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UNITED STATES DISTRICT COURT

NORTHERN DISTRICT OF CALIFORNIA

ADVANCED MICRO DEVICES, INC., et al., Plaintiffs and Counterdefendants, v. SAMSUNG ELECTRONICS CO., LTD., et al., Defendants and Counterclaimants.	Case No. 3:08-CV-0986-SI **SAMSUNG'S REPLY IN SUPPORT OF MOTION FOR SUMMARY JUDGMENT OF INVALIDITY OF U.S. PATENT NO. 5,545,592** DATE: May 20, 2009 TIME: 4:00 p.m. COURTROOM: 10, 19th Floor JUDGE: The Honorable Susan Illston

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I. INTRODUCTION

AMD's opposition to Samsung's summary judgment motion attempts to create the impression of a triable issue of fact where none actually exists. Recognizing that U.S. Patent No. 5,975,912 to Hillman ("Hillman" or "the Hillman patent") discloses every step of the asserted claims of AMD's '592 patent,[1] AMD focuses on a small portion of one particular step of the '592 patent and tries to argue that Hillman shows something different. AMD's effort fails for several reasons.

First, Hillman discloses exactly what Samsung and its expert, Dr. Michael Thomas, have explained that it does: the exposure of titanium silicide to nitrogen ionized in a plasma. AMD submits a declaration of its own expert, Dr. Alexander Glew, in order to make the argument that Hillman's process does not result in the complete conversion of titanium to titanium silicide, and it is therefore the allegedly unconverted titanium—not titanium silicide—that is exposed to the plasma. Dr. Glew's declaration, however, represents nothing more than semantic gamesmanship: Dr. Glew never says that the Hillman process *does not* result in the complete conversion of titanium to titanium silicide; just that he does not read Hillman to *say* that it does. In fact, all of the relevant evidence—the disclosure of Hillman, the other contemporaneous statements of the inventors of the Hillman patent, and even the materials that Dr. Glew himself relies upon—show that Hillman's titanium is fully converted to titanium silicide. AMD's reliance on semantics cannot create a triable issue of fact in light of such evidence.

Second, even if Dr. Glew's statements are accepted, Hillman still expressly discloses the method of the asserted claims of the '592 patent. AMD argues that Hillman's process does not "necessarily" result in the complete conversion of titanium to titanium silicide. It is undisputed, however, that there are only two possible alternatives: either the titanium is, or it is not, completely converted to silicide. And, as AMD recognizes, time and temperature conditions can be manipulated to make either one or the other of these scenarios take place. It would be well within

[1] References in this brief to "the '592 patent" are to Exhibit 1 to the Declaration of Christine Saunders Haskett in Support of Samsung's Motion for Summary Judgment of Invalidity of U.S. Patent No. 5,545,592 (Dkt. # 145). References to "Hillman" or "the Hillman patent" are to Exhibit 2 of the same declaration.

the general knowledge of one of ordinary skill in the art to recognize that time and temperature can be adjusted to determine whether all of the titanium is converted to silicide. Therefore, even if Dr. Glew's statements and explanations are accepted, Hillman discloses both scenarios: complete conversion and incomplete conversion. One of ordinary skill in the art would therefore read Hillman as disclosing the process claimed in the '592 patent.

Finally, AMD and Dr. Glew ignore important portions of the express disclosure of Hillman in trying to argue that Hillman is ambiguous. In fact, Hillman teaches an alternative method, involving the direct deposition of titanium silicide, that also results in the exposure of titanium silicide to nitrogen ionized in a plasma. When these portions of the disclosure of Hillman are considered, there can be no doubt but that Hillman discloses the precise methods of the '592 patent.

II. ARGUMENT

Claim 1 of the '592 patent recites:

> 1. A method for forming a contact to a semiconductor body, said method comprising the steps of:
> [a.] forming a metal silicide layer on said body;
> [b.] exposing said metal silicide layer to nitrogen ionized in a plasma, thereby converting a portion of said metal silicide layer to a first metal nitride layer;
> [c.] depositing a layer of a second metal nitride over said metal silicide layer, such that said second metal nitride layer overlays and engages said first metal nitride layer; and
> [d.] depositing a layer of a second metal over said second metal nitride layer.

Claim 4 recites:

> 4. The method of claim 1, wherein said metal silicide is titanium silicide, and wherein the second metal nitride is titanium nitride.

Of all of the claim elements above, the only one that AMD disputes is disclosed by Hillman is step [b] of claim 1. And even with respect to that element, AMD concedes that Hillman discloses "nitrogen ionized in a plasma," as well as the conversion of a portion of silicide to a first metal nitride layer. In fact, the only dispute between the parties is whether Hillman discloses the exposure of *titanium silicide*—the "metal silicide" required by the claims—or only *titanium* (which is not a metal silicide) to the "nitrogen ionized in a plasma."

AMD argues that Hillman does not expressly disclose the exposure of titanium silicide to the plasma because when titanium is put down on the silicon wafer using Hillman's method, some

of the titanium allegedly remains unconverted to silicide and therefore remains as a top layer between the silicide and the nitrogen plasma. AMD is incorrect. In fact, there can be no genuine dispute over this issue; all of the evidence demonstrates that Hillman discloses the full conversion of titanium to titanium silicide and therefore the exposure of titanium silicide to nitrogen ionized in a plasma.

A. Hillman Discloses the Conversion of the Entire Layer of Titanium to Titanium Silicide.

AMD's entire argument in opposition to Samsung's motion relies on AMD's expert's description of the technology, rather than the disclosure of the Hillman patent itself. Moreover, AMD's expert's description is unsupported by any relevant evidence whatsoever and runs exactly contrary to the relevant evidence that is available. AMD's expert's conclusions must therefore be disregarded and cannot be relied upon to create a fact dispute where no such dispute actually exists.

Hillman explicitly discloses "depositing titanium onto a silicon surface by PECVD. This will form a layer of titanium silicide." Hillman at 15:30-31. This disclosure describes the deposition of titanium atoms, which then combine with the silicon atoms from the substrate to form titanium silicide. Declaration of Michael Thomas in Support of Samsung's Motion for Summary Judgment ("Thomas Opening Decl.") (Dkt. # 144) ¶¶ 8, 21. In the very next sentence, Hillman describes performing an ammonia plasma anneal, which AMD does not dispute involves exposure to nitrogen ionized in a plasma. Hillman thus could not be more clear: depositing titanium onto a silicon surface forms titanium silicide; the next step exposes that silicide to nitrogen ionized in a plasma.

AMD attempts to obfuscate the issue by arguing that perhaps the entire titanium layer is not converted to titanium silicide. Perhaps, AMD speculates, only the lower portion of the titanium layer is converted to titanium silicide, leaving a surface layer of titanium to be exposed to nitrogen ionized in a plasma. *See* Plaintiffs' Opposition to Samsung's Motion for Summary Judgment of Invalidity of U.S. Patent No. 5,545,592 ("AMD Opp.") at 8, 14-15. AMD's conjecture, however, is belied by Hillman's unambiguous language, which states that exposure to the nitrogen ionized in a plasma "is performed to provide an *upper layer* of nitrided silicide titanium." Hillman at 15:32-33

1 (emphasis added). The fact that an "upper layer" of nitrided silicide is created means that the
2 silicide was on the upper surface and was then nitrided by the nitrogen from the plasma, to create a
3 nitrided silicide layer at the surface. This is exactly what claim 1 of AMD's '592 patent is referring
4 to when it states "converting a portion of said metal silicide layer to a first metal nitride layer."
5 Moreover, when read in the context of the rest of the Hillman disclosure, Samsung's reading
6 of "upper layer of nitrided silicide titanium" is the only plausible interpretation. For example,
7 elsewhere in the patent, the Hillman inventors refer to "nitrided titanium film" to describe the result
8 of nitriding a titanium layer (as opposed to a titanium silicide layer). Hillman at 15:63-16:4. The
9 inventors therefore used one term—nitrided titanium film—to describe what happens when
10 *titanium* is exposed to nitrogen, and a different term—nitrided silicide titanium—to describe what
11 happens when *titanium silicide* is exposed to nitrogen. Reply Declaration of Dr. Michael Thomas
12 in Support of Samsung's Motion for Summary Judgment of Invalidity of U.S. Patent No. 5,545,592
13 ("Thomas Reply Decl.") ¶¶ 6-11.
14 This reading of column 15 of Hillman is also directly supported by the statement at column
15 3 of Hillman that "[t]his will permit PECVD deposition of titanium onto a silicon surface to form
16 titanium suicide [*sic*, silicide] which can be annealed with an ammonia plasma." Hillman at 3:49-
17 52. Again, this is an explicit statement that it is titanium silicide that is exposed to the plasma.
18 AMD devotes an entire section of its brief to trying to argue that this disclosure at column 3 cannot
19 be used to inform the disclosure of column 15, AMD Opp. at 19-21, but AMD's arguments are
20 baseless. The relevant portion of column 3 appears in the section entitled "Summary of the
21 Invention," and there can be no doubt that it is referring to precisely the same method that is
22 described in column 15. *Compare* Hillman at 3:47-53 (referring to the use of "a plasma-enhanced
23 ammonia anneal," "PECVD deposition of titanium," and "PECVD of a titanium nitride layer, all in
24 the same reactor" *with* Hillman at 15:29-35 (referring to the use of "an ammonia plasma anneal,"
25 "depositing titanium onto a silicon surface by PECVD," and noting that "a titanium nitride layer
26 can be deposited by PECVD, again in the same reaction chamber"); Thomas Reply Decl. ¶ 6 n.1.
27 AMD's argument that column 3 is somehow describing a different embodiment than column 15 is
28 entirely unsupported, even by AMD's expert, who stops conspicuously short of saying that columns

3 and 15 describe two different processes. Declaration of Alexander Glew in Support of AMD's Opposition to Samsung's Motion for Summary Judgment of Invalidity of U.S. Patent No. 5,545,592 ("Glew Decl.") ¶ 62; *compare* Reply Declaration of Christine Saunders Haskett in Support of Samsung's Motion for Summary Judgment of Invalidity of U.S. Patent No. 5,545,592 ("Haskett Reply Decl."), Ex. 1 (Glew depo.) at 60:11-23 (admitting that the Summary of the Invention section provides an "overview of the invention") *and* 65:5-24 (admitting that the disclosure in column 3 "is similar" to the disclosure in column 15) *with* AMD Opp. at 20 (alleging that columns 3 and 15 are "unrelated processes" and "disparate disclosures"). Finally, AMD is flat-out wrong that Samsung did not cite Hillman's column 3 in its invalidity contentions. *See*, *e.g.*, Declaration of Jacob Zimmerman in Support of AMD's Opposition to Samsung's Motion for Summary Judgment ("Zimmerman Decl."), Ex. 4 at 1 (Samsung contentions citing Hillman at 3:47-58).

Notwithstanding Hillman's express language, AMD's expert, Dr. Glew, goes to great lengths to describe a scenario under which it might be possible for a silicide to be created below the surface of the titanium, and then, during the exposure to the nitrogen plasma, for the silicon atoms to migrate upwards while the nitrogen atoms migrate downwards, thus eventually meeting to create the nitrided silicide layer. According to Dr. Glew, when Hillman refers to "nitrided silicide titanium," the patent might be referring to this phenomenon of the silicon and the nitrogen atoms "meeting in the middle." Dr. Glew, however, offers no support whatsoever for his opinion that the words "nitrided silicide titanium" might mean this. His opinion regarding the meaning of these words in the Hillman disclosure consists of nothing more than rank speculation, unsupported by any evidence regarding the actual method of Hillman.[2]

In fact, the only relevant evidence regarding the Hillman method, outside of the Hillman patent itself, consists of U.S. Patent No. 5,665,640 ("the '640 patent"), which was filed on the same day as Hillman by the same inventors who filed Hillman. Significantly, the '640 patent discusses

[2] Dr. Glew relies heavily on the statement in Hillman's Abstract that "[w]hen titanium is so deposited over a silicon surface, titanium silicide will form at the juncture . . ." *See, e.g.*, Glew Decl. ¶¶ 32, 37. This statement in the Abstract, however, is merely intended to distinguish the contact, where titanium and silicon meet, from the dielectric, where they do not. Thomas Reply Decl. ¶¶ 22-24. In fact, Dr. Glew confirmed this distinction in his deposition. *See* Haskett Reply Decl., Ex. 1 (Glew depo.) at 21:2-24.

the very same examples as the Hillman patent, including examples showing the deposition of titanium onto silicon surfaces. And the ’640 patent makes the following unambiguous statement:

> In conclusion, titanium films have been deposited by chemical vapor deposition at temperatures of 450ºC. to 550ºC. The titanium is fully converted to $TiSi_2$ during the deposition process for depositions onto silicon surfaces.

Thomas Reply Decl., Ex. A (’640 patent at 30:36-39). This statement says that the titanium layer that is deposited on the silicon is completely converted to silicide, meaning that the surface turns into silicide (ready for exposure to nitrogen plasma). Thomas Reply Decl. ¶¶ 12-17. Furthermore, this statement is referring to the *very same work* that was described and discussed in the Hillman patent. The Hillman inventors ran a series of experiments—including experiments in which titanium was deposited and converted entirely to titanium silicide—and then they used that work as the basis of both the Hillman patent and the ’640 patent. *Id.* ¶¶ 12, 16. Therefore, there can be no dispute that the Hillman patent discloses a method that includes the complete conversion of titanium to silicide. AMD’s argument that the words “nitrided silicide titanium” in the Hillman patent mean something different is therefore specious.

AMD attempts to make much of another patent (the ’496 patent) on which Hillman was the fourth named inventor and that refers to titanium silicide “formed between the silicon surface and the titanium film.” That patent, however, also goes on to refer to “an upper layer of nitrided silicide titanium,” Zimmerman Decl., Ex. 3 (’496 patent at 7:67-8:1), again showing that the titanium fully converts to silicide prior to being nitrided. And the very next paragraph distinguishes “nitrided titanium silicide film” from “nitrided titanium film,” demonstrating that the silicide embodiment of the prior paragraph involved a silicide exposed to nitrogen plasma. *Id.*, Ex. 3 at 8:3-4; Thomas Reply Decl. ¶¶ 18-21. AMD is unable to rebut this evidence, as its expert has formulated no opinion regarding the difference between a “nitrided titanium film,” “nitrided silicide titanium,” and “nitrided titanium silicide film,” as those terms are used in the ’496 patent. Haskett Reply Decl., Ex. 1 (Glew depo.) at 81:7-20, 86:13-88:7, 88:23-89:9. Moreover, the ’496 patent contains no examples and no descriptions of the work discussed in the Hillman patent, so it is necessarily

less relevant to those methods than the ’640 patent, which does provide evidence regarding the precise methods of Hillman and states that all of the titanium is converted to titanium silicide.

Finally, other contemporaneous art also demonstrates that the titanium that is deposited by the Hillman method is fully converted to titanium silicide. In particular, U.S. Patent No. 4,526,665 to Tanielian (issued on July 2, 1985) contains the following statements regarding the deposition of titanium onto silicon:

> In the preferred embodiment, titanium is sputtered onto a silicon substrate. . . . In this embodiment, the silicon wafer can be heated to a relatively high temperature typically in the range of 450º C. to 650ºC. . . . By heating the substrate to a relatively high temperature, the titanium fully reacts with the underlying silicon during deposition to produce titanium silicide. The typical temperature at which fully reacted titanium disilicide is formed is above 500º C.

Thomas Reply Decl., Ex. B at 3:14-27. In light of these statements, and given that the temperatures used by Hillman are higher than the 500º C specified by the Tanielian ’665 patent, AMD has no basis for arguing that the Hillman method does not result in full conversion of titanium to titanium silicide prior to exposure to a plasma. Thomas Reply Declaration ¶¶ 25-27.

Indeed, in light of the conclusive and undisputed evidence showing that Hillman’s titanium layer is fully converted to titanium silicide, the Court should disregard AMD’s expert’s conclusions to the contrary. Every piece of relevant evidence—including the language of Hillman itself, the ’640 patent describing the same work as Hillman, the ’496 patent on which AMD relies, and the ’665 patent—point to an interpretation of “upper layer of nitrided silicide titanium” meaning that it is titanium silicide that is exposed to the nitrogen ionized in a plasma. Dr. Glew’s speculation to the contrary is entirely unsupported and cannot form the basis for a disputed issue of fact.

B. At the Very Least, Hillman Anticipates Both the Scenario in Which the Titanium Is Fully Converted to Silicide and the Scenario in Which It Is Not.

It is undisputed that, given the appropriate time and temperature, titanium deposited on silicon will be fully converted to titanium silicide. The process by which this happens is explained in AMD’s brief:

> The conversion of titanium to titanium silicide is the result of diffusion of the underlying silicon into deposited titanium. During this reaction, silicon molecules from the silicon substrate diffuse, or “migrate” through and react with the titanium to

1 form titanium silicide. Time and temperature play significant roles in the rate at
2 which silicon diffuses through titanium, and along with thickness determine the
resulting quantity of titanium silicide that is formed. ***Given enough time and***
3 ***sufficiently high temperatures, silicon can migrate all the way through the***
titanium—in which case the entire layer of titanium becomes titanium silicide.

4

5 AMD Opp. at 15 (emphasis added) (citations omitted). AMD then goes on to argue that, because
6 "Hillman's column 15 does not describe any of the process variables that define the extent to which
7 titanium silicide will form while Hillman's titanium is being deposited," the silicon does not
8 "'*necessarily*' migrate[] all the way through Hillman's titanium, such that the entire titanium layer
9 is converted to titanium silicide before the ammonia plasma anneal is initiated." *Id.* at 15-16
10 (emphasis added).

11 Therefore, even accepting as true AMD's own statements—and the statements of AMD's
12 expert—it is undisputed that there are only two possible scenarios that could be encompassed by the
13 Hillman method: either the deposited titanium is fully converted to titanium silicide, or it is not
14 fully converted to titanium silicide. Logic dictates that no other option is possible.[3]

15 Whether there is full conversion of titanium to titanium silicide in any particular case, or
16 only partial conversion, will depend on the temperature under which the deposition of titanium is
17 performed and the deposition time. Thomas Reply Decl. ¶ 5; AMD Opp. at 15.; Glew Decl. ¶ 51;
18 Haskett Reply Decl., Ex. 1 (Glew depo.) at 117:5-10. Furthermore, one of ordinary skill in the art
19 would recognize these as the primary factors affecting the conversion of titanium to silicide and
20 would also know how to adjust these factors to increase or decrease the extent of the conversion of
21 titanium to silicide. Thomas Reply Decl. ¶ 5; *see also* Haskett Reply Decl., Ex. 1 (Glew depo.) at
22 110:7-16. Therefore, control over whether there is full conversion, or only partial conversion, of
23 titanium to silicide, is well within the level of ordinary skill in the art. Thomas Reply Decl. ¶ 5.

24 Indeed, the '592 patent itself provides little detail regarding its process, relying instead on
25 the general knowledge of one of ordinary skill in the art. The '592 patent discloses forming

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27 [3] This fact is also demonstrated by the '640 patent, which refers to the full conversion of
titanium to titanium nitride. Thomas Reply Decl., Ex. A at 30:36-39. Even if the '640 patent did
28 not conclusively show that Hillman describes full conversion, at the very least, it demonstrates that
full conversion is one of two possible alternatives. *Id.*

titanium silicide by annealing at "high temperature, typically with rapid thermal anneal (RTA) in the range of 600° C. to 900° C." '592 patent at 1:30-31. No time or other process parameters are disclosed. Thus, the '592 patent assumes that one of ordinary skill in the art knows how to adjust the process parameters, such as temperature and deposition time, to deposit titanium in such a manner that the titanium is fully converted to titanium silicide.

When, as in Hillman, at most only two options exist and both options are within the knowledge and control of one of ordinary skill in the art, both options are considered to be disclosed. *See*, *e.g.*, *Upsher-Smith Labs., Inc. v. Pamlab, LLC*, 412 F.3d 1319, 1322 (Fed. Cir. 2005) (stating that a teaching of vitamin supplements with an "'optional inclusion' of antioxidants teaches vitamin supplement compositions that both do and do not contain antioxidants."); *Alza Corp. v. Mylan Labs., Inc.*, 388 F. Supp. 2d 717, 735 (N.D. W. Va. 2005) (finding that methods of prior art patent that operated in accordance with the asserted claim limitations under only some operating conditions nevertheless anticipated the asserted method claims). Therefore, even accepting AMD's assertion that Hillman is ambiguous as to whether the titanium is fully converted to silicide, Hillman discloses to one of ordinary skill in the art *both* of the two possible alternatives: the one in which there is full conversion of titanium to silicide and the one in which there is not. As such, Hillman anticipates the claims of the '592 patent that disclose a method in which there is full conversion of the titanium to silicide. *Hewlett-Packard Co. v. Mustek Sys., Inc.*, 340 F.3d 1314, 1326 (Fed. Cir. 2003) ("[A] prior art product that sometimes, but not always, embodies a claimed method nonetheless teaches that aspect of the invention.").

Finally, AMD's focus on whether Hillman's process "necessarily" fully converts titanium to titanium silicide is misplaced. *See* AMD Opp. at 15-16. Samsung is not arguing that Hillman anticipates the claims of the '592 patent under principles of inherency. Rather, Hillman, *as interpreted by AMD* and as understood by one of ordinary skill in the art, discloses both a method for forming contacts in which titanium silicide is exposed to a plasma, as well as a method in which titanium is exposed to a plasma. *See ArthroCare Corp. v. Smith & Nephew, Inc.*, 406 F.3d 1365, 1373-74 (Fed. Cir. 2005) ("[E]ven if a piece of prior art does not expressly disclose a limitation, it anticipates if a person of ordinary skill in the art would understand the prior art to disclose the

limitation and could combine the prior art description with his own knowledge to make the claimed invention.") (citing *Helifix Ltd. v. Blok-Lok, Ltd.*, 208 F.3d 1339, 1347 (Fed. Cir. 2000)). Significantly, nowhere does Hillman state a preference for either of these scenarios; under AMD's interpretation, both scenarios are acceptable, both scenarios are known to one of ordinary skill in the art, and Hillman is indifferent as to which one is used. And this indifference is entirely justified; even AMD acknowledges that both scenarios ultimately lead to the same result. Glew Decl., Ex. A, final frame.

C. Hillman Discloses Directly Depositing Titanium Silicide onto the Substrate.

Finally, Hillman discloses more than one method of forming a titanium silicide layer on the silicon substrate. While the discussion above, and all of AMD's arguments, concentrate on the two-step method of depositing titanium on silicon and then heating it to convert it to titanium silicide, Hillman also discloses a one-step method by which titanium silicide is deposited directly onto the substrate. *See*, *e.g.*, Hillman patent at 7:45-60; Thomas Reply Decl. ¶ 28.

Indeed, in the passage (Hillman at 15:20-28) immediately preceding the passage describing the method that anticipates the claims of the '592 patent (*id.* at 15:29-42), Hillman expressly refers to the direct deposition of titanium silicide onto the substrate: "The procedures previously described for deposition of individual layers of tungsten, titanium, titanium nitride, or titanium silicide are employed to deposit a first layer onto the substrate followed by a different second layer. . . . Optimally, additional layers can be deposited. When advantageous, an ammonia anneal would be used." *Id.* at 15:21-28. When this passage is read in conjunction with the next paragraph, what is disclosed is the direct deposition of a titanium silicide layer, followed by the exposure of that silicide layer to the ammonia plasma.[4] Thomas Reply Decl. ¶ 28. For this additional reason, therefore, Hillman anticipates claims 1 and 4 of the '592 patent.

In the alternative, Hillman renders claims 1 and 4 obvious in light of these passages. "Combining two embodiments disclosed adjacent to each other in a prior art patent does not require a leap of inventiveness." *Boston Scientific Scimed, Inc. v. Cordis Corp.*, 554 F.3d 982, 991 (Fed.

[4] AMD's expert admits a connection between the two paragraphs. Haskett Reply Decl., Ex. 1 (Glew depo.) at 48:3-20.

Cir. 2009) (finding a claim obvious in view of features in two separate embodiments, depicted in different figures, of a single prior art patent). One of skill in the art would know to replace Hillman's two-step titanium silicide formation technique (Hillman at 15:29-31) with the one-step deposition technique suggested in the immediately preceding paragraph (Hillman at 15:21-25). Thomas Reply Decl. ¶ 29. There can be no dispute that forming the titanium silicide layer in a single deposition step would guarantee that the subsequent ammonia plasma step would expose the titanium silicide layer to nitrogen ionized in a plasma, as required by claims 1 and 4 of the '592 patent. *Id.* At minimum, then, Hillman renders claims 1 and 4 obvious.

III. CONCLUSION

Based on the foregoing, Samsung respectfully requests that its motion for summary judgment of invalidity of the '592 patent be granted.

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