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opinion in support of the decision being entered today (1) was not written for publication in a law journal and (2) is not binding precedent of the Board.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. 27

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte HOWARD C. NICHOLLS,
MICHAEL J. NORRINGTON,
and MICHAEL K. THOMPSON

Appeal No. 96-1848
Application 08/161,604[1]

HEARD: April 5, 1999

Before BARRETT, FLEMING, and HECKER, Administrative Patent Judges.

BARRETT, Administrative Patent Judge.

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[1] Application for patent filed December 6, 1993, entitled (as amended in Paper No. 3) "Semiconductor Device With A Tungsten Contact," which is a division of Application 07/502,526, filed March 30, 1990, now abandoned, which is a continuation of Application 07/739,381, filed August 1, 1991, now abandoned.

DECISION ON APPEAL

This is a decision on appeal under 35 U.S.C. § 134 from the final rejection of claims 10, 11, 13-17, and 25-36, which comprise all of the claims pending in the application.

We affirm-in-part.

BACKGROUND

The disclosed invention is directed a semiconductor device having a tungsten contact.

Claim 31 is reproduced below.

> 31. A semiconductor device incorporating a tungsten contact, the device including a silicon substrate, a series of dielectric layers on the substrate, a tungsten contact extending through the series of dielectric layers and contacting a doped region of the substrate and an interconnect layer disposed over the contact in a non-overlapping configuration on at least one side thereof.

The examiner relies on the following prior art references:

Shirai et al. (Shirai)	4,271,582	June 9, 1981
Deleonibus et al. (Deleonibus)	4,592,802	June 3, 1986
Tomozawa et al. (Tomozawa)	4,782,037	November 1, 1988
Haskell	4,964,143	October 16, 1990
Turner	5,143,861	September 1, 1992

(filed March 6, 1989)

S.M. Sze, Semiconductor Devices--Physics and Technology (John Wiley & Sons 1985), pages 360-61.

The examiner cites the following patents in rebuttal to arguments in appellants' brief:

Huttemann et al. (Huttemann)	4,981,550	January 1, 1991
Lee et al. (Lee)	4,990,467	February 5, 1991

Claims 31, 32, 35, and 36 stand rejected under 35 U.S.C. § 103 as being unpatentable over Turner or, alternatively, over Haskell and Deleonibus.

Claims 10, 11, 13, 14, 16, 25-28, and 30 stand rejected under 35 U.S.C. § 103 as being unpatentable over Haskell and Deleonibus.

Claims 29 and 33 stand rejected under 35 U.S.C. § 103 as being unpatentable over Haskell and Deleonibus, further in view of Shirai.

Claims 15 and 34 stand rejected under 35 U.S.C. § 103 as being unpatentable over Haskell, Deleonibus, and Shirai, further in view of Sze.

Claim 17 stands rejected under 35 U.S.C. § 103 as being unpatentable over "Shirai et al. considered together with Deleonibus et al., and considered further in view of Tomozawa" (Examiner's Answer, page 7).[2]

We refer to the Final Rejection (Paper No. 9) and the Examiner's Answer (Paper No. 16) (pages referred to as "EA__") for a statement of the examiner's position and to the Appeal Brief (Paper No. 15) (pages referred to as "Br__") and the Reply Brief (Paper No. 27) (pages referred to as "RBr__") for a statement of appellants' arguments thereagainst.

OPINION

Appellants argue that "the present invention teaches a method for fabricating a tungsten contact in a semiconductor device while properly controlling the occurrence of tunnelling, encroachment of tungsten underneath the silicon/dielectric interface, consumption of the silicon and

[2] Since claim 17 depends on independent claim 10, which stands rejected over Haskell and Deleonibus, the examiner's statement of the rejection is confusing. The rejection seems to indicate that Tomozawa is added for the limitations of claim 17, implying that the previous rejection (of claim 10) is over Shirai and Deleonibus. The rejection is considered to be over Haskell, Deleonibus, Shirai, and Tomozawa.

high contact resistances, without compromising the inherent advantages of tungsten plug processing" (Br7; Br8; Br12). It is noted that all claims are directed to a semiconductor device having certain structural features, not to a process of making such a device. The advantages of a device made by the disclosed process have not been shown by appellants to be inherent in the semiconductor device structures claimed, no matter how they are manufactured. Implied limitations and advantages which result from the unclaimed process will not be read into the claims.

Claims 31, 32, 35, and 36

Turner

Appellants argue that the dielectric layers of Turner are not configured in series (Br7, 9, 10). We find that the spin-on glass (SOG) layer 69 and the dielectric capacitor oxide layer 66 are dielectric layers in series (figure 12). The claim 31 limitation of "a series of dielectric layers" does not preclude other, non-dielectric, layers from being interposed with the dielectric layers; i.e., it does not require a succession of touching dielectric layers. Thus,

we agree with the examiner that Turner teaches a series of dielectric layers.

The examiner finds that Turner teaches in figure 13 that the interconnection layers 78 are non-overlapping on the top and bottom sides with the tungsten plugs because the contact openings 70 are shown extending past the layers 78 (EA4-5). Appellants argue that Turner does not teach an interconnect layer disposed in a non-overlapping configuration on at least one side of the contact because figure 12 shows that the upper part of the tungsten contact 76 is entirely covered by the interconnect layer 78 in both directions ((Br10-11). We agree with appellants that figure 12 of Turner plainly shows the tungsten contact overlapped by the layer 78 in both directions. Figure 13 may show the width of the contact opening as slightly greater than the width of the interconnection line 78; however, it does not depict the width of the sidewall nitride layer 74 which surrounds the contact 76. Since the examiner has not added any other evidence or reasoning, the rejection of claims 31, 32, 35, and 36 over Turner alone is reversed.

Haskell and Deleonibus

Haskell discloses a semiconductor device having a polysilicon source contact 46s and polysilicon drain contact 46d. Haskell discloses that "tungsten may be used in place of polysilicon, such as for the source/drain contacts" (col. 10, lines 30-31). As shown in figure 15b of Haskell, the source and drain contacts have a field oxide layer 28a, etch-stop silicon nitride layer 28b, and oxide layer 28c on one side of the contact and a field oxide layer 28a and an oxide 64 on the other side. The contact "extend[s] through the series of dielectric layers" because claim 31 does not define the series of layers or imply that the layers must be all around the contact. Figure 15b does not show an interconnect layer, but Haskell discloses that "[c]ontacts may be made to the source 46s, drain 46d, and control gate 58 by means well-known in the art" (col. 10, lines 26-27). Deleonibus discloses that the interconnect layer can be located on a contact, which may be tungsten (col. 3, lines 42-45), in a non-overlapping manner as shown in figure 8 where it is desired to reduce the width between adjacent conductors to a minimum (col. 3, line 65 to col. 4,

line 2). We agree with the examiner's conclusion that one of ordinary skill in the semiconductor art would have been motivated to use an interconnect layer that does not overlap the contacts in Haskell given the teachings in Deleonibus, for the purpose of reducing spacing between conductors. Therefore, we sustain the rejection of claims 31, 32, 35, and 36 over Haskell and Deleonibus.

Appellants argue that "[t]he present invention employs a unique, specified process which alleviates several problems encountered in practicing the existing prior art, such as Haskell" (Br12) and that because Haskell does not disclose the tungsten deposition process, "[Haskell] thereby fails to resolve the existing prior art inadequacies addressed by the teachings of the present invention" (Br12). The claims recite a structure, not the process for producing the structure. Appellants have not shown that the broadly claimed structure inherently resolves the prior art inadequacies no matter how the structure is manufactured.

Appellants argue that "Deleonibus et al., like Haskell, notes that the contact material may consist of a metal such as tungsten . . ., but likewise lacks any teaching,

disclosure or suggestion of a viable fabricating technique to alleviate the problems addressed by the present invention" (Br13). Again, the claims are directed to the structure, not the process.

Appellants argue that "while Deleonibus et al. illustrates a non-overlapping interconnect layer, one of ordinary skill in the art would recognize that, if the tungsten contact of Figure 8 were deposited by a blanket deposition and etch back process, then the formation [of] the non-overlapping interconnect layer (14) would not work" (Br13) because a blanket deposition of tungsten would require an adhesion layer between the tungsten contact and the side walls of the contact channel and this adhesion layer would be degraded during etching of the aluminum interconnect layer. This same problem is said to exist with Haskell (Br14). The examiner has produced references to Lee and Huttemann, which appellants acknowledge "disclose the manufacture of tungsten contacts without adhesion layers" (RBr4). Therefore, appellants' argument that there is some undisclosed condition keeping the combination from working is not persuasive. In addition, attorney argument is not

evidence. Absent evidence, it must be assumed that Haskell with tungsten contacts would have the same cross-section as shown in figure 15b.

Claims 10, 11, 13, 14, 16, 25-28, and 30: Haskell and Deleonibus

Claim 10 more specifically recites three dielectric layers. The claimed "bottom layer of oxide on the substrate" corresponds to the field oxide layer 28a in Haskell. The claimed "sealing layer on the oxide layer" corresponds to the etch-stop silicon nitride layer 28b in Haskell. The claimed "interlevel layer on the sealing layer" corresponds to oxide layer 28c in Haskell. Because Haskell shows each successive dielectric layer in immediate contact with the underlying layer there is no need to decide whether the terms "on the substrate," "on the oxide layer," and "on the sealing layer" require direct contact between layers or permit intervening layers. Since the silicon nitride layer 28b in Haskell is the same material as appellants' sealing layer, as evidenced by claim 14, it is considered to inherently perform the function of "acting to seal the underlying oxide layer." Appellants have not

argued otherwise in their Brief. The "sealing layer on the oxide" limitation itself does not define how much of the oxide layer is covered by the sealing layer. Therefore, we find that Haskell discloses the claimed dielectric layers. As discussed with respect to claim 31, we conclude that it would have been obvious to connect an interconnect layer to the tungsten contact in Haskell in a non-overlapping manner in view of the teaching of Deleonibus.

One feature brought out by counsel at oral hearing was that the silicon nitride layer 28b has been removed in the area between the source and drain contacts in the final device of Haskell, figure 15b. Claim 10 recites "the tungsten contact being disposed in a contact hole which is defined in a series of dielectric layers . . .," which we interpret to require that the defined dielectric layers extend around the contact hole; thus, the difference in structure is claimed. Compare claim 10 to claim 31, supra, which does not define the layers or any structural relationship between the layers and the contact. Although we do not find where this limitation is argued in the Brief as not being described in the prior art as required by

37 CFR § 1.192(c)(8)(4) (1995), the limitation is too important to ignore. Haskell does not disclose or suggest "a contact hole which is defined in a series of dielectric layers comprising a bottom layer of oxide on the substrate, a sealing layer on the oxide layer, . . . and an interlevel layer on the sealing layer" because the silicon nitride layer 28b corresponding to the "sealing layer" is removed during manufacture. The deficiency of Haskell is not cured by Deleonibus. Therefore, we conclude that the examiner has failed to establish a prima facie case of obviousness with respect to claim 10. The deficiency of Haskell and Deleonibus with respect to claim 10 is not cured by Shirai, Tomozawa, or Sze as applied in the rejection of the dependent claims. Accordingly, the rejection of claims 10, 11, 13-17, and 25 is reversed.

Claim 26 recites a "bottom dielectric oxide layer," "a sealing dielectric layer," and "an interlevel dielectric layer." These layers correspond to layers 28a, 28b, and 28c, respectively, of Haskell. Claim 26 defines "said sealing layer mechanically modifying stresses at the interface between said silicon substrate and said dielectric

oxide layer so as to impede the lateral diffusion of tungsten into the interface between said substrate and said oxide layer." The sealing layer is disclosed to be silicon nitride of a certain thickness and, hence, the silicon nitride layer 28b in Haskell, which is of greater thickness, is considered to perform the function of modifying stresses to impede the lateral diffusion of tungsten into the interface. Appellants have not shown otherwise. The recited function of the sealing layer does not require, expressly or implicitly, that the sealing layer extend around the tungsten plug member and impede lateral diffusion in all directions: the function of modifying stresses to impede the lateral diffusion of tungsten into the interface is broadly satisfied if the sealing layer is on one side of the plug and lateral diffusion of tungsten is impeded in that direction.

However, claim 26, similar to claim 10, recites "a tungsten plug . . . extending up through a contact hole etched through said bottom dielectric oxide layer, said sealing dielectric layer, and said interlevel dielectric layer." We interpret this limitation to require that the

three layers extend around the tungsten plug since the plug is defined through all three layers. Haskell does not meet this limitation because the silicon nitride layer 28b corresponding to the "sealing layer" is removed during manufacture. The deficiency of Haskell is not cured by Deleonibus. We give no weight to the process-type limitation "etched" because it has not been argued or shown that this limitation produces a different final structure. For these reasons, we conclude that the examiner has failed to establish a prima facie case of obviousness with respect to claim 26. The deficiency of Haskell and Deleonibus with respect to claim 26 is not cured by Shirai, as applied in the rejection of dependent claim 29. The rejection of claims 26-30 is reversed.

Claims 29 and 33: Haskell, Deleonibus, and Shirai

The rejection of claim 29 has been reversed.

Haskell discloses a silicon nitride layer of about 800 Angstroms ± 5% (col. 5, lines 10-13), but indicates that "[t]he minimum and maximum thickness depend on the etch uniformity of the process and apparatus" (col. 5, lines 15-17). The examiner applies Shirai, which teaches

that silicon nitride thicknesses of 400 and 500 Angstrom units may be used (col. 5, lines 7-10). The examiner concludes that it would have been obvious to use a silicon nitride thickness of 200 to 600 Angstroms in view of the teachings of Shirai.

Appellants argue that "Haskell, as noted above, utilizes a silicon nitride etch stop layer, but lacks any suggestion or teaching of the interlevel dielectric layer deposition and reflow, and non-overlapping layer configuration of the present invention" (Br15). This argument is nonresponsive to the rejection. No "interlevel dielectric layer deposition and reflow" is claimed in claim 33. The "non-overlapping layer configuration" is taught by Deleonibus. Appellants have not shown error in the examiner's reasoning. Accordingly, the rejection of claim 33 is sustained.

Claims 15 and 34: Haskell, Deleonibus, Shirai, and Sze

The rejection of claim 15 has been reversed.

The examiner stated that "[u]nderstanding from Sze that phosphorus-doped silicon oxide is useful to planarize by reflowing, we conclude it to have been obvious for one to

having accordingly used phosphorus-doped silicon oxide to constitute oxide layer (28c) of Haskell" (Final Rejection, page 4; see also EA6).

Appellants argue that "[t]his rejection still results with the inadequacies of the Haskell, Deleonibus and Shirai, as set forth in the above arguments, regarding any disclosures or suggestions necessary to render the present invention obvious under 35 U.S.C. § 103" (Br16). This argument does not point out the error in the examiner's reasoning about claim 34.

Appellants argue that "[a]dditionally, one of the advantages of the present invention over the prior art is the elimination of the extra step of planarizing as disclosed by Haskell" (Br16). The claims do not recite method steps: a "layer of reflowable material" only requires the property that the material can be reflowed, it does not require that the layer has been reflowed during manufacture. The examiner concluded that a reflowable material could be used over the silicon nitride layer for the reason of allowing planarizing and appellants have not shown the error in that position.

For these reasons, the rejection of claim 34 is sustained.

Claim 17: Shirai, Deleonibus, and Tomozawa

The rejection of claim 17 has been reversed.

CONCLUSION

The rejections of claims 31-36 are sustained.

The rejections of claims 10, 11, 13-17, and 25-30 are reversed.

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

AFFIRMED-IN-PART

LEE E. BARRETT)
Administrative Patent Judge)
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MICHAEL R. FLEMING) APPEALS
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