The opinion in support of the decision being entered today was not written for publication and is not binding precedent of the Board.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

Appeal No. 2005-0123
Application No. 10/114,759

HEARD: April 6, 2005

Before HAIRSTON, GROSS, and BARRY, ***Administrative Patent Judges***.
GROSS, ***Administrative Patent Judge***.

DECISION ON APPEAL

This is a decision on appeal from the examiner's final rejection of claims 1 through 10, which are all of the claims pending in this application.

Appellant's invention relates to forming contacts in an integrated circuit. The disclosed method includes forming on a semiconductor layer a barrier layer having a sublayer of metal nitride and a substantially pure metal layer and electroplating on the pure metal layer a conductive layer. Claim 1 is illustrative of the claimed invention, and it reads as follows:

1. A method of fabricating an integrated circuit, comprising:

loading a semiconductor workpiece into a chamber;

providing a metallic source and a supply of nitrogen source gas to the chamber;

depositing a conductive barrier layer on the workpiece within the chamber, wherein the layer is formed from the metallic source and the nitrogen source gas;

reducing continuously the supply of nitrogen source gas while depositing the barrier layer, wherein the barrier layer comprises a substantially pure metal sub-layer; and

electroplating a metal layer directly on a top surface of the substantially pure metal sub-layer without an intervening deposition on the semiconductor workpiece.

The prior art references of record relied upon by the examiner in rejecting the appealed claims are:

Simpson et al. (Simpson)	6,174,425	Jan. 16, 2001 (filed May 14, 1997)
Xu et al. (Xu)	6,217,721	Apr. 17, 2001 (filed Apr. 05, 1996)

Prior art relied upon by the Board is:

Admissions as to the prior art at page 2 of the specification (appellant's admissions)

Claims 1 through 10 stand rejected under 35 U.S.C. § 103 as being unpatentable over Xu in view of Simpson.

Reference is made to the Examiner's Answer (mailed April 22, 2004) for the examiner's complete reasoning in support of the rejection, and to appellant's Brief (filed

January 15, 2004) and Reply Brief (filed June 18, 2004) for appellant's arguments thereagainst.

OPINION

As a preliminary matter, we note that appellant indicates on page 4 of the Brief that all of the claims stand or fall together. In accordance with this statement, appellant has argued the claims as a single group. Therefore, we will treat the claims as one group with claim 1 as representative.

We have carefully considered the claims, the applied prior art references, and the respective positions articulated by appellant and the examiner. As a consequence of our review, we will reverse the obviousness rejection of claim 1 through 10 over Xu in view of Simpson and, pursuant to 37 C.F.R. § 41.50(b), enter a new ground of rejection for claims 1 through 10 under 35 U.S.C § 103 over Xu, Simpson, and appellant's admissions taken together.

The examiner explains (Answer, pages 3-4) that Xu discloses a method of making an integrated circuit including all of the steps of claim 1 except the last step of electroplating a metal layer directly over the metal sublayer. Specifically, Xu discloses (column 1, lines 14-18) that the invention relates to a method of filling metal into contacts through insulating layers

in a semiconductor integrated circuit and depositing metal lines interconnecting the contacts. Xu summarizes the method (column 8, lines 3-28) as depositing by high density plasma vapor deposition a first sublayer of refractory metal (such as Ti), a second sublayer of a refractory metal nitride (such as TiN), and a third sublayer of the refractory metal (graded from TiN in its lower portion), and then depositing by a standard plasma vapor deposition an interconnect metal (such as aluminum). To remedy the deficiency of Xu, the examiner turns to Simpson. Specifically, the examiner states (Answer, page 5) that based on Simpson's disclosure of a method of electroplating copper over a refractory metal seed layer without an intervening deposition, it would have been obvious to "replac[e] the sputtered aluminum layer with electroplated copper since copper is an alternative to aluminum metalization and electroplating is one of the most desirable ways to deposit copper."

Appellant agrees (Brief, page 6) that "Simpson's statements show a <u>general</u> desire in the art to replace aluminum with copper and the indication of copper electroplating." However, appellant contends that "Simpson's statements do not provide sufficient teaching, suggestion or motivation to modify Xu in particular and therefore the two references cannot be properly combined." In

particular, appellant argues (Brief, page 6) that Xu's reason for forming the third sublayer with a top surface of pure titanium is for promoting aluminum reflow into narrow plugs and is limited to applications where aluminum is sputtered. Appellant asserts (Brief, pages 6-7) that "the use of copper electroplating negates the need for the pure titanium layer in the barrier deposition of Xu because of the dependence between the aluminum sputtering and the pure titanium layer." We agree with appellant that the teachings of Xu and Simpson alone do not support a ***prima facie*** case of obviousness.

Xu discloses (column 8, lines 21-23) that the third sublayer of pure titanium "performs two functions. Its formation cleans the sputter target for the next wafer, and its refractory-metal surface promotes reflow in narrow apertures." Xu further explains (column 13, lines 52-60) that the titanium provides strong wetting at the interface with the aluminum, allowing the aluminum to flow along the walls of the contact hole "at reasonably low temperatures over reasonably short times." Thus, "the metal [aluminum] layer **156** can be deposited by traditional PVD processes" (column 14, lines 16-17). Accordingly, it is clear from Xu that the top sublayer of pure titanium is

specifically for depositing aluminum by traditional PVD processes, not for electroplating copper.

We note that Xu does disclose (column 27, lines 55-59) that copper may be substituted for the aluminum, and that the copper is "subject to the same limitations as Al contacts and interconnects, and thus can enjoy similar benefits of the invention." Further, claim 59 of Xu suggests forming three sublayers of a refractory metal (tantalum), a refractory metal nitride (tantalum nitride), and a third sublayer with a pure metal (tantalum) at the top surface prior to depositing copper. However, claim 59 also indicates that the copper is formed by sputtering. Therefore, Xu's teachings appear to be limited to using a pure metal sublayer under the metal interconnect only when the metal interconnect is sputter deposited.

Simpson suggests (column 4, lines 6-12) that a conductive seed layer is necessary under electroplated copper. However, as Simpson indicates that the seed layer may be titanium, tantalum, titanium nitride, or tantalum nitride, Simpson fails to provide adequate motivation for forming a pure metal sublayer under the copper if the copper is electroplated rather than sputter deposited. Therefore, we cannot sustain the obviousness rejection of claims 1 through 10 as presented by the examiner.

REJECTION UNDER 37 C.F.R. § 41.50(b)

Under the provisions of 37 C.F.R. § 41.50(b), we enter the following new ground of rejection against appellant's claims 1 through 10. Claims 1 through 10 are rejected under 35 U.S.C § 103 as being unpatentable over Xu, Simpson, and appellant's admissions, taken together.

As explained ***supra***, Xu teaches all of the steps of the claims except that the copper is sputter deposited instead of electroplated. Further, as explained ***supra***, appellant admits that Simpson suggests a desire in the art to replace aluminum with copper and an indication of copper electroplating. However, the teachings of Xu and Simpson fail to suggest a layer of titanium (or tantalum) between the titanium nitride (or tantalum nitride) and the copper when the copper is electroplated.

Appellant states (specification, page 2) that copper has been used for metal interconnects because of its low resistivity, and that it typically is electroplated to insure adequate filling of deep vias or trenches. Appellant continues that:

> It is difficult, however, to satisfactorily electroplate copper (Cu) directly over the metal nitride barriers. Although metal nitrides can be sufficiently conductive for circuit operation, where current flows through the thickness of the barrier layer, lateral conductivity across such layers is

> inconsistent. High sheet resistivity makes it difficult to maintain an equipotential surface.

Thus, in view of appellant's admissions, the skilled artisan would have realized that Simpson's seed layers of titanium nitride and tantalum nitride would not work particularly well for electroplating copper. We note that appellant further states (specification, page 2) that because the metal nitrides do not work as seed layers, a copper seed layer is typically used, deposited by PVD. Thus, given the teachings of Simpson and appellant's admissions, the skilled artisan would have been left with a choice of titanium, tantalum, or copper for the seed layer, with no suggestion to select titanium or tantalum over the copper.

However, Xu discloses (column 6, lines 47-65) that a prior art method involves depositing titanium and titanium nitride, then moving the wafer to a separate chamber for annealing, and then moving the wafer to yet another chamber for sputtering the aluminum. Xu states (column 6, lines 63-65) that "[i]t is greatly desired to provide a simpler process for filling plugs of high aspect ratios." Xu thus suggests the need for a method which reduces the number of times that the wafer is moved.

As explained ***supra***, Xu also teaches that the third sublayer ending in pure metal (titanium or tantalum) serves two purposes, a wetting layer for sputtering aluminum and also for cleaning the sputter target for the next wafer. Thus, Xu suggests that the third sublayer could be useful, even when aluminum is not to be sputtered, to clean the sputter target for the next wafer.

Returning to the choices for the seed layer, the skilled artisan would have recognized that a copper seed layer would require moving the wafer to a separate chamber for sputtering the copper, and then moving the wafer again for electroplating the copper. On the other hand, the skilled artisan would have recognized that a seed layer of titanium or tantalum would have required moving the wafer only for electroplating the copper, since Xu's method already potentially includes a third sublayer ending in pure titanium or tantalum. Thus, the skilled artisan, given all of the teachings described ***supra***, would have selected Simpson's titanium or tantalum for the seed layer to serve Xu's purpose of reducing the number of times the wafer gets moved for another process step while improving the electroplating process, as taught by appellant's admissions. We note that the deposition time for sputtering the titanium or tantalum might need to be lengthened to provide a seed layer. However, such a

determination clearly would be within the level of skill of the skilled artisan. The level of the skilled artisan should not be underestimated. ***See In re Sovish***, 769 F.2d 738, 743, 226 USPQ 771, 774 (Fed. Cir. 1985). Accordingly, claims 1 through 10 would have been obvious over the teachings of Xu, Simpson, and appellant's admissions, all taken together.

CONCLUSION

The decision of the examiner rejecting claims 1 through 10 under 35 U.S.C. § 103 is reversed. A new ground of rejection of claims 1 through 10 under 35 U.S.C § 103 has been added pursuant to provisions of 37 C.F.R. § 41.50(b).

This decision contains a new ground of rejection pursuant to 37 C.F.R. § 41.50(b) (effective September 13, 2004, 69 Fed. Reg. 49960 (August 12, 2004), 1286 Off. Gaz. Pat. Office 21 (September 7, 2004)). 37 C.F.R. § 41.50(b) provides "[a] new ground of rejection pursuant to this paragraph shall not be considered final for judicial review."

37 C.F.R. § 41.50(b) also provides that the appellant, <u>WITHIN TWO MONTHS FROM THE DATE OF THE DECISION</u>, must exercise one of the following two options with respect to the new ground

of rejection to avoid termination of the appeal as to the rejected claims:

> (1) *Reopen prosecution*. Submit an appropriate amendment of the claims so rejected or new evidence relating to the claims so rejected, or both, and have the matter reconsidered by the examiner, in which event the proceeding will be remanded to the examiner. . . .
>
> (2) *Request rehearing*. Request that the proceeding be reheard under § 41.52 by the Board upon the same record. . . .

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

REVERSED
37 C.F.R. § 41.50(b)

KENNETH W. HAIRSTON Administrative Patent Judge	)	
ANITA PELLMAN GROSS Administrative Patent Judge	)	BOARD OF PATENT APPEALS AND INTERFERENCES
LANCE LEONARD BARRY Administrative Patent Judge	)	

APG:clm

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