

THIS OPINION WAS NOT WRITTEN FOR PUBLICATION

The opinion in support of the decision being entered today (1) was not written for publication in a law journal and (2) is not binding precedent of the Board.

Paper No. 26

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte MITSURU TAGUCHI and KAZUHIDE KOYAMA

Appeal No. 1996-2088
Application No. 08/082,432¹

ON BRIEF

Before GARRIS, OWENS, and SPIEGEL, *Administrative Patent Judges*.

SPIEGEL, *Administrative Patent Judge*.

¹ Application for patent filed June 28, 1993. According to appellants, this application is a continuation of Application 07/844,128, filed March 2, 1992, now abandoned.

DECISION ON APPEAL

This is a decision on appeal under 35 U.S.C. § 134 from the decision of the examiner finally rejecting claims 16 through 22 and 24 and refusing to allow claim 23 as amended subsequent to the final rejection, which are all of the claims pending in this application.²

Claims 16, 19 and 22 are illustrative:

16. A metallization method comprising the steps of:
forming a contact hole in an insulating film on a substrate;
forming a barrier metal layer on at least a bottom and a sidewall of the contact hole, said barrier metal layer comprising a composite titanium/titanium oxynitride/titanium layer; and then
depositing a layer of aluminum-based material directly on the uppermost titanium layer in the contact hole while heating the substrate at a temperature of 450EC to 550EC to fill the contact hole.

19. A metallization method comprising the steps of:
forming at least one contact hole in an insulating film on a substrate;
forming a barrier metal layer on at least a bottom and a sidewall of the contact hole, said barrier metal comprising a composite titanium/titanium oxynitride/titanium layer;
depositing a first layer of aluminum-based material directly on the uppermost titanium layer of the barrier metal layer without heating the substrate, said first layer having a thickness less than enough to completely fill the contact hole; and then
depositing a second layer of aluminum-based material in the contact hole while heating the substrate at a temperature of 450EC to 550EC to completely fill the contact hole.

²The amendment filed April 19, 1995 (Paper No. 16), amending claim 23, was entered by the examiner in the advisory action mailed May 8, 1995 (Paper No. 17).

22. A metallization method comprising the steps of:
forming at least one contact hole in an insulating film on a substrate;
forming a barrier metal layer structure on at least a bottom and sidewall of the hole by depositing a first titanium layer on the sidewall and bottom, forming a titanium oxynitride layer on the first titanium layer and then depositing a second titanium layer on the titanium oxynitride layer; and then
depositing an aluminum-based material directly on the second titanium layer in the contact hole.

The examiner relies upon the following references as evidence of obviousness:

| | | |
|----------------------------------|-----------|----------------------------------------|
| Tracy et al. (Tracy) | 4,970,176 | Nov. 13, 1990 |
| Sugano et al. (Sugano) | 5,290,731 | Mar. 01, 1994 (filed Mar. 09, 1992) |
| Madokoro ³ (Kokai) | 1-160036 | Jun. 22, 1989 |

Hu et al. (Hu), "Dry etching of TiN/Al(Cu)/Si for very large scale integrated local interconnections," 8 *Journal of Vacuum Science and Technology A*, 3, 1498-1502 (May/June 1990).

Maeda et al. (Maeda), "Effects of Ti Interlevel Existence in Al/Ti/TiN/Ti Structure for Highly Reliable Interconnection," 1985 *Symposium on VLSI Technology*, IEEE CAT. No. 85, CH 2125-3, 50-51 (May 14-16, 1985/Kobe).

In addition to the foregoing prior art references, the examiner has also relied upon the admitted prior art set forth and described by appellants on pages 1-4 of the specification (hereinafter referred to as APA) (answer, page 3).

ISSUES

³We refer in our opinion to the translation of Madokoro prepared for the PTO by Fls, Inc., in April 1993, a copy of which is attached to this decision.

Appeal No. 1996-2088
Application No. 08/082,432

Claim 22 stands rejected under 35 U.S.C. § 112, first paragraph, as based on a nonenabling disclosure. Claims 16-24 stand rejected under 35 U.S.C. § 103 as being unpatentable over (A) Maeda or Hu in view of (B) APA and (C) either Tracy or Madokoro. Claims 16-24 stand rejected under the judicially created doctrine of obviousness-type double patenting over claims 1, 2 and 5-7 of Sugano in view of either Tracy or Madokoro.

We reverse the § 112, first paragraph (enablement) rejection. We affirm-in-part the § 103 and obviousness-type double patenting rejections.

In reaching our decision in this appeal, we have given careful consideration to the appellants' specification and claims and to the respective positions articulated by the appellants and the examiner. We make reference to the examiner's answer (Paper No. 20, mailed September 11, 1995) for the examiner's reasoning in support of the rejection and to the appellants' brief (Paper No. 19, filed July 24, 1995) and the appellants' reply brief (Paper No. 21, filed November 16, 1995) for the appellants' arguments thereagainst.

According to appellants, the claims are divided into three groups: (I) claim 22, (II) claims 16-18 and 23, and (III) claims 19-21 and 24 (reply brief, page 1). Therefore, we decide this appeal on the basis of claims 16, 19 and 22. 37 C.F.R. § 1.192(c)(7)(1995).

THE INVENTION

Appellants' claimed invention is directed to a metallization method used in the preparation of a silicon substrate semiconductor device comprising the steps of forming a contact hole, providing a Ti/TiON/Ti three-layer barrier metal structure and forming a layer of Al-based material thereon by either a one-stage process (i.e., by sputtering Al-based material while heating the substrate to a temperature in the range of 450EC to 550EC at a rate not greater than 0.6 μm per minute) or a two stage process (i.e., by sputtering a first layer of Al-based material without heating the substrate followed by sputtering additional Al-based material while heating the substrate to a temperature in the range of 450EC to 550EC to obtain the total layer) (brief, pages 2-3; specification, pages 1 and 4).

OPINION

I. Enablement of claim 22

According to the examiner, the instant disclosure only enables aluminum deposition at a high temperature (answer, page 3).⁴ Here, Example 2 on page 10 (para. 3) of the specification discloses depositing an Al-based layer on a Ti/TiON/Ti barrier metal layer without heating.

⁴The examiner cited "M.P.E.P. §§ 706.03(n) and 706.03(z)" (answer, page 3). These sections are entitled "Correspondence of Claim and Disclosure" and "Undue Breadth," respectively, and last appeared in the Sixth Edition of the MPEP. (Jan. 1995). See Rev. 1 of the Sixth Edition of the MPEP (Sept. 1995). We observe that both of these section remained unchanged since at least Rev. 6 of the Fifth Edition of the MPEP (Oct. 1987). Neither section refers to 35 U.S.C. § 112, first paragraph, in whole or by requirement, and thus we will not further refer in this decision to either of these MPEP sections.

Appeal No. 1996-2088
Application No. 08/082,432

A specification of a patent application is presumed to comply with the enablement requirement of 35 U.S.C. § 112, first paragraph. An examiner may reject claims in a patent application on the basis of an alleged failure of the applicant to comply with the enablement requirement if the examiner can establish by a preponderance of the evidence that there is reason to doubt the objective truth of the statements contained in the specification. *In re Marzocchi*, 439 F.2d 220, 223-24, 169 USPQ 367, 369-70 (CCPA 1971). In our opinion, the examiner has not sustained his burden for making the enablement rejection. The examiner cites no evidence and makes no analysis of the kind which the Federal Court approved in *In re Wands*, 858 F.2d 731, 737, 8 USPQ2d 1400, 1404 (Fed. Cir. 1988) (discussion of factors to be considered in determining whether undue experimentation would be necessary to justify broad claim). Moreover, the examiner has failed to establish that any **essential** step has been omitted from the claimed invention. The mere fact that other steps have been disclosed in the preferred embodiment does not render each and every step thereof an **essential** step. Therefore, the rejection under 35 U.S.C. § 112, first paragraph, is reversed.

II. Obviousness

To establish a *prima facie* case of obviousness, there must be both some suggestion or motivation to modify the reference or combine reference teachings and a reasonable expectation of success. Furthermore, the prior art must teach or suggest all the claim limitations. *In re Vaeck*, 947 F.2d 488, 493, 20 USPQ2d 1438, 1442 (Fed. Cir. 1991).

Maeda discloses forming a Ti layer on each side of a TiN layer in a conventional Al/TiN metallization process to suppress Al electromigration, especially at contact holes, which occurs in the Al/TiN structure (page 50, col. 2, para. 1-2). Hu discloses an Al(Cu)/Ti/TiN/Ti structure, noting that the Ti serves to reduce contact resistance between metal silicide and the Al(Cu) conductor, to enhance electromigration resistance and to provide better adhesion to dielectric materials while the TiN layer is used as a diffusion barrier layer between Al and Si (para. bridging pages 1498-99). As recognized by the examiner, “[n]either Maeda nor Hu et al. teach a TiON layer or a two layer Al structure” (answer, page 4).

The APA, i.e., the “BACKGROUND OF THE INVENTION” section of the specification, acknowledges both that Ti/TiN and Ti/TiON structures have been used as barrier metal layers between a silicon (Si) substrate and an Al-based material because Ti alone does not function as an effective barrier (i.e., Al spikes onto the Si substrate); and, that oxygenating during deposition of the TiN layer (i.e., forming a TiON layer) has been proposed to further suppress Al migration in the TiN grain boundary (para. bridging pages 2-3).

Tracy discloses a two-step metallization process comprising depositing a first portion of predetermined thickness of a metal on a semiconductor device having a via (i.e., contact hole) at a cold temperature of approximately less than 200EC, wherein the first portion is of sufficient thickness to form a continuous metal layer in the via at a high temperature of approximately 400EC to 500EC, increasing

the temperature to the high temperature, and depositing a second portion of the metal on the wafer to obtain the desired thickness (col. 3, line 52 - col. 4, line 27), thereby improving metal step coverage (abstract). Madokoro also discloses a two-step metallization process comprising depositing a first Al-based material layer without heating on a silicon substrate having a contact hole and then depositing a second Al-based material layer by bringing the effective substrate temperature to 420-450EC (page 5, first full para.), which process obviates ohmic defects and improves resistance against stress migration (page 4, first full para.)..

According to the examiner, it would have been obvious to one of ordinary skill in the art to substitute a TiON layer for the TiN layer of either Maeda or Hu as recited in claims 22, 19 and 16 because TiON has improved Al migration resistance compared to TiN as suggested by the APA (answer, page 8).

a. claim 22

Appellants argue (1) claim 22 requires depositing an aluminum layer on a Ti/TiON/Ti barrier layer without heat and (2) a lack of motivation to combine because the APA did not recognize a three-layer barrier structure and because the APA taught, as far as a two layer barrier structure, that TiON is unsatisfactory when using deposition at a high temperature (brief, page 8; reply brief, page 3). First, claim 22 neither precludes nor requires a high temperature Al layer deposition step (answer, page 7). Second, the test for obviousness is based on the combined teachings of the applied references as a

whole. *In re Keller*, 642 F.2d 413, 425, 208 USPQ 871, 881 (CCPA 1981). Here, Maeda and Hu both disclose a three-layer barrier structure comprising a TiN layer for the purpose of suppressing Al migration/diffusion and the APA suggests oxygenating the TiN layer, i.e., using a TiON layer, to further suppress Al migration in the TiN grain boundary. Admittedly, the APA does disclose that high temperature bias sputtering produces a non-uniform deposition of an Al-based material on a Ti/TiON structure because of a tendency for voids to be produced (specification, page 3, first full para.). However, claim 22 does not require high temperature bias sputtering deposition of an Al-based material or deposition onto a TiON layer (answer, pages 7-8). Moreover, Tracy explicitly addressed the high temperature deposition voiding problem (recognized at col. 1, line 55 - col. 2, line 3) by his disclosed method which “favors a filled via rather than the formation of a void” (col. 4, lines 39-43). Therefore, we agree with the examiner that one of ordinary skill in the art would have been motivated by the **combined** teachings of the applied references to substitute TiON for the TiN layer in the barrier structure of Maeda or Hu to further suppress Al migration in the barrier structure as suggested by the APA. Arguments drawn to the incompatibility with and/or use of a high temperature Al-based material deposition step are not only not commensurate in scope with the claimed invention, but also ignore the explicit teachings of Tracy for addressing the problem of voiding in high temperature metal depositions. Thus, these arguments are insufficient to overcome the rejection.

b. claim 19

Appeal No. 1996-2088
Application No. 08/082,432

According to the examiner, it would have been obvious to one of ordinary skill in the art to substitute the two-layer Al metal of Tracy or Madokoro for the single layer Al metal of Maeda or Hu to improve step coverage (Tracy) and increase stress migration resistance (Madokoro) (answer, para. bridging pages 4-5).

Appellants again argue there is no motivation to make the various substitutions as proposed (reply brief, pages 4-5) absent a hindsight reconstruction based on appellants' disclosure (brief, pages 8-9). We note that any judgment on obviousness is in a sense necessarily a reconstruction based upon hindsight reasoning, but so long as it takes into account only knowledge which was within the level of ordinary skill at the time the claimed invention was made, and does not include knowledge gleaned only from the applicant's disclosure, such a reconstruction is proper. See *In re McLaughlin*, 443 F.2d 1392, 1395, 170 USPQ 209, 212 (CCPA 1971). We believe that to be the case here. For the reasons set forth above, we find that one of ordinary skill in the art would have been motivated to combine the references as suggested by the examiner. Thus, these arguments are insufficient to overcome the rejection.

c. claim 16

As noted by the examiner, claim 16 requires “that Al is to be deposited in a single high temperature (450-550 EC) step” (answer, page 9).

However, as argued by appellants, Maeda and Hu are silent as to how the Al is deposited and Tracy and Madokoro teach away from a single step deposition of Al while heating the substrate to a temperature of 450E to 550EC (brief, pages 7-8; reply brief, pages 3-4) because “use of higher deposition temperatures causes unpredictable voiding or discontinuities in the metal layer” (Tracy, col. 1, lines 32-34) and because Madokoro teaches a *lower* substrate temperature, i.e., 400EC *or less*, for improving step coverage (page 3, top para.). Thus, this rejection is reversed.

To summarize, the § 103 rejection of claims 19-22 and 24 is sustained, the § 103 rejection of claims 16-18 and 23 is reversed.

III. Obviousness-type double patenting

In obviousness-type double patenting rejections, one must determine whether the claims of the later filed application would have been obvious in view of the claims of the earlier patent. *In re Goodman*, 11 F.3d 1046, 1052, 29 USPQ2d 2010, 2015 (Fed. Cir. 1993). Any analysis employed parallels the guidelines for analysis of a § 103 obviousness determination. *In re Longi*, 759 F.2d 887, 892-93, 225 USPQ 645, 648 (Fed. Cir. 1985).

Claims 1, 2 and 5-7 of Sugano are directed to a metallization process comprising providing a connecting hole (i.e., contact hole) in an insulating film on a substrate, forming a three-layer barrier

Appeal No. 1996-2088
Application No. 08/082,432

metal layer comprising Ti/one of TiON, TiN or TiW/Ti thereon, and then depositing a layer of an Al-based material thereon. According to the examiner, Sugano differs in failing to specify the specifics of the metal Al deposition but it would have been obvious to substitute the two-layer Al metal of Tracy or Madokoro in the method of Sugano to improve step coverage (Tracy) and increase stress migration resistance (Madokoro) (answer, para. bridging pages 5-6).

As noted above, the analysis of obviousness-type double patenting parallels the obviousness determination outlined above for the rejection under 35 U.S.C. § 103, except that the claims of the earlier filed patents form the basis for the obviousness determination. If the application is the later filed case or both the application and the patented cases are filed on the same day, only a one-way determination in which the examiner asks whether the application claims are obvious over the patent claims is needed in resolving the issue of patentability. Similarly, as here, even if the application at issue is the earlier filed case, only a one-way determination of obviousness is needed to support a double patenting rejection, in the absence of a finding of administrative delay on the part of the Patent and Trademark Office (PTO) causing delay in prosecution of the application at issue, i.e., the earlier filed case. Thus, a two-way test need only be applied when there is administrative delay. In the absence of administrative delay, a one-way test is appropriate.

Appellants argue that the patented claims are not obvious over the appealed claims (brief, page 11), i.e., that a two-way test is required in the present case, and that *Goodman* does not apply

Appeal No. 1996-2088
Application No. 08/082,432

because there is no genus/species relationship between the pending/patented claims (reply brief, page 5). However, appellants have not established that the later filed application issued to a patent before the present application as a result of delay entirely within the control of the PTO. No such argument has been advanced by appellants. Thus, a one-way test to determine obviousness-type double patenting is appropriate.

Here, we agree with the examiner that claims 22 and 19, but *not* claim 16, would have been obvious over claims 1, 2 and 5-7 of Sugano in combination with Tracy or Madokoro for the reasons set forth above in the § 103 obviousness discussion. Therefore, the obviousness-type double patenting rejection of claims 19-22 and 24 is sustained and the obviousness-type double patenting rejection of claims 16-18 and 23 is reversed.

CONCLUSION

To summarize, the decision of the examiner (I) to reject claim 22 under 35 U.S.C. § 112, first paragraph (enablement) is **reversed**, (II) to reject claims 16-24 under 35 U.S.C. § 103 as being unpatentable over Maeda or Hu in view of APA and either Tracy or Madokoro is **affirmed-in-part**, and (III) to reject claims 16-24 under the judicially created doctrine of obviousness-type double patenting over claims 1, 2 and 5-7 of Sugano in view of either Tracy or Madokoro is **affirmed-in-part**.

Appeal No. 1996-2088
Application No. 08/082,432

CAS/kis
HILL, STEADMAN & SIMPSON
85TH FLOOR - SEARS TOWER
CHICAGO, IL 60606