• The opinion in support of the decision being entered today was *not* written for publication and is *not* binding precedent of the Board.

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Ex parte Robert P. Meagley, Kevin P. O'Brien,
Tian-An Chen, Michael D. Goodner,
James Powers and Huey-Chiang Liou

Appeal No. 2006-0367
Application No. 10/353,506

ON BRIEF

Before McKELVEY, *Senior Administrative Patent Judges*; BARRY and LEVY, *Administrative Patent Judges*.

BARRY, *Administrative Patent Judge*.

A. INTRODUCTION

A patent examiner finally rejected claims 17-20, 26, and 27. The appellant appeals therefrom under 35 U.S.C. § 134(a). We affirm.

B. FINDINGS OF FACT ("FOF")

INVENTION

1. The invention concerns semiconductor structures. (Spec., p. 1, ll. 2-3.)

2. A complementary metal oxide semiconductor ("CMOS") device is formed by a combination of lithographic and etching techniques. (*Id.* at ll. 4-6.)

3. An interlayer dielectric ("ILD") material is deposited around the structures (e.g., transistors) and between the interconnections that constitute the CMOS device "for the purpose of establishing a dielectric constant." (*Id.* at ll. 14-18.)

4. The dielectric constant effects the speed at which signals propagate through the interconnections. (*Id.* at ll. 18-20.)

5. The appellants have found that air gaps feature the lowest dielectric constant. (*Id.* at ll. 21-24.)

6. Accordingly, the appellants' invention is a method for forming air gaps in semiconductor structures. (*Id.* at p. 2, ll. 10-11.)

REJECTIONS

7. Claims 17-20 and 26 stand rejected under 35 U.S.C. § 103(a) as obvious over U.S. Patent No. 6,610,593 ("Kohl") and U.S. Patent No. 6,652,922 ("Forester").

8. Claims 17 and 27 stand rejected under § 103(a) as obvious over Kohl and U.S. Patent No. 6,159,842 ("Chang").

REPRESENTATIVE CLAIM

9. "When multiple claims subject to the same ground of rejection are argued as a group by appellant[s], the Board may select a single claim from the group of claims that are argued together to decide the appeal with respect to the group of claims as to the ground of rejection on the basis of the selected claim alone. Notwithstanding any other provision of this paragraph, the failure of appellant[s] to separately argue claims which appellant[s] has grouped together shall constitute a waiver of any argument that the Board must consider the patentability of any grouped claim separately." 37 C.F.R. § 41.37(c)(1)(vii) (Sep. 30, 2004).

10. Here, the appellants argue the rejected claims as a group. (Appeal Br. at 9-10; Reply Br. at 1-3.) We select claim 17 from the group as representative of the claims therein.

11. Claim 17 follows, with references to corresponding element of the appellants' figures or passages of his specification added thereto:

> 17. A method comprising:
>
> covering a semiconductor structure [15] with a thermally decomposing layer [14];
>
> forming a cover [12] including spin-on glass over said thermally decomposing layer [14];
>
> densifying [sic] the cover [12]; and
>
> thermally decomposing the thermally decomposing layer [14] underneath said cover [12].

12. According to the appellants' specification (p. 4, l. 16 - p. 5, l. 2.), the cover "layer 12 may be sufficiently porous to facilitate the exhaustion of the decomposed sacrificial layer 14 upon heating. A thin layer of hydrogen silsesquioxane (HSQ) or methylsilsesquioxane (MSQ) spin-on glass (SOG) may be utilized as the capping layer 12."

13. "After being cured, the HSQ or MSQ layer 14 may be exposed to electron beam or plasma conditions to densify the HSQ or MSQ film to be like a silicon dioxide film." (Spec., p. 5, ll. 2-5.)

PRIOR ART

14. Kohl is prior art under 35 U.S.C. § 102(e).

15. No attempt has been made to antedate Kohl.

16. Kohl "provides a method of forming an air gap or gaps (or multi level structures having such gaps) within . . . semiconductor structures to reduce capacitive coupling between [the structure's] electrical elements such as metal lines." Col. 3, ll. 21-25.

17. More specifically, "a patterned layer of sacrificial material 30 is formed on a substrate 32," col. 16, ll. 38-39; "the substrate may be a semiconductor wafer which may, for example, contain transistors, diodes, and other semiconductor elements (as are well known in the art)." *Id.* at ll. 45-47.

18. "[A] permanent dielectric 36 is deposited over the patterned layer of sacrificial material 30. . . . The permanent dielectric 36 is deposited as a solid layer and covers the sacrificial layer 30. . . ." Col. 17, ll. 7-10.

19. "The permanent dielectric layer may be deposited by spin coating. . . ." *Id.* at ll. 14-15.

20. "The sacrificial material 30 is removed through the permanent dielectric layer 36 to form the air gaps 38 as shown in FIG. 2F. The removal of the sacrificial material is . . . accomplished by thermal decomposition and passage of one or more of the decomposition products through the permanent dielectric layer 36 by diffusion." *Id.* at ll. 28-33.

21. Kohl does not expressly mention densifying its permanent dielectric cover 36.

22. Forester is prior art under 35 U.S.C. § 102(e).

23. No attempt has been made to antedate Forester.

24. Forester "relates to electron-beam processed films for microelectronics structures, such as integrated circuits ('IC'). More particularly, [its] invention relates to an improvement in the method of processing such films which results in uniform, dense films, some of which also possess a low dielectric constant and a low wet etch rate." Col. 1, ll. 13-18.

25. "The electron-beam processed films of [Forester's] invention not only **advantageously** form a dense, uniform coating on substrates, but also electron beam cured SOG films possess a dielectric constant which is significantly lower than that reported for similar compositions which were thermally treated at high temperatures. Moreover, the time and temperature for processing such films is significantly reduced." Col. 3, ll. 26-32 (emphasis added).

26. Because Kohl describes a semiconductor structure that includes a permanent dielectric cover 36; and Forester explains that processing with an electron-beam offers the advantages of a more dense, uniform coating, a lower dielectric constant, and a reduction in time and temperature for processing; one skilled in the art would have been motivated to use an electron-beam to process a semiconductor structure that includes a permanent dielectric cover.

27. A person of ordinary skill in the art would have recognized that such processing would have made the permanent dielectric cover more dense.

28. Chang is prior art under § 35 U.S.C. § 102(b).

29. Chang "relates to a method for making integrated circuits on semiconductor substrates . . . using a hybrid low-k (low dielectric constant) intermetal dielectric (IMD) layer that reduces the RC time delays." Col. 1, ll. 9-14.

30. Chang identifies a problem with porous insulators. Specifically, "low-k insulators [that] are . . . very porous . . . do not provide good structural support for integration. Further, absorbed moisture and other chemicals in the porous insulator can cause corrosion of the metal lines." *Id.* at ll. 55-59.

31. Chang solves the problem by a plasma treatment. Specifically, a "low-k insulator 18 is plasma treated, for example, with argon or nitrogen to densify the top surface 19 of layer 18. . . ." Col. 4, ll. 41-43.

32. Because Kohl describes a semiconductor structure that includes a permanent dielectric cover 36, i.e., an insulating cover; and Change explains that plasma treatment of an insulator makes the insulator denser, and a denser insulator provides good structural support for integration and resists moisture and other chemicals that can corrode metal lines; one skilled in the art would have been motivated

to apply a plasma treatment to a semiconductor structure that includes a permanent dielectric cover.

33. A person of ordinary skill in the art would have recognized that such processing would have made the permanent dielectric cover more dense.

34. The references establish the level of ordinary skill in the art. *See In re GPAC Inc.,* 57 F.3d 1573, 1579, 35 USPQ2d 1116, 1121 (Fed. Cir. 1995) (finding that the Board of Patent Appeals and Interference did not err in concluding that the level of ordinary skill was best determined by the references of record); *In re Oelrich*, 579 F.2d 86, 91, 198 USPQ 210, 214 (CCPA 1978) ("[T]he PTO usually must evaluate ... the level of ordinary skill solely on the cold words of the literature.").

C. DISCUSSION

With the aforementioned findings of fact, in mind, rather than reiterate the positions of the appellants *in toto*, we focus on their three points of contention:

- motivation to combine teachings of Kohl and Forester
- motivation to combine teachings of Kohl and Chang
- alleged disincentive to densify.

1. MOTIVATION TO COMBINE TEACHINGS OF KOHL AND FORESTER

The appellants argue that "the only thing in Forester that could be considered with respect to the rationale to use densification here would be a vague reference to uniformity." (Appeal Br. at 9.)

"The presence or absence of a motivation to combine references in an obviousness determination is a pure question of fact." *In re Gartside*, 203 F3d 1305, 1316, 53 USPQ2d 1769, 1776 (Fed. Cir. 2000) (citing *In re Dembiczak*, 175 F.3d 994, 1000, 50 USPQ2d 1614, 1617 (Fed. Cir. 1999)). A suggestion to combine teachings from the prior art "may be found in explicit or implicit teachings within the references themselves, from the ordinary knowledge of those skilled in the art, or from the nature of the problem to be solved." *WMS Gaming Inc. v. Int'l Game Tech.*, 184 F.3d 1339, 1355, 51 USPQ2d 1385, 1397 (Fed. Cir. 1999) (citing *In re Rouffet*, 149 F.3d 1350, 1355, 47 USPQ2d 1453, 1456 (Fed. Cir. 1998)).

Here, we have found that Forester describes a dense, uniform coating as advantageous. (FOFs 23-24.) We have further found that the electron beam processing described by Forester offers additional advantages of a lower dielectric constant and a reduction in time and temperature for processing. (*Id.*) We have also found that these advantages would have motivated one skilled in the art to use an electron-beam to process a semiconductor structure that includes a dielectric cover. (*Id.*, 24.)

2. MOTIVATION TO COMBINE TEACHINGS OF KOHL AND CHANG

The appellants argue that "there is no reason to densify in this specific case based on anything pointed to in the Chang reference." (Appeal Br. at 10.)

We have found that Chang identifies a problem with porous insulators, (FOF 28), and describes a solution to that problem, viz., a plasma treatment. (FOF 29.) We have also found that Chang explains that plasma treatment of an insulator offers the advantages of a denser insulator, which provides good structural support for integration and resists moisture and other chemicals that can corrode metal lines. (FOF 30.) We have further found that these advantages would have motivated one skilled in the art to use an electron-beam to process a semiconductor structure that includes a dielectric cover. (*Id.*)

3. ALLEGED DISINCENTIVE TO DENSIFY

The appellants argue that "one skilled in the art would be skeptical about densifying the material since one skilled in the art would believe that densifying it would have made it more difficult for the underlying material to escape." (Appeal Br. at 9.) In addressing the point of contention, we conduct a two-step analysis. First, we construe the representative claim at issue to determine its scope. Second, we determine whether the subject matter of the construed claim would have been obvious.

a. Claim Construction

"Analysis begins with a key legal question — *what* is the invention *claimed*?" *Panduit Corp. v. Dennison Mfg. Co.*, 810 F.2d 1561, 1567, 1 USPQ2d 1593, 1597 (Fed. Cir. 1987). In answering the question, "the PTO gives claims their 'broadest reasonable interpretation.'" *In re Bigio*, 381 F.3d 1320, 1324, 72 USPQ2d 1209, 1211 (Fed. Cir. 2004) (quoting *In re Hyatt*, 211 F.3d 1367, 1372, 54 USPQ2d 1664, 1668 (Fed. Cir. 2000)). Furthermore, "[u]nless the steps of a method actually recite an order, the steps are not ordinarily construed to require one." *Interactive Gift Express Inc. v. Compuserve Inc.,* 256 F.3d 1323, 1342, 59 USPQ2d 1401, 1416 (Fed. Cir. 2001) (citing *Loral Fairchild Corp. v. Sony Corp*., 181 F.3d 1313, 1322, 50 USPQ2d 1865, 1870 (Fed. Cir. 1999)).

Here, claim 17 recites in pertinent part the following limitations: "forming a cover including spin-on glass over said thermally decomposing layer; densifying the cover; and thermally decomposing the thermally decomposing layer underneath said cover." Although the step of densifying happens to have been inserted before the step of thermally decomposing, (Reply to Paper No. 6, p. 2), the claim language does not require this order (as it would if the claim instead recited "thermally decomposing the thermally decomposing layer underneath said **densified** cover"). The rest of the specification, (FOF 12-13), moreover, favors performing the step of densifying after the step of thermally decomposing.

Assuming that the representative claim was interpreted to require performing the step of densifying before the step of thermally decomposing, moreover, we would interpret it to limit densification so as not to prevent thermally decomposition of the sacrificial layer underneath the cover. Any other interpretation would render the step of thermally decomposing, and hence the claimed method, inoperable. We decline to adopt an interpretation that would render the claimed subject matter inoperable. Giving claim 17 its broadest, reasonable construction, therefore, the limitations require forming a cover over a sacrificial layer, thermally decomposing sacrificial layer, and densifying the cover.

b. Obviousness Determination

Having determined what subject matter is being claimed, the next inquiry is whether the subject matter would have been obvious. The question of obviousness is "based on underlying factual determinations including . . . what th[e] prior art teaches explicitly and inherently. . . ." *In re Zurko*, 258 F.3d 1379, 1383, 59 USPQ2d 1693, 1696 (Fed. Cir. 2001) (citing *Graham v. John Deere Co.*, 383 U.S. 1, 17-18, 148 USPQ 459, 467 (1966); *In re Dembiczak*, 175 F.3d 994, 998, 50 USPQ 1614, 1616 (Fed. Cir. 1999); *In re Napier*, 55 F.3d 610, 613, 34 USPQ2d 1782, 1784 (Fed. Cir. 1995)). Of course, "'[e]very . . . reference relies to some extent upon knowledge of persons skilled in the art to complement that [which is] disclosed. . . .'" *In re Bode*, 550 F.2d 656, 660, 193 USPQ 12, 16 (CCPA 1977) (quoting *In re Wiggins*, 488 F.2d 538, 543, 179 USPQ 421, 424 (CCPA 1973)). Those persons "must be presumed to know something" about the art "apart from what the references disclose." *In re Jacoby*, 309 F.2d 513, 516, 135 USPQ 317, 319 (CCPA 1962).

Here, we have found that Kohl forms a cover over a sacrificial layer, (FOF 17), and then thermally decomposing the sacrificial layer. (FOF 19.) We have further found that Forester and Chang describe electron beam processing and plasma treatment, respectively, (FOF 22, 29), either of which would have densified the cover. (FOF 25, 31.) We have also found motivation to perform the beam processing and plasma treatment as summarized regarding the first two points of contention, *supra*. We further

find that the combined teachings of the references would have suggested forming a cover over a sacrificial layer, thermally decomposing sacrificial layer, and densifying the cover.

Assuming that the representative claim was interpreted to require performing the step of densifying before the step of thermally decomposing, moreover, we find that persons skilled in the art would have known to limit densification so as not to prevent thermally decomposition of the sacrificial layer underneath the cover. Consequently, we find that the combined teachings of the references, complemented by the knowledge of persons skilled in the art, would have suggested forming a cover over a sacrificial layer, densifying the cover so as not to prevent thermally decomposition of the sacrificial layer underneath the cover, and then thermally decomposing the sacrificial layer. Therefore, we affirm the rejections of claim 17 and of claims 18-20, 26, and 27, which fall therewith.

D. CONCLUSION

In summary, the rejections of claims 17-20, 26, and 27 under § 103(a) are affirmed.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a)(1)(iv).

AFFIRMED

FRED E. McKELVEY Senior Administrative Patent Judge	)	
LANCE LEONARD BARRY Administrative Patent Judge	)	BOARD OF PATENT APPEALS AND INTERFERENCES
STUART S. LEVY Administrative Patent Judge	)	

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