UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO. LTD,
SAMSUNG ELECTRONICS AMERICA, INC.,
SAMSUNG SEMICONDUCTOR, INC., and
SAMSUNG AUSTIN SEMICONDUCTOR, LLC
Petitioner

v.

HOME SEMICONDUCTOR INC.
Patent Owner

IPR2015-00460
Patent 6,146,997

PETITIONER'S RESPONSE TO PATENT OWNER'S OBSERVATIONS ON CROSS-EXAMINATION

Observation No. 1 (Section I, ¶ 1) Response: In response to Section I, ¶ 1, where HSC said that Doshi contemplates etching of sidewall filaments 11 and nitride cap 26 gate structure, we note that when asked by HSC on Doshi's disclosure that damage to the corners of gate structures 10 and sidewall filaments 11 is substantially minimized, Dr. Rubloff stated that the nitride anisotropic etch is "intended to go through the nitride and then stop as soon as the silicon – as the nitride is cleared from the diffusion region below," and that Doshi discloses that "there could be a very minimal amount of damage to the sidewall filaments." *See* Ex. 2006 at 75:17 – 77:13. Dr. Rubloff also stated that the anisotropic nitride etch will create a nitride sidewall spacer 30. *Id.* This is relevant because Dr. Rubloff's statements are consistent with his testimony in ¶ 2D of the Reply Declaration. *See* Ex. 1011 at ¶ 2D.

Observation No. 2 (Section I, ¶ 2) Response: In response to Section I, ¶ 2, where HSC stated that contrary to Dr. Rubloff's assertion, overetching has minimal risk of damaging the diffusion region, we note that Dr. Rubloff stated that Doshi intends the nitride etch to "stop as soon as the silicon – as the nitride is cleared from the diffusion region below." *See* Ex. 2006 at 38:17 – 39:10; 62:21 – 63:9; 76:1-10. This is relevant because Dr. Rubloff's statements are consistent with his testimony in the Reply Declaration that the aggressive over-etch contemplated by HSC would likely damage the diffusion region of Doshi. *See* Ex. 1011, ¶¶ 2H-2K.

Observation No. 3 (Section I, ¶ 3) Response: In response to Section I, ¶ 3, where HSC stated that contrary to Dr. Rubloff's claim, overetching nitride layer 30 is something that a POSITA would do when implementing Doshi to ensure that all nitride material in the contact area was removed, we note that when asked by HSC on Doshi's disclosure that damage to the corners of gate structures 10 and sidewall filaments 11 is substantially minimized, Dr. Rubloff explained that the over-etch is used to address a minor variation of thickness across the wafer. *See* Ex. 2006 at 75:17 – 77:13; 88:11-13; 89:20 – 90:9. This is relevant because Dr. Rubloff's statements are consistent with his testimony in the Reply Declaration that the aggressive over-etch contemplated by HSC would likely damage the diffusion region of Doshi. *See* Ex. 1011, ¶¶ 2H-2K.

Observation No. 4 (Section I, ¶ 4) Response: In response to Section I, ¶ 4, where HSC stated that Dr. Rubloff's testimony contradicts his assertion that overetching nitride layer 30 would damage the diffusion region, we note that when asked by HSC on Doshi's disclosure that damage to the corners of gate structures 10 and sidewall filaments 11 is substantially minimized, Dr. Rubloff stated that the nitride anisotropic etch is "intended to go through the nitride and then stop as soon as the silicon – as the nitride is cleared from the diffusion region below." *See* Ex. 2006 at 75:17 – 77:13; 88:11-13; 89:20 – 90:9. This is relevant because Dr. Rubloff's statements are consistent with his testimony in the Reply Declaration that the

aggressive over-etch contemplated by HSC would likely damage the diffusion region of Doshi. *See* Ex. 1011, ¶¶ 2H-2K.

Observation No. 5 (Section I, ¶ 5) Response: In response to Section I, ¶ 5, where HSC stated that contrary to Dr. Rubloff's claims, Dr. Rubloff cannot reliably speculate about the results of the anisotropic etch of nitride layer 30, we note that when asked by HSC whether a light tilt or angle in a sidewall profile could have unpredictable effects on the degree of etching that occurs, Dr. Rubloff stated that "[i]t certainly isn't unpredictable," and he "wouldn't expect much of an angle there." *See* Ex. 2006 at 51:16 – 52:12; 54:7-21; 75:17 – 77:13. This is relevant because Dr. Rubloff's statements are consistent with his testimony in ¶¶ 5C-5D of the Reply Declaration. *See* Ex. 1011, ¶¶ 5C-5D.

Observation No. 6 (Section I, ¶ 6) Response: In response to Section I, ¶ 6, where HSC stated that Dr. Rubloff's testimony contradicts his claims that Doshi explicitly shows a spacer being formed by the nitride etch of nitride layer 30, we note that when asked by HSC about Doshi not specifically saying that nitride layer 30 is used to form a spacer, Dr. Rubloff answered that "if there is very little damage at the NC corner and it's a highly anisotropic etch, then the layer 30 will remain on the sidewall as depicted properly in 3F and 3G. That's a spacer, whether it's called a spacer or not." *See* Ex. 2006 at 104:9 – 105:21; 106:5-15. This is relevant because Dr. Rubloff's statements are consistent with and provide

additional basis for his testimony in ¶ 5C of the Reply Declaration. *See* Ex. 1011, ¶ 5C.

Observation No. 7 (Section I, ¶ 7) Response: In response to Section I, ¶ 7, where HSC stated that Dr. Rubloff's testimony contradicts his claims that any etching of nitride layer 30 during the BPSG etch would have mainly removed the nitride layer 30 over the diffusion region, we note that when asked by HSC whether the contour of the nitride layer 30 would change during the etching of BPSG, Dr. Rubloff answered "I think minimally because it's a selective etch." *See* Ex. 2006 at 132:11-15. This is relevant because Dr. Rubloff's statements are consistent with his testimony in ¶ 5A of the Reply Declaration. *See* Ex. 1011, ¶ 5A.

Observation No. 8 (Section II, ¶ 1) Response: In response to Section II, ¶ 1, where HSC stated that Dr. Rubloff's testimony contradicts with Fig. 3k, we note that when asked by HSC whether FIG. 3K shows no damage to the gate structure 10 and sidewall filaments 11, Dr. Rubloff answered that FIG. 3K is totally inconsistent with the description in the specification. *See* Ex. 2006 at 91:22 – 92:11. Dr. Rubloff explained that "I just can't speculate about a drawing that's clearly wrong," and "this is contrary to everything that this patent is about in terms of telling you how to make a self-aligned contact that's tolerant of lithography error." *Id.* at 100:13 – 101:3. This is relevant because Dr. Rubloff's statements are consistent with his testimony in ¶ 3A of the Reply Declaration. *See* Ex. 1011, ¶ 3A.

Observation No. 9 (Section II, ¶ 2) Response: In response to Section II, ¶ 2, where HSC stated that contrary to Dr. Rubloff's assertion, Doshi never states that it is trying to form self-aligned contacts, we note that Dr. Rubloff explained that while Doshi does explicit say "self-aligned contact," "one of ordinary skill knows that one of the prime drivers for using conformal deposition followed by anisotropic etching is to form sidewall spacers that help in functioning as diffusion barriers, electrical isolation barriers, and self-alignment of contacts to improve lithography. So I think it's implicit here." *See* Ex. 2006 at 103:1-9. This is relevant because a POSITA would have understood that Doshi discloses the formation of self-aligned contacts.

Observation No. 10 (Section II, ¶ 3) Response: In response to Section II, ¶ 3, where HSC stated that Dr. Rubloff's assertions regarding Fig. 3k are not credible, we note that when asked by HSC whether he had studied the whole Doshi reference at the time of submitting his first declaration, Dr. Rubloff indicated that he studied the whole reference. *See* Ex. 2006 at 98:2-9. This is relevant because Dr. Rubloff's declarations are credible.

Observation No. 11 (Section III, ¶ 1) Response: In response to Section III, ¶ 1, where HSC stated that the citation to Dr. Rubloff's prior testimony was accurate and not misleading, we note that Dr. Rubloff stated that the nitride layer 30 is a diffusion barrier, and a diffusion barrier is a function that a spacer can perform. *See*

Ex. 2006 at 98:2-9. Dr. Rubloff further stated that "Later on, there's a spacer which is an electrical spacer that's more central to this patent at issue that has a different shape because it's been morphed by the anisotropic etching process to make a new shape. So that's a different spacer." *Id.* at 124:6-14. This is relevant because Dr. Rubloff's statements are consistent with his testimony in ¶ 3A of the Reply Declaration that in HSC's Patent Owner Response, "HSC has omitted my subsequent statements that follow the statements quoted by HSC, where I acknowledged that whether Doshi discloses a structure that may function as a spacer before the nitride etch process is not the proper inquiry." *See* Ex. 1011, ¶ 3A.

Observation No. 12 (Section IV, ¶ 1) Response: In response to Section IV, ¶ 1, where HSC stated that Doshi does not recite the use of thermal oxidation, we note that during Dr. Rubloff's first deposition, Dr. Rubloff established that although not all oxidation of silicon is thermal, a POSITA would have understood that Doshi refers to thermal oxidation when Doshi says oxidizing the sides of the polysilicon layer:

> HSC: "So Doshi doesn't specifically disclose thermal oxidation, correct?"
>
> Dr. Rubloff: "One of ordinary skill would interpret oxidizing any kind of silicon as thermal oxidation."
>
> HSC: "Is it –"

> Dr. Rubloff: "Otherwise it would say CVD using such and such precursor."
>
> HSC: "So is thermal oxidation the only method amenable to oxidize the polysilicon layer?"
>
> Dr. Rubloff: "No. I am sorry. To oxidize polysilicon. No, it's not. You could do anodic oxidation, which is a wet chemical electric chemical technique. I mean, I don't think anybody would do it here, but it could be done."
>
> HSC: "Well, how do you know that Doshi, when it says oxidizing the sides of the polysilicon layer, is referring to thermal oxidation as opposed to the other form of oxidation using the wet chemical electrodes?"
>
> Dr. Rubloff: "If it were wet chemical, it would have said anodization because it's a standard way of describing it. Poured silicon is made this way, for example. And in this technology domain, silicon, oxidizing means you use O2, or conceivably O2 with some water, or conceivably N2O, but it's a gas-phase process. Oxidizing means that what used to be silicon becomes a new compound."
> *See* Ex. 2004 at 172:17 – 174:3.

During Dr. Rubloff's second deposition, he again confirmed that not all oxidation of silicon is thermal. *See* Ex. 2006 at 135:21 – 136:3. This is relevant because Dr. Rubloff's statements in the first and the second depositions are consistent, where his first deposition testimony that "[o]ne of ordinary skill would interpret oxidizing any kind of silicon as thermal oxidation" was not disputed in the Patent Owner Response or HSC's expert testimony. *See* Ex. 2004 at 172:17-22. HSC has waived the issue of whether Doshi recites the use of thermal oxidation by failing to raise it in its Patent Owner Response.

Observation No. 13 (Section IV, ¶ 2) Response: In response to Section IV, ¶ 2, where HSC stated that contrary to Dr. Rubloff's claim, Doshi does not teach forming an oxide layer over the diffusion region by any method, we note that when asked by HSC whether Doshi says any oxide layer is being thickened during the oxidation step, Dr. Rubloff stated that "Doshi doesn't address what's going on at the surface of the diffusion region," and "we're left to infer from what we know in the art what's likely to happen." *See* Ex. 2006 at 150:12-18. Dr. Rubloff later explained that "when the gate is etched to define the gate structure, it did not etch the gate oxide that was there. Then the polysilicon oxidation is taking place on the sidewall, and that will further grow oxide over the diffusion region." *Id.* at 160:5-21. This is relevant because Dr. Rubloff's statements are consistent with his testimony in ¶¶ 6A-6B of the Reply Declaration. *See* Ex. 1011, ¶¶ 6A-6B.

Observation No. 14 (Section IV, ¶ 3) Response: In response to Section IV, ¶ 3, where HSC stated that the Petition is wrong and that the source/drain (diffusion) regions are not uncovered doped silicon susceptible to oxidation, we note that Dr. Rubloff explained that silicon covered by a gate oxide also forms a oxide layer. *See* Ex. 2006 at 141:3 – 143:4. This is relevant because the petition is not wrong because Doshi as applied discloses oxidation over the diffusion region. *See* Ex. 1011, ¶ 6B.

Respectfully submitted,

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CERTIFICATE OF SERVICE

Pursuant to 37 CFR § 42.6(e)(4), the undersigned certifies that on January 12, 2016, a complete and entire copy of this Petitioner Response to Patent Owner's Motion for Observation on Cross-Examination was provided via email to the Petitioner by serving the correspondence email address of record as follows:

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