of the '501 patent is
9 that the silicon nitride being discussed in this
10 claim is a stress-inducing film.
11 And second, like I explained earlier,
12 silicon nitride always -- in the context of this
13 patent, always creates stress, the silicon nitride
14 film of the kind that's being referred to here.
15 So that's the context. The silicon
16 nitride film -- and understanding what they mean,
17 they're talking about a stress-inducing silicon
18 nitride film. And they're not talking about an etch
19 stop layer.
20 **BY MR. HRYCYSZYN:**
21 Q. So it's your opinion that in order for a
22 silicon nitride film to meet the limitations of
23 Claim 1, it must induce stress?
24 **MR. SMITH:** Objection.
1 **THE WITNESS:** No.
2 **BY MR. HRYCYSZYN:**
3 Q. So the silicon nitride film that's called
4 out in Claim 1 isn't required to apply stress to
5 meet the limitations of the claim?
6 **A. That's correct, yes.**

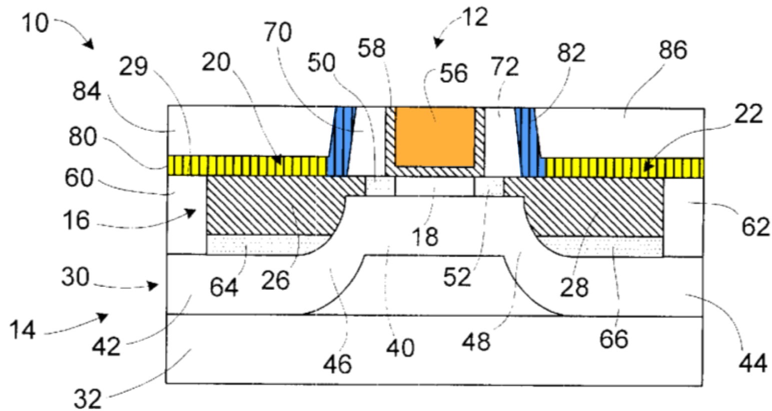
Shanfield Reply Depo., Ex. 2232 at 51:22-53:6
(Paper No. 37 at 1)

20 Q. So it is your understanding that Claim 1 of
21 the '501 patent requires that the silicon nitride
22 film induce stress; is that accurate?
23 **A. Yes.**

Shanfield Reply Depo., Ex. 2232 at 160:20-23
(Patent Owner's Observations, Paper No. 30, #1)

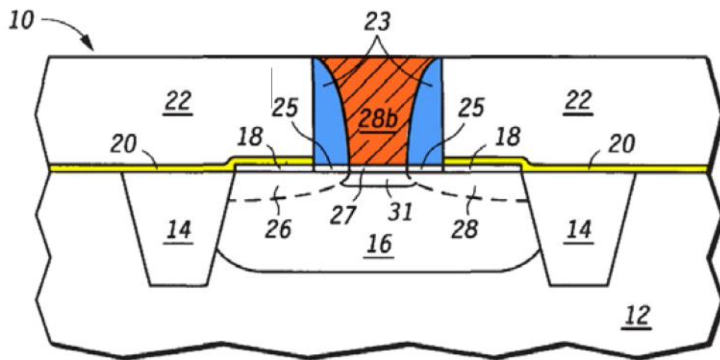
insulating film 9 a and a sidewall insulating film 10 a.") Accordingly, in both Xiang and Matsuda, the layers cited during prosecution are each: deposited in a single step; perform a single function; and comprise a singular structure. Ex. 1232, ¶23.

Petitioner's Reply, Paper No. 22 at 10



Xiang (Ex.-2202), Fig. 1 (annotated)

POR at 69



Misra (Ex.-1204), Fig. 7 (annotated)

POR at 69

20 Q. So even though the Xiang patent refers to
21 208 and 210 as "layers," plural, and here in 212 it
22 talks about depositing it in a layer, you're saying
23 that doesn't matter? Really we should read Step 212
24 in Figure 2 as saying "Deposit the layers"?

1 **A. I'm not -- I'm not opining on how to word**
2 **it. I'm telling you what's actually occurring as**
3 **understood by someone of skill in the art. And that**
4 **is that it's being deposited on the left- and the**
5 **right-hand side simultaneously.**
6 Q. So you view that as one layer, even though
7 Xiang refers to them as "layers"; is that right?
8 **A. No. It could be more than one layer.**
9 **Because he describes it that way. He says there**
10 **could be silicon nitride and silicon dioxide or a**
11 **filler. So it could be an etch stop with layers in**
12 **it --**
13 Q. So --
14 **A. -- that form an etch stop layer -- I'm**
15 **sorry.**
16 Q. So this film in Xiang could be made up of
17 multiple layers which include silicon nitride and
18 silicon oxide, I think is what you said? Am I
19 understanding you correctly?
20 **A. Yes, let me refer you to where . . .**
21 **When we were talking about Figure 1 --**
22 **or in Column 4, I should say, in line 11, it says,**
23 **"The etch stop layers 80 and 82 may include silicon**
24 **nitride," and that "may" means, well, maybe it has a**

1 **layer of silicon nitride and silicon dioxide.**
2 **I think the "may" most likely -- I mean,**
3 **the easiest way to make an etch stop layer is with**
4 **just one material. But I have seen it done with a**
5 **mixture.**

Shanfield Reply Depo., Ex. 2232 at 78:20-80:5
(cited Patent Owner's Observations, Paper 30, #8)

’501 patent at Claim 1

a silicon nitride film formed over from side surfaces of the gate electrode to upper surfaces of the source/drain regions,

**A. “silicon nitride film”**

As demonstrated below, the BRI of “silicon nitride film” is a “thin coating of one or more layers of silicon nitride.” Ex.-2208(Glew-Decl.), ¶61.

POR at 28

Furthermore, each of the internal stress films **8***a* and **8***b* does not have to be a single layer but may include multiple layers, as long as each of the internal stress films **8***a* and **8***b* can apply a stress to the substrate as a whole.

’501 patent at 5:60-63
(cited POR at 7)

’501-patent at 3:53-55 (stress film 8a is a silicon nitride film). Internal stress film 8a is the support in the specification for the claimed silicon nitride film. Ex.-2208(Glew-Decl.), ¶69; ’501-patent at 7:5-9 (stress film 8a is formed when “***silicon nitride film*** 8x is etched back”); Ex.-1203 at 8 (“In … FIGS. 1 and 4A, the gate electrode 6a, 6b protrudes upward from … ***silicon nitride film 8a***.”). Thus, the specification’s disclosure that film 8a may include multiple layers explicitly discloses that the claimed silicon nitride film may include multiple layers. Ex.-2208(Glew-Decl.), ¶69.

POR at 31-32

70. Where the ’501 patent states that silicon nitride film 8a may be multiple layers, a POSA would have understood that the ’501 patent discloses, as illustrated below, vertically stacked layers (purple below), adjacent side-by-side layers (green below), or both, for the silicon nitride film. As can be seen below, side-by-side layers (like those in Misra) apply “stress to the substrate ***as a whole***” as described in the ’501 specification because each layer can act directly on the substrate. For example, in the simple diagram below, side-by-side (green) layers

Glew Decl., Ex. 2208, ¶ 70 (cited in POR at 33)

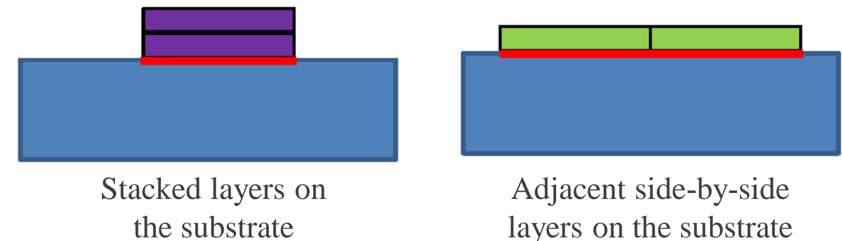



Figure 1: Vertical vs. Horizontal Layers

Glew Decl., Ex. 2208, ¶ 70 (cited in POR at 33)

# Shanfield Interprets The '501 Patent Specification To Further Narrow Petitioner's Interpretation of "Film"

Furthermore, each of the internal stress films **8***a* and **8***b* does not have to be a single layer but may include multiple layers, as long as each of the internal stress films **8***a* and **8***b* can apply a stress to the substrate as a whole.

'501 patent at 5:60-63
(cited POR at 7)

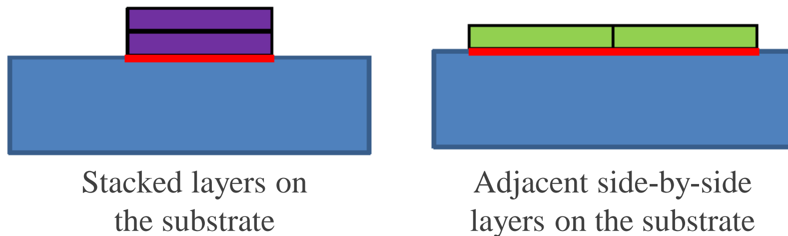
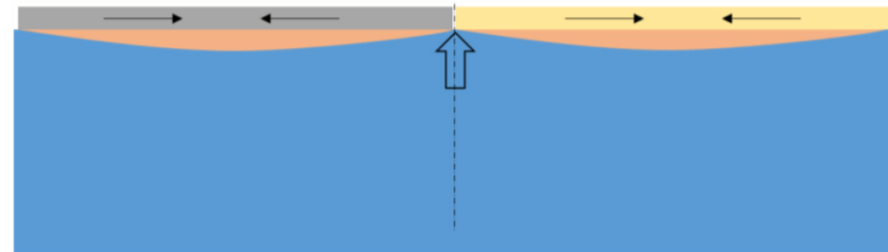



Figure 1: Vertical vs. Horizontal Layers

Glew Decl., Ex. 2208 at 35
(cited POR at 19)

two side-by-side films, as identified by the large arrow. In other words, placing two separately deposited (and, in this case, identical) thin films side-by-side does not provide a higher magnitude stress field and, in contrast, results in each film generating its own separate stress film, with the condition of zero stress in the underlying substrate at the point between the two separate films.



*Two films deposited side-by-side, each applying its own compressive stress*

Shanfield Reply Decl., Ex. 1232 at ¶ 40

# Petitioner's Narrow Interpretation Of "Film" Is Inconsistent With The '501 Patent's Specification

Furthermore, each of the internal stress films **8***a* and **8***b* does not have to be a single layer but may include multiple layers, as long as each of the internal stress films **8***a* and **8***b* can apply a stress to the substrate as a whole.

'501 patent at 5:60-63 (cited POR at 7)

71. For both the stacked layers and the adjacent side-by-side layers disclosed in the '501 patent, each layer is a different structure formed through a different set of processes. Simply put, whenever a layered structured is formed,

Glew Decl., Ex.2208, ¶ 71 (cited in POR at 33)

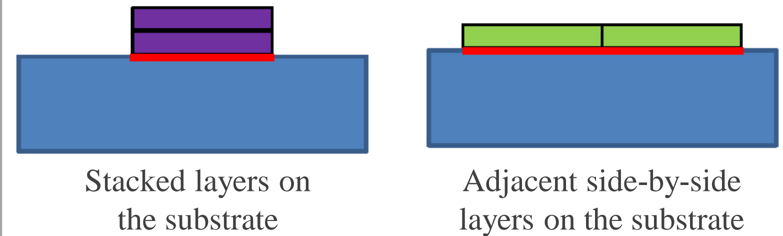
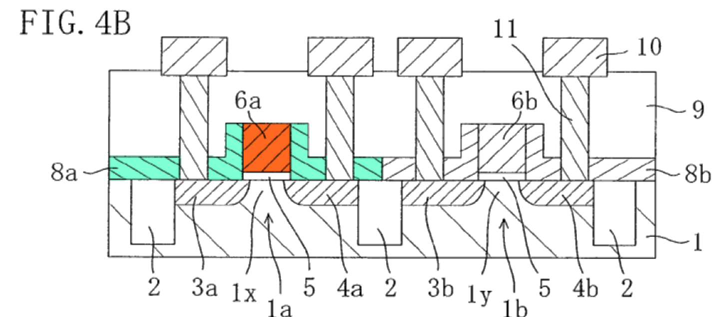



Figure 1: Vertical vs. Horizontal Layers

Glew Decl., Ex.2208, (cited in POR at 33)

Silicon nitride film 8a in Fig. 4B covers the upper surface of source/drain regions and side surfaces of the gate electrode and has different parts that "serve separate functions." Petition at 42. The function performed by the part of film 8a atop the substrate is to apply stress to the substrate. Ex.-2208(Glew-Decl.), ¶¶73-73; '501-patent 1:20-23, 4:34-52. The function performed by the part that covers the side surface of the gate electrode (Figure 4B) is to impart stress on gate electrode 6a. Ex.-2208(Glew-Decl.), ¶74; '501-patent at 8:22-44.

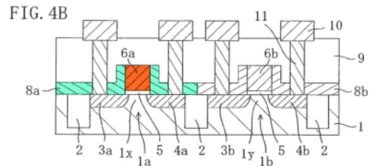
POR at 34




'501-patent (Ex.-1201), Figure 4B (annotated)

POR at 34, Fig. 4B

# Petitioner's Narrow Interpretation Of "Film" Is Inconsistent With The '501 Patent's Specification



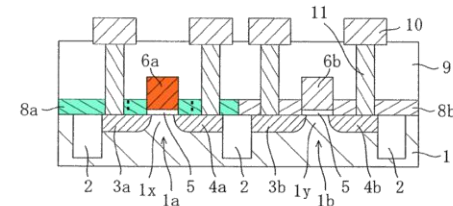

'501-patent (Ex.-1201), Figure 4B (annotated)

75. Thus, the '501 patent discloses embodiments where different parts of the same silicon nitride film "serve separate functions." As discussed in §IV.A-B, the claims do not read on the Fig. 4B embodiment, however, this disclosure refutes Petitioner's and Dr. Shanfield's assertion that the BRI "film" consistent with the '501 specification does not encompass structures that serve separate functions.

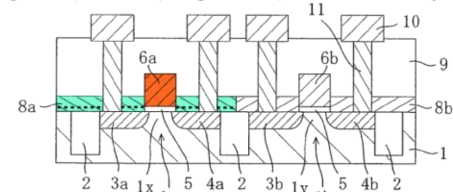
76. Moreover, a POSA would have understood that the silicon nitride film in the claimed embodiments has parts which serve separate functions. For example, as shown below, there could be side-by-side-layers or stacked-layers in Figure 4A (a protruding gate electrode embodiment) as indicated by the dotted black lines. In the case of side-by-side-layers shown below, one layer applies stress only to the substrate and another layer applies stress to the gate electrode and the substrate—these layers serve separate functions. Similarly, in the case of stacked-layers, one layer applies stress only to the substrate and the other layer applies stress to the gate electrode and may not (depending on the exact

38

dimensions, *see* §VII.A.3a) apply stress to the substrate—again, these layers serve separate functions.




'501-patent (Ex.-1201), Figure 4A (annotated, side-by-side-layers)




'501-patent (Ex.-1201), Figure 4A (annotated, stacked-layers)

77. Further, in both of the above examples of the protruding gate electrode embodiments, silicon nitride film 8a covers not only the active regions but also the isolation region 2. Ex.-1201 ('501-patent) at claim 10. In the side-by-side-layer example, one layer covers the isolation region and the other layer does not—thus, these layers serve separate functions. Similarly, in the side-by-side layer example, only one layer applies stress over the isolation region while the other layer applies stress only over the source/drain regions, again, serving different functions.

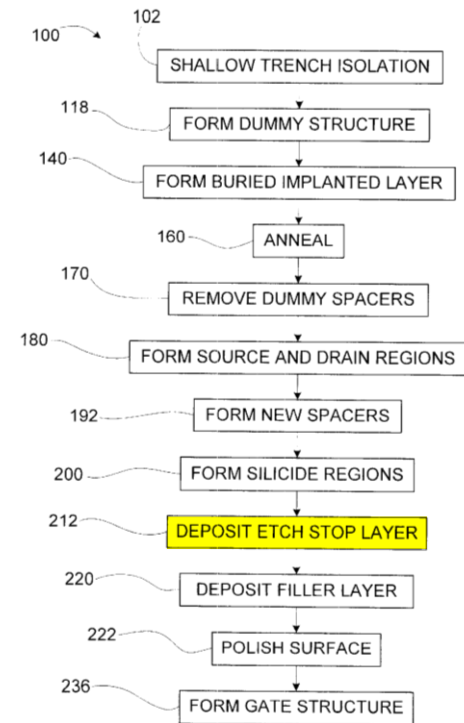
39

insulating film 9 a and a sidewall insulating film 10 a.") Accordingly, in both Xiang and Matsuda, the layers cited during prosecution are each: deposited in a single step; perform a single function; and comprise a singular structure. Ex. 1232, ¶23.

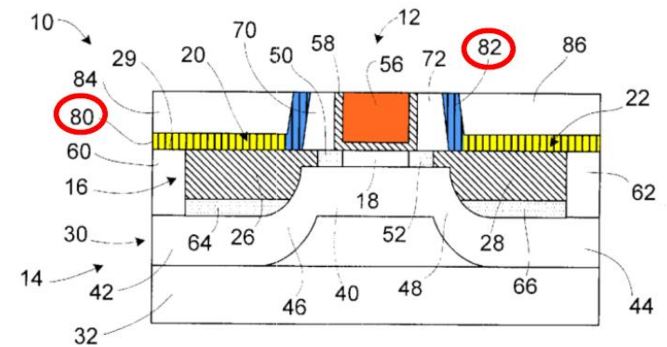
Petitioner's Reply, Paper No. 22 at 10

146. During prosecution, the examiner identified a silicon nitride film in Xiang, which like Misra, is made of multiple layers. Ex.-2204 at 3 (Figure 1 shows "a silicon nitride film ***80,82*** formed over the side surface … of the gate electrode."); Ex.-2202 at 2:57-59 (Fig. 2 illustrates a method for manufacturing Figure 1), 4:9-11 (describing that "[t]he device 10 also includes ***etch stop layers*** 80 and 82"), 6:43-45 ("As illustrated in FIG. 10, ***etch stop layers*** 208 and 210 are deposited in step 212."), Figs. 1, 2 (showing step 212), 10 (showing etch stop layers 208 and 210 which are formed in step 212). Xiang expressly identifies that 80 and 82 are layers (plural) and in the figures, the numeral 82 points to the vertical portion on the right of the gate electrode while numeral 80 points to the horizontal portion on the left of the gate electrode. Ex.-2202 at 4:9-11 (describing that "[t]he device 10 also includes ***etch stop layers*** 80 and 82"), Figure 1. A POSA

Glew Decl., Ex. 2208 at ¶ 146
(cited POR at 68)




Xiang at Fig. 2



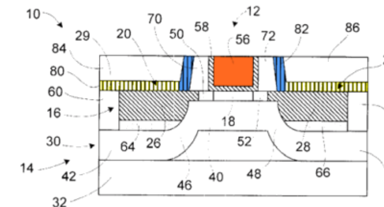

Xiang (Ex.-2202), Figure 1 (annotated)

Glew Decl., Ex. 2208 at ¶ 146

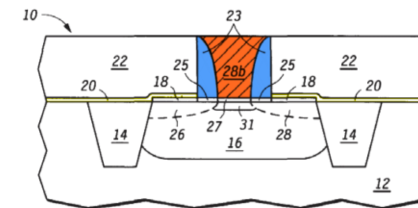
insulating film 9 a and a sidewall insulating film 10 a.") Accordingly, in both Xiang and Matsuda, the layers cited during prosecution are each: deposited in a single step; perform a single function; and comprise a singular structure. Ex. 1232, ¶23.

Petitioner's Reply, Paper No. 22 at 10

Indeed, any such assertion also contradicts the prosecution history. Ex.-2208(Glew-Decl.), ¶¶146-47. The examiner identified a silicon nitride film in Xiang that ***consists of two layers just like Misra***. Ex.-2208(Glew-Decl.), ¶146; Ex.-2204 at 3 (Figure 1 shows "a silicon nitride film ***80,82*** formed over the side surface … of the gate electrode"); Ex.-2202 at 2:57-59, 4:9-11 (describing "etch stop ***layers*** 80 and 82"), 6:43-45, Figs. 1, 2, 10. As Dr. Glew explains, a POSA would have understood that the film (80, 82) identified by the examiner consists of a vertical layer 82 (blue below) and a horizontal layer 80 (yellow below). Ex.-2208(Glew-Decl.), ¶146. Under the BRI, the examiner found these adjacent and contiguous layers were one silicon nitride film and ***agreed with the applicant*** that the gate electrode did not protrude from the parts (blue) of the silicon nitride film located at both side surfaces of the gate electrode.

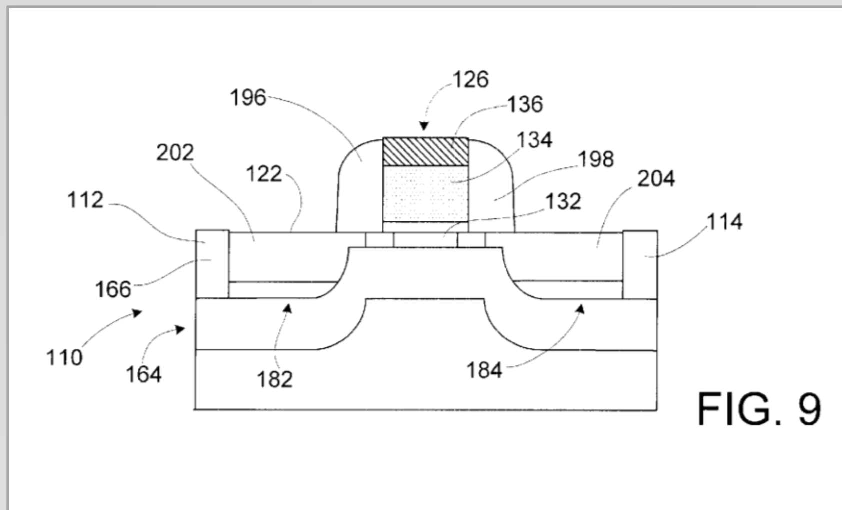



Xiang (Ex.-2202), Figure 1 (annotated)

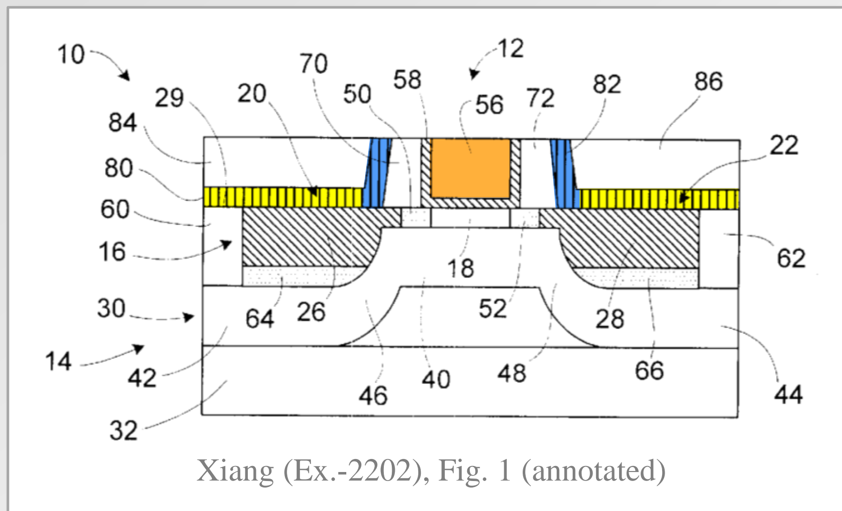



Misra (Ex.-1204), Figure 7 (annotated)

POR, Paper No. 20, at 68-69




Xiang at Fig. 9




Xiang (Ex.-2202), Fig. 1 (annotated)

POR at 69

19 So there is a reduction in the
20 sidewall spacer 196, 198 that has changed
21 shape. There's an etching process not
22 described here.
23 So
24 etch stop put down. The spacers are etched
25 back.
1 Then the spacers, now that they
2 have new shape, are covered with additional
3 material. One couldn't etch the spacers with
4 material on the

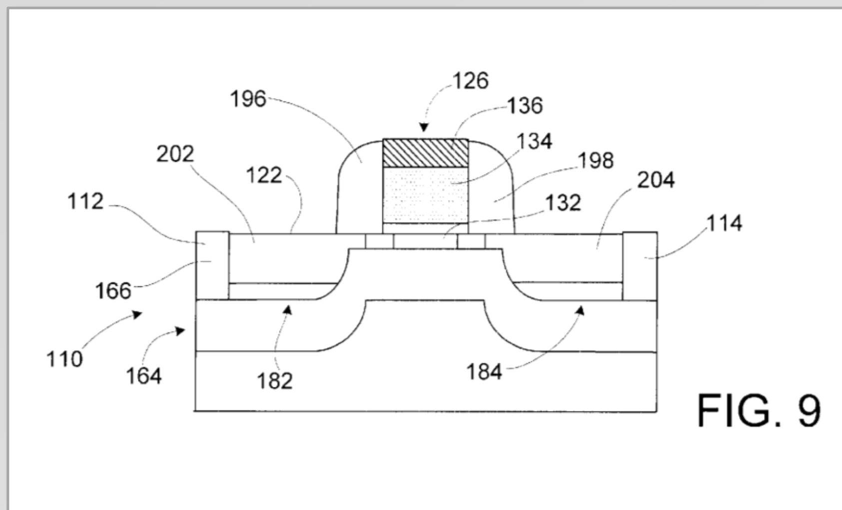
5 the material under it. So imagining a
6 horizontal layer of silicon nitride goes down.
7 The spacers are etched, then the
8 spacers are covered, then filler layers and
9 dialectics are
10 that's essentia
11 what's going on
12 Q. And in Figure 10, the etch stop
13 layers 208 and 210 are deposited in step 212,
14 correct?
15 A. Step 212 is sort of -- like all of
16 these, this is really hundreds of steps to get
17 from shallow trenched gate structure. So this
18 is, I understand, to be a group of -- kind of a
19 grouping of activities.
20 Q. Within step 212, am I
21 understanding it correctly that what becomes
22 layer 208 and 210, that is deposited, and then
23 etched back?
24 A. No, not exactly. They are silicon
25 nitride, so they stop other things from being
1 etched.
2 Wh
3 specifications,
4 brief for somet

5 steps, what appears is that the sidewall spacer
6 is being etched while the -- the sidewall
7 spacer, for example, 198 is being etched, while
8 the horizontal surfaces are being protected by
9 silicon nitride 210.
10 Th
11 etched, and tha
12 for one reason it could be called an etch stop,

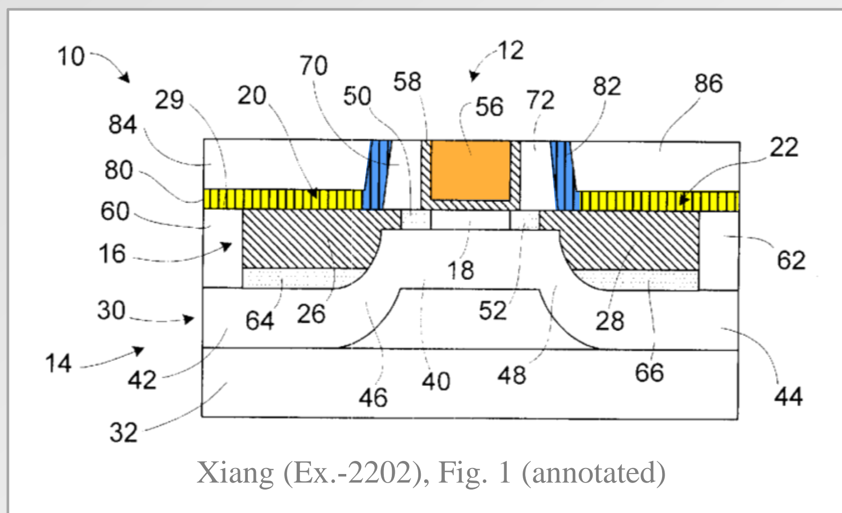
13 well, I don't know, but once the sidewall
14 spacer is etched to its new shape, then
15 additional material is put on the sidewall
16 spacer. Shown in hatching, also silicon
17 nitride.
18 Th
19 filler layers
20 filler layers

Glew Depo., Ex. 1231 at 127:3-129:20
(Patent Owner's Observations, Paper No. 30, #19)

Demonstrative Exhibit




Xiang at Fig. 9

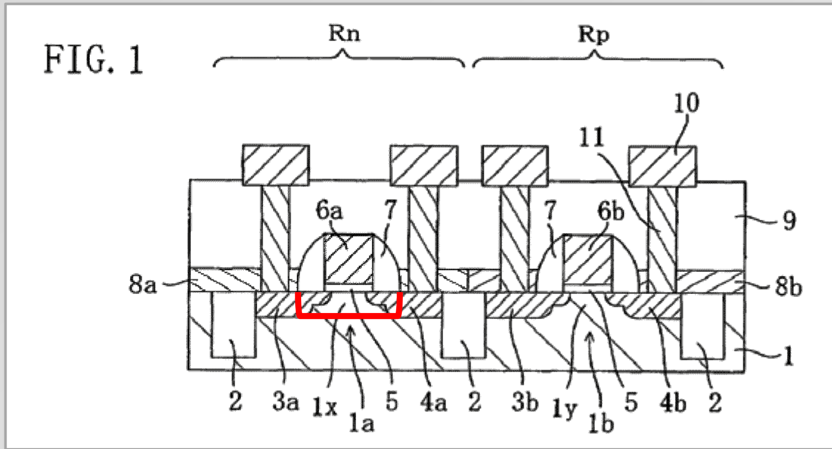



Xiang (Ex.-2202), Fig. 1 (annotated)

POR at 69

2 Q. Well, let me reask then. Maybe I asked the
3 wrong question. So I think earlier you said the CMP
4 process planarizes; is that accurate?
5 **A. Yes. I didn't say that was the only step**
6 **between 9 and 10. I didn't mean to imply that.**
7 **That was just shorthand for this is the CM -- I**
8 **mean, that would be described by process engineers**
9 **as the CMP step because the rest of it is pretty**
10 **standard: depositing the two films and then**
11 **planarizing it.**
12 Q. So CMP would reduce the height of spacers
13 196 and 198; is that right?
14 **A. Among other things, yes.**
15 Q. Would CMP change the side profile of
16 spacers 196 and 198?
17 **A. Like I explained, between Figure 9 and**
18 **Figure 10, I used the term "CMP" as the process step**
19 **because that's what real process engineers usually**
20 **refer to it as.**
21 **It's actually a couple of depositions.**
22 **First the layer 208, 210, and then layer 216, 218,**
23 **and then CMP. But the shorthand in semiconductor**
24 **manufacturing is that's often called just the CMP**
1 **step. But that's what -- it's a pretty simple jump**
2 **from Figure 9 to Figure 10.**

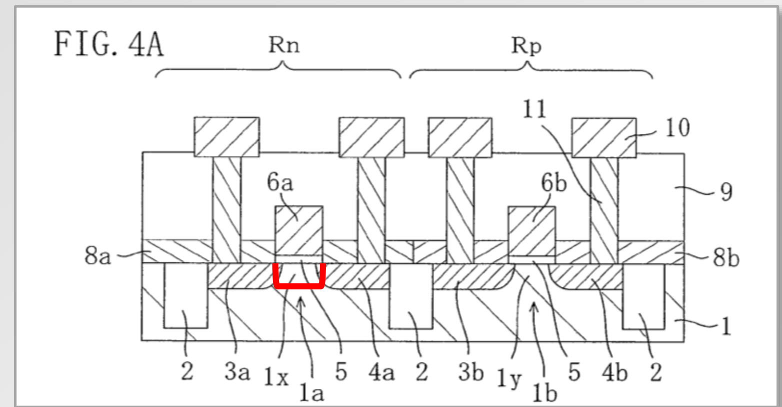
Shanfield Reply Depo., Ex. 2232 at 164:2-165:2




’501 patent at Fig. 1

thickness of the first-type internal stress film **8***a* is 20 nm, a space between respective parts of the source and drain regions **3***a* and **4***a* being in contact with the first-type internal stress film **8***a*, i.e., the length of the channel region **1***x*, is 0.2 µm, a tensile stress in the gate length direction generated at a depth of 10 nm from the surface of the substrate is 0.3 GPa (J. Appl.

’501 patent at 4:61-66
(Patent Owner’s Observations, Paper No. 30, #21)




’501 patent at Fig. 4a

the mobility of electrons is +10% (Phys. Rev., vol. 94, p. 42, 1954). To obtain a larger change in the mobility than this, the tensile stress of a semiconductor can be increased. Thus, a film having a large internal stress can be used as the first-type internal stress film **8***a*, the thickness of the first-type internal stress film **8***a* can be increased, or the space between the parts of the source and drain regions **3***a* and **4***a* being in contact with the first-type internal stress film **8***a*, i.e., the length of the channel region **1***x*, can be reduced for a larger change in the mobility. For example, when the thickness of the first-type internal stress film **8***a* is doubled, the space between the parts of the source and drain regions **3***a* and **4***a* being in contact with the first-type internal stress film **8***a*, i.e., the length of the channel region **1***x* is reduced to half, the improvement rate of the mobility of electrons is +40%. As another way to obtain a

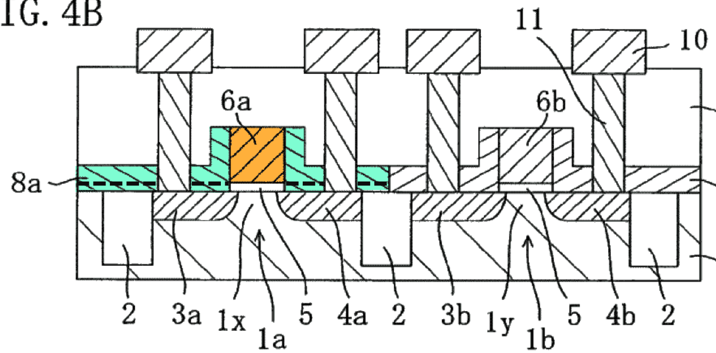
’501 patent at 5:1-15
(Patent Owner’s Observations, Paper No. 30, #21)

A semiconductor device according to a first modified example shown in FIG. **4A** has a structure in which the sidewall **7** of the first embodiment is omitted. Moreover, each

’501 patent at 7:62-64
(Patent Owner’s Observations, Paper No. 30, #21)

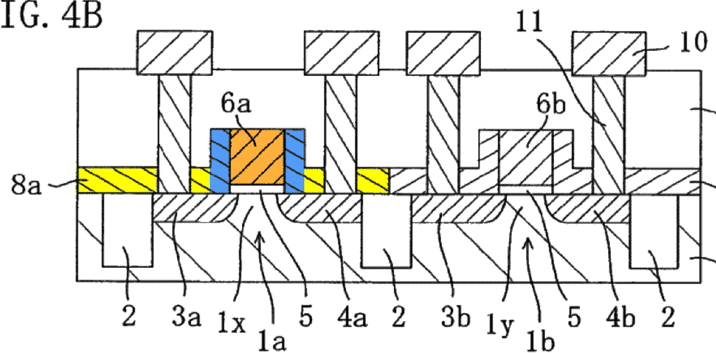
that of the semiconductor device of the first embodiment. In this modified example, no sidewall exists in forming an internal stress film, so that a space between respective parts of the source/drain regions **3***a* and **4***a* being in contact with the first-type internal stress film **8***a* is small. Thus, a stress applied to each of the channel regions **1***x* and **1***y* is increased, so that

’501 patent at 8:1-6
(Patent Owner’s Observations, Paper No. 30, #21)




’501-patent (Ex.-1201), Fig. 4B (annotated)

POR at 61

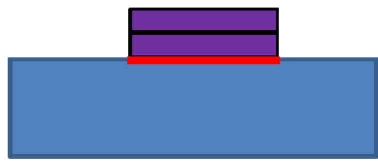



’501-patent (Ex.-1201), Figure 4B
(annotated, side-by-side-layers)

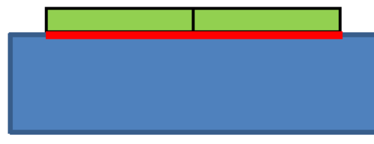
POR at 62

Furthermore, each of the internal stress films **8***a* and **8***b* does not have to be a single layer but may include multiple layers, as long as each of the internal stress films **8***a* and **8***b* can apply a stress to the substrate as a whole.

’501 patent at 5:60-63
(cited POR 7)



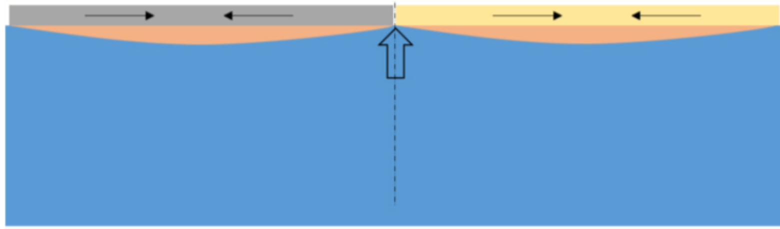
Stacked layers on the substrate



Adjacent side-by-side layers on the substrate

Figure 1: Vertical vs. Horizontal Layers

Glew Decl., Ex. 2208, ¶ 70
(cited POR at 32)

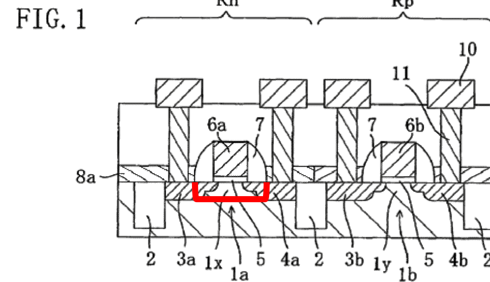


*Two films deposited side-by-side, each applying its own compressive stress*

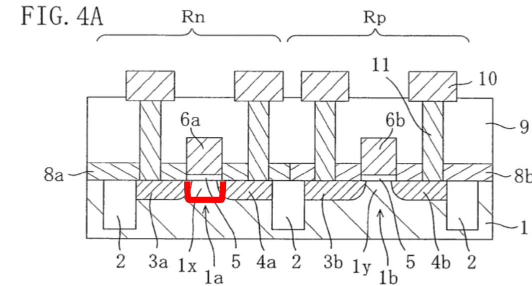
Shanfield Reply Decl., Ex. 1232 at 27

40. The final diagram illustrates two films (gray and yellow) deposited side-by-side onto the substrate (blue). In this example, and in contrast with the stacked arrangement shown above, each film applies its own compressive stress into the substrate, resulting in two independent compressive stress fields (peach).

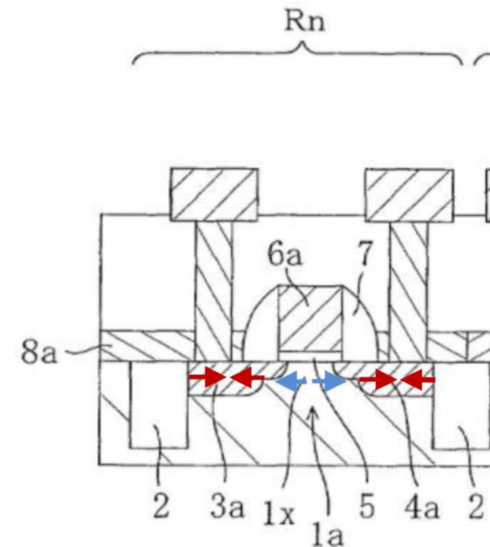
Shanfield Reply Decl., Ex. 1232 at ¶ 40




’501 patent at Fig. 1

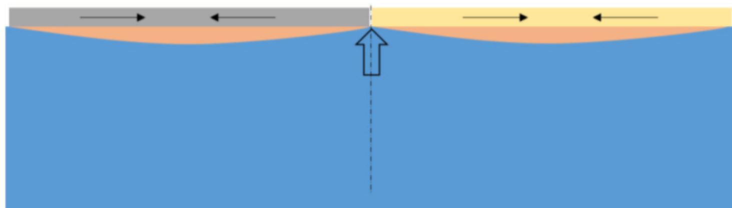



’501 patent at Fig. 4A



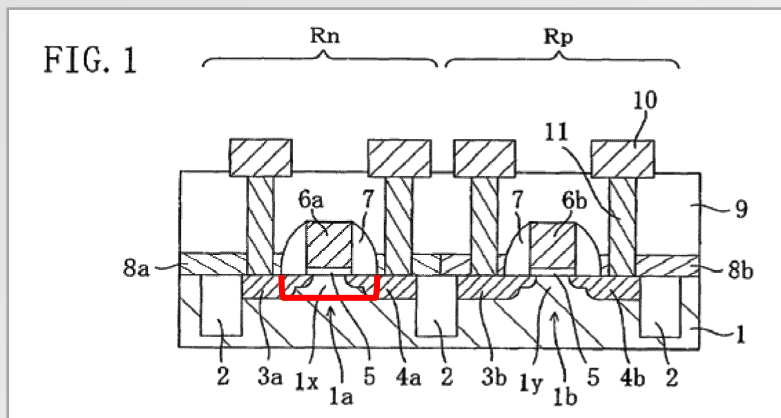

Glew Decl., Ex. 2208 at ¶ 36
(cited POR at 19)

two side-by-side films, as identified by the large arrow. In other words, placing two separately deposited (and, in this case, identical) thin films side-by-side does not provide a higher magnitude stress field and, in contrast, results in each film generating its own separate stress film, with the condition of zero stress in the underlying substrate at the point between the two separate films.



*Two films deposited side-by-side, each applying its own compressive stress*

Shanfield Reply Decl., Ex. 1232 ¶ 40



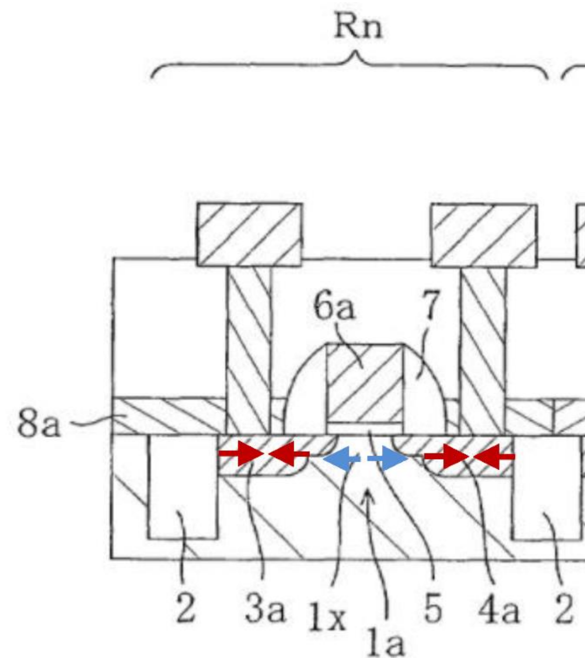

'501 patent at Fig. 1

5 Q. So there's an interface between 8a and 7
6 there?
7 **A. Right, yes, that's shown schematically, yes.**
8 Q. What would the stress look like at that
9 interface?

* * * *

2 **there's going to be some discontinuity in stress at**
3 **that interface between the two separate structures:**
4 **this structure 7 and 8a.**
5 **And it's going to have some of the**
6 **qualities of the discontinuity in stress that I**
7 **tried to depict in, say, page 27 in my 1843 reply**
8 **declaration.**

Shanfield Reply Depo., Ex. 2232 at 66:5-9; 67:2-8
(Patent Owner's Observations, Paper No. 30, #21)




Glew Decl., Ex. 2208 at ¶ 36
(cited POR at 19)

a general level for a silicon nitride film, i.e., 1.5 GPa, the thickness of the first-type internal stress film **8***a* is 20 nm, a space between respective parts of the source and drain regions **3***a* and **4***a* being in contact with the first-type internal stress film **8***a*, i.e., the length of the channel region **1***x*, is 0.2 μm, a tensile stress in the gate length direction generated at a depth of 10 nm from the surface of the substrate is 0.3 GPa (J. Appl.

'501 patent at 4:61-66
(Patent Owner's Observations, Paper No. 30, #21)

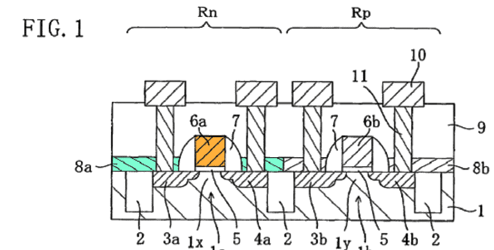
# Claim 1 Does Not Only Require That The Gate Electrode Protrude from Some Part Of The Silicon Nitride Film

Applicants respectfully submit that, at a minimum, none of the cited references discloses or suggests that "*the gate electrode protrudes upward from a surface level of parts of the silicon nitride film located at both side surfaces of the gate electrode*," as recited by amended claim 15. In the present subject matter, as shown in, for example, FIGS. 1 and 4A, the gate electrode 6a, 6b protrudes upward from a surface level of parts of the silicon nitride film 8a, 8b located at both side surfaces of the gate electrode 6a, 6b. In other words, a height of the gate electrode from the surface of the substrate is higher than a height of the silicon nitride film disposed at the sides of the gate electrode.

Ex.-1203 at 8 (cited in POR at 3)

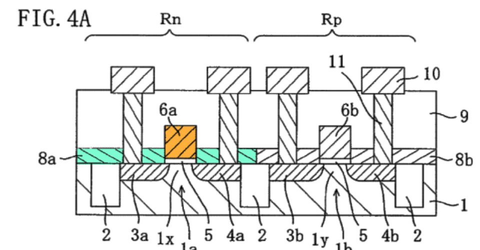
Next, in the process step of FIG. **5**B, after the resist film **12** has been removed, the silicon nitride film **8***x* is etched back, part of the silicon nitride film **8***x* located on the gate electrode **6***a* is removed and the thickness of the silicon nitride film **8***x* is further reduced. Thus, a first-type internal stress film **8***a*

'501 patent at 9:62-66 (cited in POR 59)



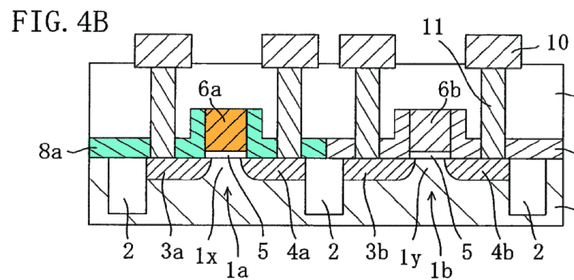

'501-patent (Ex.-1201), Fig. 1 (annotated)

POR at 60



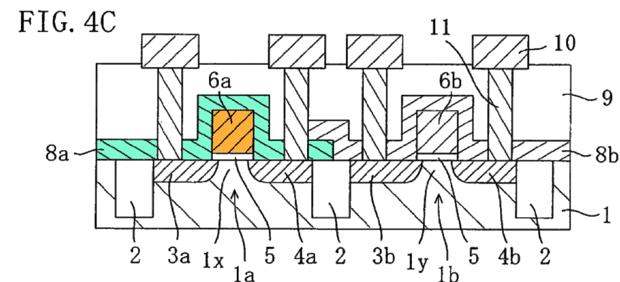

'501-patent (Ex.-1201), Fig. 4A (annotated)

POR at 60




'501-patent (Ex.-1201), Fig. 4B (annotated)

POR at 29




'501-patent (Ex.-1201), Fig. 4C (annotated)

POR at 29