

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

TAIWAN SEMICONDUCTOR MANUFACTURING COMPANY, LTD.,
and GLOBALFOUNDRIES U.S. INC.,
Petitioners,

v.

GODO KAISHA IP BRIDGE 1,
Patent Owner.

Case IPR2016-01376¹

Patent 6,197,696 B1

Before JUSTIN T. ARBES, MICHAEL J. FITZPATRICK, and
JENNIFER MEYER CHAGNON, *Administrative Patent Judges*.

**PETITIONER’S RESPONSES TO PATENT OWNER’S MOTION FOR
OBSERVATIONS REGARDING THE CROSS-EXAMINATION OF
BRUCE W. SMITH, PH.D.**

¹ GlobalFoundries U.S. Inc.’s motion for joinder in IPR2017-00921 was granted.

Petitioner provides the following responses to Patent Owner's observations on the cross-examination testimony of Bruce W. Smith, Ph.D. (Paper 34).

Response to Observation No. 1:

Patent Owner's Observation No. 1 is improper as it contains arguments the Board's rules do not permit. *See* Office Trial Practice Guide, 77 Fed. Reg. 48,767-68 (Aug. 14, 2012). Under the guise of a statement of relevance, Patent Owner argues Petitioner and Dr. Smith are attempting "to rewrite the Japanese Application's express disclosures." Paper 34, at 1–2. That explanation has nothing to do with relevance. Dr. Smith's testimony referenced here and in Observation No. 1 is relevant, not for the reasons Patent Owner advances, but because that testimony is consistent with the statement in the Japanese '371 application that "the second silicon dioxide film 355 and the organic film 354 are sequentially dry-etched using the second resist pattern 359 as a mask." EX1014, at ¶0093; *see also* EX1049, at ¶¶29–36. Observation No. 1 also references incomplete testimony. Dr. Smith was asked, "So it's your testimony that the second resist pattern 359 is removed during etching of the organic film 354?" EX2040, at 15:4–6. Dr. Smith responded,

Well, it doesn't say it's fully removed. It's a statement that says that 359 is removed during that step. That layer 359 would need to remain at least partially, some of that material, until all of 354 is etched through, becomes

354A. And then as the Figure 16B shows, to remove resist pattern 359A [sic], one would continue the etch process through the organic film 354. Which would then completely remove 359.

Id. at 15:7–15.

Response to Observation No. 2:

As Observation No. 2 notes, Dr. Smith was asked, “Is film 354A being used as a mask in etching film 353?” Dr. Smith responded, “It says that in the specification, but 354A is not -- would not be part of the mask that would be etching 353.” EX2040, at 18:3–7. Dr. Smith was also asked, “Does layer 354 become a mask during this process, after layer 355 is completely removed?” Dr. Smith responded (after a form objection from Mr. Davis) that “354, once 355A is removed -- and 354 being the organic film, or an organic film -- would then be masking 353.” EX2040, at 59:20–60:3. This testimony is relevant because it supports Petitioner’s argument that layer 354A does not act as a mask until it is exposed (Paper 26, at 13–14), and supports the Board’s construction finding that “a layer positioned between an overlying layer and the layer being etched” can act as a mask “in an instance where the overlying layer is also removed during the etching, and thus, the between layer acts to shield the layer being etched during etching.” Paper 11, at 18, n.7. It does not contradict Petitioner’s arguments or the Board’s

construction, as Patent Owner incorrectly suggests. Dr. Smith's testimony also highlights the internally inconsistent usage of the term "mask" in the specification of the '696 patent, as Dr. Smith explained in his declaration. EX1049, at ¶¶20–28. Contrary to Patent Owner's assertion (Paper 34, at 2–3), Dr. Smith's testimony cited in Observation No. 2 (EX2040, at 16:1–17:20) is irrelevant to the process for transitioning between Figures 16(c) and 16(d). Dr. Smith's testimony relates to transitioning between Figures 16(b) and 16(c), not between Figures 16(c) and 16(d). EX2040, at 16:16–18:7.

Response to Observation No. 3:

Patent Owner's Observation No. 1 is improper as it contains arguments the Board's rules do not permit, and because it extends nearly two pages, not a short paragraph as permitted under the rules. *See* Office Trial Practice Guide, 77 Fed. Reg. 48,767-68 (Aug. 14, 2012). Patent Owner argues that Dr. Smith's testimony at EX2040, at 18:13–20:20, is relevant to "whether a buried layer that has a lateral edge 'in line and flush with [a lateral] edge of' an overlying layer can act as a mask." Paper 34, at 3. Dr. Smith's testimony is not relevant to this issue. Nowhere in this passage was Dr. Smith asked about, nor did he testify about buried layers, lateral edges, or in line and flush edges with an overlying layer. Dr. Smith's testimony in the cited passage relates to the internally inconsistent treatment of masks by the specification of the '696 patent, as Dr. Smith has extensively opined.

EX1049, at ¶¶20–28. Contrary to Patent Owner’s arguments, Dr. Smith’s testimony in this passage about layer 505A from Figs. 23(b) and 23(c) of the ’696 patent are irrelevant to layers 355 and 358 from the Japanese ’371 application. Patent Owner did not ask Dr. Smith about those layers in the cited excerpt. Figures 23(b) and 23(c) do not even appear in the Japanese ’371 application. Dr. Smith’s testimony in Observation No. 3 is consistent with, and supports, the Board’s construction finding that “a layer positioned between an overlying layer and the layer being etched” can act as a mask “where the overlying layer is also removed during the etching, and thus, the between layer acts to shield the layer being etched during etching” (Paper 11, at 18, n.7), because Dr. Smith explained layer 505A acts as a mask until layer 504A is exposed.

Response to Observation No. 4:

Patent Owner’s Observation No. 1 is improper as it contains arguments the Board’s rules do not permit. *See* Office Trial Practice Guide, 77 Fed. Reg. 48,767–68 (Aug. 14, 2012). Contrary to Patent Owner’s arguments, Dr. Smith’s testimony at EX2040, at 20:21–22:1, about layer 605A from Figs. 32(a) and 32(b) of the ’696 patent is not relevant to different layers 355 and 358 from the Japanese ’371 application, about which Dr. Smith was not asked in the cited passage. Patent Owner mischaracterizes and misquotes Dr. Smith’s testimony when it writes, “605A will act to mask etching until *the film [603]* is removed.” Paper 34, 5

(emphasis added). The proper quotation is, “605A will act to mask etching until *that film* is removed,” and “that film” refers to layer 605A, not layer 603. EX2040, at 21:20–22:1. Dr. Smith’s opinion about such layers has been consistent from the beginning. *See, e.g.*, EX1002, at ¶¶104–09. Figures 32(a) and 32(b) do not even appear in the Japanese ’371 application. Dr. Smith’s testimony cited in Observation No. 4 is consistent with, and supports, the Board’s construction finding that “a layer positioned between an overlying layer and the layer being etched” can act as a mask “in an instance where the overlying layer is also removed during the etching, and thus, the between layer acts to shield the layer being etched during etching” (Paper 11, at 18, n.7), because he explained layer 605A acts as a mask until layer 604A is exposed.

Response to Observation No. 5:

Patent Owner’s Observation No. 1 is improper as it contains arguments the Board’s rules do not permit. *See* Office Trial Practice Guide, 77 Fed. Reg. 48,767–68 (Aug. 14, 2012). Patent Owner argues Dr. Smith’s testimony at EX2040, at 27:13–33:12, contradicts his opinions provided regarding whether vertical sidewalls have a role in masking. Paper 34, at 5–7. The testimony cited does not support Patent Owner’s argument or lead to its conclusion, as nowhere in the cited passage was Dr. Smith asked whether vertical sidewalls have a role in masking. Patent Owner also improperly re-argues here that “vertical sidewalls block lateral removal

and lateral flow of etchant.” *Id.* at 7. None of the cited testimony supports this argument, as Dr. Smith was never asked about, nor did he ever testify about any function of a vertical sidewall in an etching process. Patent Owner was asking about RIE in the abstract, not about any processes at issue in these proceedings or even dual damascene processes. In that regard, Dr. Smith testified, “The desired attribute of a multi-layer process like dual-damascene and the requirements for such a process to operate is the side wall angle needs to be vertical.” EX2040, at 23:11–14. He also stated that “[w]ithin the capability of measurement or within the requirements of manufacturing,” dry etches can provide “perfectly vertical sidewalls.” EX2040, at 22:6–10.

Response to Observation No. 6:

Patent Owner’s Observation No. 1 is improper as it contains arguments the Board’s rules do not permit. *See* Office Trial Practice Guide, 77 Fed. Reg. 48,767–68 (Aug. 14, 2012). Patent Owner argues Dr. Smith made a concession at EX2040, at 33:13–38:9, whether vertical sidewalls block lateral removal and lateral flow of etchant. Paper 34, at 8. The testimony cited does not support Patent Owner’s argument or lead to its conclusion, as nowhere in the cited passage was Dr. Smith asked about vertical sidewalls or whether they have any role in blocking lateral removal or lateral flow of etchant. Patent Owner was asking about RIE in the abstract, not about any processes at issue in these proceedings or even dual

damascene processes. In that regard, Dr. Smith testified, “The desired attribute of a multi-layer process like dual-damascene and the requirements for such a process to operate is the side wall angle needs to be vertical.” EX2040, at 23:11–14. He also stated, “Within the capability of measurement or within the requirements of manufacturing,” dry etches can provide “perfectly vertical sidewalls.” EX2040, at 22:6–10.

Response to Observation No. 7:

Patent Owner’s Observation No. 1 is improper as it contains arguments the Board’s rules do not permit. *See* Office Trial Practice Guide, 77 Fed. Reg. 48,767–68 (Aug. 14, 2012). Patent Owner argues Dr. Smith’s testimony (EX2040, at 40:13–50:3) “contradicts and is inconsistent with [his] earlier opinion . . . that ‘while concurrently removing’ covers a case where the photoresist layer is not completely removed as an underlying film is etched.” Paper 34, at 8 (quoting EX1049, at ¶46 n.1). Dr. Smith’s testimony directly supports his opinion. The testimony in Observation No. 7 is incomplete and misleading. In full, the exchange states the opposite of what Patent Owner suggests:

Q What is the difference between concurrently and partially concurrently?

A *In the case of partially concurrently*, since the etching is being done in two layers, the first dielectric and the second dielectric,

simply -- that simply said, concurrently, *it wouldn't cover the situation where one layer is removed before another layer is completely removed.*

Q Okay.

A *If in the first instance there is a situation where not -- for instance, not all the photoresist is gone during the concurrent removal, one would know that an overetch would strip the photoresist. So I don't think "partially concurrently" is appropriate in the first instance.*

EX2040, at 44:16–45:6 (emphasis added). Dr. Smith explained several times that “transferring [a pattern into a dielectric layer]. . . while concurrently removing [a layer of photoresist]” (EX1005, at 13:47–50) means the photoresist is also being etched during the entire period of time the pattern is being etched into the dielectric. See EX2040, at 45:1–6, 46:4–48:5. He stated, “I think concurrent is appropriate, since it’s talking about an etch step and a [concurrent] removal step,” not mutually concurrent dielectric patterning and photoresist removal steps. EX2040, at 46:8–47:1. In other words, dielectric patterning must be completed before the photoresist removal is completed. He contrasted this with “transferring, at least partially concurrently, [one dielectric] layer . . . and [another dielectric] layer” (EX1005, at 13:54–58), because “[t]here are two . . . transfer processes [that] are occurring

concurrently. But since they may not take the same time to complete, they would only be partially concurrent.” EX2040, at 45:11–19. The “partially concurrent” transfer step allows for either layer to finish being patterned before the other, whereas the “concurrent” removal of the photoresist does not allow for the photoresist mask to be completely removed before dielectric layer is done being etched. Dr. Smith’s testimony cited in Observation No. 7 thus supports his opinion that the Grill provisional supports Grill’s claim 28.

Response to Observation No. 8:

Patent Owner’s Observation No. 1 is improper as it contains arguments the Board’s rules do not permit. *See* Office Trial Practice Guide, 77 Fed. Reg. 48,767–68 (Aug. 14, 2012). Patent Owner argues Grill is not entitled to an earlier effective prior-art date based on the same incomplete and misleading quotation it presented in Observation No. 7 (discussed above). Patent Owner’s analysis of these misleading and incomplete statements is improper for a motion for observations, and premised on a failure to understand the difference between the phrase “transferring . . . while concurrently removing” and the phrase “transferring, at least partially concurrently, [one] layer . . . and [another] layer” (also discussed above). EX1005, at 13:47–50, 13:54–57.

Response to Observation No. 9:

Patent Owner's Observation No. 1 is improper as it contains arguments the Board's rules do not permit. *See* Office Trial Practice Guide, 77 Fed. Reg. 48,767-68 (Aug. 14, 2012). Patent Owner argues Dr. Smith's testimony (EX2040, at 43:13–50:5) “is inconsistent with [his] previous opinions in EX1049, at ¶36, that an ‘overetch’ technique is used to remove resist pattern 359” and “inconsistent with Petitioner's assertion that the ‘overetch’ technique is used to remove resist pattern 359.” Paper 34, at 10–11. To begin, Dr. Smith's testimony is the opposite of what Patent Owner claims. Dr. Smith testified, “That photoresist would be removed through the continuation of that step until all the photoresist is gone, and overetch would occur.” EX2040, at 48:2–5; *see also id.* at 45:1–6, 46:14–48:5. In addition, Dr. Smith's testimony in Observation No. 9 is about claim 28 of the Grill reference. EX2040, at 43:13–50:5. It is not about resist pattern 359 of the '696 patent or Japanese '371 application, and is thus irrelevant for Patent Owner's purposes.

Response to Observation No. 10:

Patent Owner's Observation No. 1 is improper as it contains arguments the Board's rules do not permit, and because by extending nearly two pages, it is not a short paragraph as the rules permit. *See* Office Trial Practice Guide, 77 Fed. Reg. 48,767-68 (Aug. 14, 2012). Patent Owner argues “Dr. Smith's understanding of the term ‘substantially overlap’ includes situations where the feature (i.e., opening) of

underlying via pattern shares the exact same feature (i.e., opening) of an overlying wire pattern, thereby eliminating the distinction between the via pattern and the wire pattern.” Paper 34, at 12. Rather than make observations about Dr. Smith’s cross-examination testimony, Observation No. 10 focuses solely on his declaration, which states, “the via pattern substantially (even completely) overlaps the wiring pattern.” EX1049, at ¶57. The statement means only that the entire via pattern overlaps part of the wiring pattern, not that all of the wiring pattern completely overlaps the via pattern. The testimony in Observation No. 10 merely states that “the dual relief pattern collectively refers to the openings in the blue layer, that’s a wiring pattern, and a green layer, a via pattern.” EX2040, at 50:20–51:1. Dr. Smith nowhere suggests the wiring and via patterns would be identical patterns, which, as Patent Owner observes, would be “nonsensical.” Paper 34, at 12.

Response to Observation No. 11:

Patent Owner’s Observation No. 1 is improper as it contains arguments the Board’s rules do not permit. *See* Office Trial Practice Guide, 77 Fed. Reg. 48,767-68 (Aug. 14, 2012). Under the guise of a statement of relevance, Patent Owner improperly mischaracterizes Dr. Smith’s prior opinion, and argues his cross-examination testimony contradicts it. Dr. Smith never opined that “no such cross-sections proposed by Patent Owner in the preliminary response could exist.” Paper 34, at 13. He stated only that any such patterns would involve “obscure, restrictive,

and difficult-to-imagine circuit layouts with complex and unnecessary shapes.” EX1049, at ¶26. Dr. Smith’s testimony (EX2040, at 52:2–53:6), referenced here and in Observation No. 11, follows his position that the cross-sections illustrated in the ’696 patent are not uniform throughout. *See, e.g.*, EX2040, at 53:2–6; EX1002, at ¶220. The conclusion IPB seeks to draw from Dr. Smith’s deposition testimony (i.e., that the ’696 patent illustrates layer 509 acting as a mask in transitioning from Figure 22(b) to 22(c)) does not follow. Even Patent Owner’s own expert rejected Patent Owner’s unsupported argument layer 509 is a mask in Figures 22(b) to 22(c). EX1047, at 97:12–99:21.

Response to Observation No. 12:

Patent Owner’s Observation No. 1 is improper as it contains arguments the Board’s rules do not permit. *See* Office Trial Practice Guide, 77 Fed. Reg. 48,767–68 (Aug. 14, 2012). Under the guise of a statement of relevance, Patent Owner argues Dr. Smith’s prior declaration testimony “improperly imported descriptions from Grill’s embodiment of Figure 6A into Grill’s embodiment of Figures 5A–5H.” Paper 34, at 14. Whether column 8, lines 24 to 31, of Grill describe Figure 5 is irrelevant. The preceding paragraph states FIGS. 6A–6F show a “variation of the FIG. 5 method.” EX1005, at 8:9–13. Dr. Smith’s declaration, which Patent Owner’s Observation No. 12 references, states, “Grill’s hard mask layers are about 20 to 50 nm thick,” finding the description of Grill at column 8, lines 24 to 31,

representative of what a POSITA would have understood the thickness of the hard mask layers in Grill's embodiments would be. EX1049, at ¶65. His opinion is consistent not only with the written description of Grill, but also with the '696 patent and other examples of record. *See, e.g.*, EX1001, at 10:44–45, 15:9–11, 16:59–64, 19:8–12, 21:5–7, 23:1–3, 25:9–11, 28:14–16, 30:14–16; EX1005, at 8:24–31; EX1010, at 7:4–6.

Response to Observation No. 13:

Patent Owner's Observation No. 1 is improper as it contains arguments the Board's rules do not permit. *See* Office Trial Practice Guide, 77 Fed. Reg. 48,767–68 (Aug. 14, 2012). Under the guise of a statement of relevance, Patent Owner argues Dr. Smith's prior declaration testimony "is importing teachings into the '696 patent and the Japanese '371 application." Paper 34, at 15. Whether the '696 patent or the Japanese '371 application specifically use the term "overetch" is irrelevant to whether they describe an overetch process. Dr. Smith's declaration explains how the Japanese '371 application describes overetch, and explains that overetch is so well known in the art it has a name. EX1049, at ¶36. The cited testimony (EX2040, at 53:17–54:11) is also incomplete. *See* EX2040, at 54:12–57:4. Dr. Smith further testified that overetch "was something that was commonly known, and one of ordinary skill would have carried this out," citing the Chang & Sze reference (EX1031). EX2040, at 55:14–17. He also noted that "some overetch is always done

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in manufacturing to ensure the etch goes to completion everywhere,” citing the
Plummer reference (EX1030). EX2040, at 56:21–57:4.

Dated: August 23, 2017

Respectfully submitted,

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CERTIFICATE OF SERVICE

Under 37 C.F.R. § 42.6(e), this is to certify that I served a true and correct copy of the **PETITIONER'S RESPONSES TO PATENT OWNER'S MOTION FOR OBSERVATIONS REGARDING THE CROSS-EXAMINATION OF BRUCE W. SMITH, PH.D.** by electronic mail, on this 23rd day of August, 2017, on counsel of record for the Patent Owner as follows:

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A true and correct copy of the **PETITIONER'S RESPONSES TO PATENT OWNER'S MOTION FOR OBSERVATIONS REGARDING THE CROSS- EXAMINATION OF BRUCE W. SMITH, PH.D.** was also served by electronic mail, on this 23rd day of August, 2017, on counsel of record for Petitioner GlobalFoundries U.S. Inc. at the following:

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Dated: August 23, 2017

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