

In The Matter Of:
Taiwan Semiconductor Manufacturing Co., Ltd. v.
Godo Kaisha IP Bridge 1

Stanley R. Shanfield, Ph.D.
July 25, 2018

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IP Bridge Exhibit 2232
TSMC v. Godo Kaisha IP Bridge 1

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1 UNITED STATES PATENT AND TRADEMARK OFFICE
 2 BEFORE THE PATENT TRIAL AND APPEAL BOARD
 3 Case Nos. IPR2017-01841, IPR2017-01843
 4 Patent 7,893,501
 5 ----- X
 6 TAIWAN SEMICONDUCTOR MANUFACTURING
 7 CO., LTD.,
 8 Petitioner,
 9 v.
 10 GODO KAISHA IP BRIDGE 1,
 11 Patent Owner.
 12 ----- X
 13 VOLUME I Pages 1-181
 14
 15 DEPOSITION OF STANLEY R. SHANFIELD, Ph.D.
 16 Wednesday, July 25, 2018, 9:03 a.m.
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1 STANLEY R. SHANFIELD, Ph.D.,
2 having been satisfactorily identified by the
3 production of his driver's license, and
4 duly sworn by the court reporter, was deposed
5 and testified as follows:
6 **CROSS-EXAMINATION**
7 **BY MR. HRYCYSZYN:**
8 Q. Good morning, Dr. Shanfield.
9 A. Good morning.
10 Q. What is a film in the context of the
11 '501 patent?
12 A. So maybe in the '501 patent, you could show
13 me where that word is used and I could give you a
14 better answer.
15 Q. So you don't recall in the context of the
16 '501 patent where "film" is used or where your
17 declarations in this IPR have been submitted and
18 focus on?
19 **MR. SMITH:** Objection.
20 **THE WITNESS:** So I think I can give you
21 a more accurate and more complete answer if I have
22 the specific, at least the paragraph or sentence
23 that refers to "film."
24

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1 **BY MR. HRYCYSZYN:**
2 Q. Do you recall providing declarations in
3 this IPR?
4 A. Sure.
5 Q. Do you remember opining on "film" in this
6 IPR?
7 A. Yes.
8 Q. So I'm asking you, what was your
9 understanding of that word "film" that you used in
10 your declarations?
11 A. Well, let me take a look. Maybe the best
12 place to look is in the reply.
13 So, for example, in paragraph 18 on
14 page 11 of my reply declaration -- this is the
15 1843 -- give you a chance to find it -- Figure 5
16 shows a silicon nitride film 20 and that layer 20
17 is -- in this Misra reference, is one example of
18 "film." It's silicon nitride Si 3 and 4, some
19 hydrogen in there. And it's amorphous layer
20 material. It's been deposited in one manufacturing
21 step.
22 **MR. HRYCYSZYN:** Object as nonresponsive.
23 **BY MR. HRYCYSZYN:**
24 Q. So my question is, what was your working

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1 understanding of the term "film" that you applied in
2 opining on the claims in this case?
3 A. The answer I gave you is an example of that
4 and I defined -- or I understood layer 20 as shown
5 here is an example of a silicon nitride film. It's
6 a layer or layers of material, in this case, that
7 are silicon nitride or -- you know, that are on top
8 of each other or a single layer, silicon nitride
9 being silicon and nitrogen and some hydrogen.
10 And it's been deposited in one
11 deposition step. And generally film is a reference
12 to something -- or a layer that's fairly thin.
13 Q. So your working understanding of a film is
14 it's a layer that is relatively thin, or fairly
15 thin; is that accurate?
16 **MR. SMITH:** Objection.
17 **THE WITNESS:** No.
18 **BY MR. HRYCYSZYN:**
19 Q. Then what is your working understanding of
20 the term "film" as it is used in the claims of the
21 '501 patent?
22 A. Well, if you give me the '501 patent, I can
23 refer to a specific instance of that in the patent
24 itself. I'd appreciate that. I can't do it by

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1 **memory.**
2 Q. So you have --
3 **A. I picked out something in my declaration**
4 **that is a film to give you a sense of my**
5 **understanding of that film.**
6 Q. So you can't provide me a definition of
7 "film" as you understand it and applied in your
8 opinions related to the '501 patent?
9 **MR. SMITH:** Objection.
10 **THE WITNESS:** No, that's not true. I --
11 **BY MR. HRYCYSZYN:**
12 Q. Well, that's what I'm asking you to
13 provide. But so far --
14 **A. I'm asking you for the patents so I can**
15 **show you clearly what I mean.**
16 Q. I'm introducing what has been previously
17 marked as Exhibit 1201. It is titled U.S. Patent
18 No. 7,893,501.
19 Do you recognize that document?
20 **A. Yes.**
21 Q. What is it?
22 **A. This is the '501 patent.**
23 Q. Do you remember opining on that patent in
24 this IPR?

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1 **A. Yes, of course.**
2 Q. Do you remember providing opinions related
3 to films in your opinion in this IPR?
4 **A. I think I answered that. Yes.**
5 Q. What was your working understanding of the
6 term "film" in providing those opinions?
7 **A. If you go to Claim 1 that's in the**
8 **'501 patent. And I'll start with "a gate electrode**
9 **formed on a [sic] gate insulating film." So in this**
10 **case -- and this is the reason I need a specific**
11 **reference -- a gate insulating film here is silicon**
12 **dioxide grown or some insulating film grown on**
13 **silicon, but it's typically silicon dioxide, and the**
14 **gate sits on top of that thin layer.**
15 **In this case, it's quite thin. It's a**
16 **nanometer scale. And it separates the gate because**
17 **it's insulating from the active region. So a gate**
18 **insulating film formed on the active region, and the**
19 **gate electrode formed on the gate insulating film.**
20 **In that context, the film is a silicon-**
21 **oxygen compound that's a few nanometers thick**
22 **deposited or grown in a single deposition step.**
23 **And that's my understanding in this case.**
24 Q. So that's the extent of the -- let's say,

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1 the working definition of "film" that you used in
2 this IPR?
3 **MR. SMITH:** Objection.
4 **THE WITNESS:** No.
5 **BY MR. HRYCYSZYN:**
6 Q. So then what is the extent of the working
7 definition you used of "film" in this case?
8 **A. So like I explained, in order to give you a**
9 **good answer, I want to talk about specific context.**
10 **In this case, I talked about the gate insulating**
11 **film. I can answer any question about, you know,**
12 **other film that is mentioned in the '501, explain my**
13 **working understanding of it.**
14 Q. So let me draw your attention to
15 paragraph 19 in your reply brief.
16 **A. Paragraph 19 in which?**
17 Q. I'm introducing what has been previously
18 marked as Exhibit 1232, "Reply declaration of
19 Stanley R. Shanfield, Ph.D.," in Case
20 No. IPR2017-1843.
21 **A. I have a copy.**
22 Q. Do you recognize that document?
23 **A. Yes.**
24 Q. What is it?

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1 **A. This is my reply declaration for Case**
2 **No. IPR2017-01843.**
3 Q. Let me draw your attention to paragraph 19.
4 Are you there?
5 **A. Um-hum, yes.**
6 Q. Have you had a chance to read that
7 paragraph?
8 **A. One moment. Yes.**
9 Q. So here you refer to two layers of a single
10 film, right?
11 **A. What I said was, "no person of ordinary**
12 **skill . . . would have considered silicon nitride**
13 **film 20 and spacers 23 to be two layers of a single**
14 **film."**
15 Q. Do you agree that two layers can form a
16 single film?
17 **A. The '501 says that a film -- in that case**
18 **it's internal stress film -- can include multiple**
19 **layers, as long as they apply stress to the**
20 **substrate as a whole. So there can be layers as**
21 **long as they apply stress to the whole.**
22 Q. So I'm asking about the definition of
23 "film" more generally. So can two layers make up a
24 film generally?

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1 **MR. SMITH:** Objection.
2 **THE WITNESS:** Well, in the sense that I
3 just described it, yes. The multiple -- they can
4 have multiple layers as long as each of the layers
5 applies a stress to the substrate.
6 **BY MR. HRYCYSZYN:**
7 Q. So are you indicating that films, as the
8 term "films" is used in the claims of the
9 '501 patent, is limited to stress films?
10 **MR. SMITH:** Objection.
11 **THE WITNESS:** No.
12 **BY MR. HRYCYSZYN:**
13 Q. So the films that are used in the context
14 of the '501 patent claims are broader than just
15 films that apply stress, correct?
16 **A. As I described earlier, the gate insulating**
17 **film is not a film intended to apply stress. It's**
18 **intended to put an insulator between the gate and**
19 **the substrate and reduce -- and keep the density of**
20 **charge states low in that interface between the film**
21 **and the active region. So clearly, no, that's not**
22 **the only function of a film.**
23 **There are many functions in general.**
24 **But for the specifics of the '501, that's an example**

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1 **of something that's not a stress film.**
2 Q. So then in the context of the '501 patent
3 claims, can films include more than one layer?
4 **A. I think I answered that. I said that the**
5 **internal stress films in the '501 don't have to be a**
6 **single layer. They can be multiple layers, but as**
7 **long as each of them applies stress to the substrate**
8 **as a whole.**
9 Q. So you answered the question specific to
10 stress films. But the claims aren't limited to
11 stress films. My question is, in general, do films
12 require -- or let me rephrase that.
13 So in the context of the '501 patent
14 claims, can films include more than one layer?
15 **A. As I mentioned, in the two places where**
16 **films are mentioned in the '501, in one case,**
17 **internal stress films, the '501 patent explicitly**
18 **says that a single -- that the films do not have to**
19 **be a single layer. They can be multiple layers.**
20 Q. So let me draw your attention back to
21 paragraph 19 in your 1843 reply declaration.
22 Do you see that paragraph?
23 **A. Yes.**
24 Q. So in that paragraph, you talk about three

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1 criteria -- what appear to be three criteria:
2 process steps, functions, and structures.
3 Do you see that?
4 **A. Those were -- that's a summary of some of**
5 **the reasons why, in my opinion, no one of ordinary**
6 **skill in the art would have thought of these films.**
7 **The film 20, the silicon nitride film and spacer, is**
8 **two layers of the same film.**
9 Q. So for two adjacent layers to be considered
10 the same film, is it your opinion that they must be
11 the same structure formed through the same process
12 and perform the same function?
13 **MR. SMITH:** Objection.
14 **THE WITNESS:** That's some of the reasons
15 why I think someone of ordinary skill would not view
16 two adjacent films to be two layers of a single
17 film.
18 **BY MR. HRYCYSZYN:**
19 Q. So in addition to those three criteria --
20 same process, same structure, same function -- are
21 there other criteria that you believe are required
22 for two adjacent layers to be considered the same
23 film?
24 **MR. SMITH:** Objection.

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1 **THE WITNESS:** I can think of other ones,
2 yes.
3 **BY MR. HRYCYSZYN:**
4 Q. What other ones would those be?
5 **A. For example, the film could be different**
6 **material.**
7 Q. Any other criteria that you think applies
8 in determining whether adjacent layers are the same
9 film?
10 **MR. SMITH:** Objection.
11 **THE WITNESS:** I -- at the moment --
12 I mean, I can talk about chemical composition.
13 So they may have the same description, but the
14 deposition method being different ends up producing
15 a film that is going to be different in the detailed
16 chemistry.
17 As an example, a film deposited with a
18 plasma-enhanced CVD system always has hydrogen as
19 one of the constituents in the amorphous structure.
20 And a high temperature CVD that's not using plasma
21 tends to have a much lower level of hydrogen. So I
22 think that would be yet another aspect that I'd
23 consider.
24 Once again, I think these are reasons,

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