Paper No. 14

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

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Ex parte DIANA M. SCHONAUER, STEVEN C. AVANZINO and KAI YANG

_____

Appeal No. 2002-1992
Application 09/206,170

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ON BRIEF

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Before OWENS, TIMM and PAWLIKOWSKI, *Administrative Patent Judges*.

OWENS, *Administrative Patent Judge*.

DECISION ON APPEAL

This appeal is from the final rejection of claims 1-3 and 5-22. Claim 4, which is the only other claim in the application, has not been rejected.

THE INVENTION

The appellants' claimed invention is directed toward a method for preventing or substantially reducing the formation and/or growth of dendrites from Cu or Cu alloy lines into a

bordering open dielectric field on a semiconductor wafer surface.

Claims 1 and 17 are illustrative:

1. A method of manufacturing a semiconductor device on a wafer, the method comprising:

forming a copper (Cu) or Cu alloy interconnection pattern comprising a dense array of spaced apart Cu or Cu alloy lines bordering an open dielectric field on a surface of the wafer; and

immersing the wafer in a chemical agent to remove a sufficient amount of dielectric material from the open dielectric field to prevent or substantially reduce formation and/or growth of Cu or Cu alloy dendrites from the lines into the open dielectric field.

17. A method of preventing or substantially reducing the formation and/or growth of dendrites emanating from copper (Cu) or Cu alloy lines into a bordering open dielectric field on a wafer surface, the method comprising immersing the wafer in a chemical agent to remove a portion of dielectric material from the surface of the open dielectric field and from between the lines.

THE REFERENCES

References relied upon by the examiner

Schonauer et al. (Schonauer '769)	5,662,769	Sep. 2, 1997
Grieger et al. (Grieger)	5,855,811	Jan. 5, 1999 (filed Oct. 3, 1996)
Chen et al. (Chen)	5,989,623	Nov. 23, 1999 (filed Aug. 19, 1997)

Reference relied upon by the board

Schonauer et al. (Schonauer '727)	6,162,727	Dec. 19, 2000

THE REJECTIONS

The claims stand rejected as follows: claims 19 and 20 under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the appellants regard as the invention; claims 1, 3, 6-9, 11-14 and 17-22 under 35 U.S.C. § 103 as being obvious over Chen in view of Grieger; and claims 2, 5, 10, 15 and 16 under 35 U.S.C. § 103 as being obvious over Chen in view of Grieger and Schonauer '769.

OPINION

We reverse the aforementioned rejections and, under the provisions of 37 CFR § 1.196(b), introduce a new ground of rejection of claims 1, 3, 6, 10-13, 17 and 18.

Rejection under 35 U.S.C. § 112, second paragraph

The examiner argues that "optionally" in the appellants' claims 19 and 20 renders the claims indefinite because it is unclear whether or not the components following "optionally" are present (answer, page 3).

The examiner has not pointed to any disclosure in the appellants' specification which indicates that the appellants have given the term "optionally" any meaning other than its ordinary meaning. *See Allen Engineering Corp. v. Bartell*

Industries Inc., 299 F.3d 1336, 1344, 63 USPQ2d 1769, 1772 (Fed. Cir. 2002) ("The words of the claims themselves define the scope of the invention, and are given their ordinary and customary meaning, unless the patentee has chosen to use terms in some other manner.") The ordinary meaning of "optionally" is: "1. left to one's choice; not mandatory. 2. leaving something to choice."[1] Thus, the appellants' claims 19 and 20 leave the presence of each component following "optionally" open to choice, i.e., the claims encompass methods in which the component following any appearance of "optionally" is present and methods in which the component following any appearance of "optionally" is absent. The examiner has not explained, and it is not apparent, why the fact that the claims encompass methods in which the components following "optionally" can be either present or absent renders the claims indefinite. *See Ex parte Wu*, 10 USPQ2d 2031, 2032 (Bd. Pat. App. & Int. 1989) ("We have no difficulty determining the scope of claim 1 as drafted. The composition set forth in the claim can consist of the first three components recited or it can include a polyamine as a fourth component. We therefore do not consider the claims to be indefinite as a result

[1] *The Random House College Dictionary* 934 (Random House 1973).

of the claimed optional component."); *Ex parte Cordova*, 10 USPQ2d 1949, 1950 (1987) ("The recitation 'optionally' denotes that the unsaturated aliphatic carboxylic acid may or may not be employed. It is not apparent, and the examiner has not explained, why the use of such alternative language fails to particularly point out and distinctly claim the subject matter appellants regard as their invention.")

Accordingly, we reverse the rejection under 35 U.S.C. § 112, second paragraph.

Rejection of claims 1, 3, 6-9, 11-14 and 17-22 under 35 U.S.C. § 103 over Chen in view of Grieger

We need to address only the independent claims, i.e., claims 1 and 17.

The appellants' claim 1 requires that formation and/or growth of Cu or Cu alloy dendrites from Cu or Cu alloy lines into the open dielectric field is prevented or substantially reduced. Claim 17 recites that the claimed method is "[a] method of preventing or substantially reducing the formation and/or growth of dendrites emanating from copper (Cu) or Cu alloy lines into a bordering open dielectric field on a wafer surface". The appellants' specification does not define "substantially". Hence, we give this term its ordinary meaning, which is "of ample

or considerable amount, quantity, size, etc."[2] *See Allen Engineering Corp. v. Bartell Industries Inc.*, 299 F.3d at 1344, 63 USPQ2d at 1772.

Chen discloses a method for forming a semiconductor device on a wafer, comprising forming a dual damascene via and wire definition in a dielectric layer, depositing a barrier layer on exposed surfaces of the dielectric layer including the surfaces within the dual damascene via and wire definition, filling the dual damascene via and wire definition with a conductive metal such as copper or aluminum, and then planarizing, by a method such as chemical mechanical polishing, the conductive metal, barrier layer and dielectric layer, thereby defining a conductive wire which is connected by a via to a lower conducting region (col. 4, lines 51-63). Chen does not disclose immersing the wafer in a chemical agent to remove an amount of dielectric material sufficient to prevent or substantially reduce formation and/or growth of Cu dendrites from the Cu lines into the dielectric layer.

[2] *The Random House College Dictionary, supra* note 1 at 1310.

Grieger discloses that after planarizing, preferably by chemical mechanical polishing, a semiconductor device having a doped silica surface, e.g., a borophosphosilicate (BPSG) surface,[3] silica-containing chemical mechanical polishing residue can be completely removed from the doped silica surface, with a tolerable level of doped silica removal, by immersing the device in aqueous hydrofluoric acid (HF)/tetramethylammonium hydroxide (TMAH) (abstract; col. 2, lines 15-20 and 31-38; col. 8, lines 19-20; col. 10, lines 13-20; col. 12, lines 10-36). Grieger teaches that "[w]hile the cleaning composition and methods are very well-suited to removing residue from a device surface, the same composition and methods may also result in some removal of the atoms that form the surface of the device. Thus, while in a preferred embodiment, the inventive method removes only residue and not surface atoms, the inventive method may remove surface atoms in addition to removing residue" (col. 11, lines 43-50). Grieger also teaches that "[r]outine experimentation may be needed in order to find a composition that

[3] Chen's dielectric material can be "[a]ny dielectric material, whether presently known or yet to be discovered ... including low dielectric materials such as carbon fluorinated SiO_2, organic polymers, etc." (col. 5, line 66 - col. 6, line 2). Chen's dielectric materials, therefore, include Grieger's doped silica.

provides optimal cleaning ability with minimal degradation of the semiconductor surface" (col. 12, lines 49-52).

The examiner's reason for combining Chen and Grieger is that "[i]t would have been obvious to one of ordinary skill in the art to use the wash process set forth by Grieger after the chemical-mechanical polish of the Chen method in order to remove undesirable polish residue including metallic surface contamination" (answer, page 4). This reasoning does not include an explanation as to why that combination would have produced the claimed method wherein a sufficient amount of dielectric material is removed from the open dielectric field to prevent or substantially reduce formation and/or growth of Cu or Cu alloy dendrites from the Cu or Cu alloy lines into the open dielectric field. The examiner asserts that preventing or substantially reducing dendrite formation flows naturally from the suggestion of the prior art (answer, page 7), but provides no supporting evidence or technical reasoning.

The examiner argues (answer, page 9): "Grieger teaches the removal of surface dielectric material and surface contamination (column 10) which would reduce the formation of concentrations of surface contamination such as copper dendrites. As is disclosed in the appellants['] application it is the presence of copper

surface contamination the [sic, that] results in the formation of copper dendrites (application page 3 lines 20-30)." Grieger, however, does not disclose the amount of dielectric material which is removed by his method,[4] and does not mention copper dendrites. Thus, contrary to the examiner's argument, Grieger does not disclose surface dielectric material removal which reduces formation of copper dendrites. The examiner has not provided evidence or technical reasoning which shows that Grieger removes an amount of dielectric material which is sufficient to prevent the formation and/or growth of Cu or Cu alloy dendrites from the lines into the dielectric layer or to reduce such formation by any amount which reasonably can be considered substantial.

For the above reasons we conclude that the examiner has not carried the burden of establishing a *prima facie* case of obviousness of the methods recited in the appellants' independent claims 1 and 17. Accordingly, we reverse the rejection under 35 U.S.C. § 103 of these claims and dependent claims 3, 6-9, 11-14 and 18-22.

[4] Grieger's table 1 presents the results of a study of the relative rates at which his etchant removes silica and BPSG, but Grieger does not disclose either the treatment time used in his method or the amount of dielectric removed by that method.

Rejection of claims 2, 5, 10, 15 and 16 under 35 U.S.C. § 103 over Chen in view of Grieger and Schonauer '769

Schonauer '769 discloses a method for cleaning metal compound contaminants remaining at or in the surface of a semiconductor wafer following chemical mechanical polishing, by etching away a 30-50Å layer of oxides from the wafer surface (col. 1, lines 46-57; col. 6, lines 12-21). Schonauer '769 postulates that when the polishing slurry oxidizing agent is an iron compound, due to the abrasive nature of the chemical mechanical polishing process, some fraction of the slurry iron which contacts the wafer becomes physically buried beneath the surface of the oxides, and is not removed by post-chemical mechanical polishing cleaning agents that contact the liquid-solid interface (col. 2, lines 14-19; col. 3, lines 25-29). Schonauer '769, therefore, uses a cleaning solution containing HF and a chemical complexing agent to etch away a very shallow depth of the polished surface while simultaneously complexing the Fe impurity and other metal impurities (col. 3, lines 30-38).

The examiner argues that "[i]t would have been obvious to one of ordinary skill in the art to wash the substrate for the time periods and removal thickness set forth by Schonauer [sic]

because it is known to satisfactorily remove surface residue and contamination" (answer, page 5).

In Grieger's method, removal of the doped silica is to be minimized (abstract; col. 12, lines 49-52), whereas in the Schonauer '769 method, a very shallow depth of the surface is intentionally etched away (col. 3, lines 30-34). The examiner has not explained, and it is not apparent, why the applied references would have led one of ordinary skill in the art to combine these methods.

As for combining the teachings of Chen and Schonauer '769, the teaching in Schonauer '769 that his etching solution rapidly dissolves Ti (col. 4, lines 14-42) is evidence that this etching solution is not compatible with all metals.[5] The examiner has not provided evidence or technical reasoning which shows that one of ordinary skill in the art would have reasonably expected the Schonauer '769 etching solution to be compatible with Chen's copper wiring. Like Schonauer '769 (col. 3, lines 34-38), Grieger uses a cleaning solution which contains HF (abstract).

[5] The wiring metal which is disclosed in Schonauer '769 (col. 2, lines 14-19) and recited in the claims is tungsten.

Also like Schonauer '769, however, Grieger does not disclose applying the cleaning solution to copper.[6]

The examiner argues that use of the appellants' surface treatment times and surface removal thicknesses would have been an obvious design choice based upon well known manufacturing constraints, and would have been ascertainable by routine experimentation (answer, pages 5-6). In order for a *prima facie* case of obviousness to be established, however, the teachings from the prior art itself must appear to have suggested the claimed subject matter to one of ordinary skill in the art. *See In re Rinehart*, 531 F.2d 1048, 1051, 189 USPQ 143, 147 (CCPA 1976). The mere fact that the prior art could be modified as proposed by the examiner is not sufficient to establish a *prima facie* case of obviousness. *See In re Fritch*, 972 F.2d 1260, 1266, 23 USPQ2d 1780, 1783 (Fed. Cir. 1992). The examiner must explain why the prior art would have suggested to one of ordinary

[6] The examiner argues that "Grieger teaches that common process chemicals such as copper complexing citric acid may be added to the wash solution to enhance the removal of metallic contaminants (column 6 lines 25-35)" (answer, page 12). The portion of Grieger relied upon by the examiner discloses citric acid, but does not disclose its use for complexing copper.

skill in the art the desirability of the modification, *see Fritch*, 972 F.2d at 1266, 23 USPQ2d at 1783-84, and the examiner has not provided such an explanation.

The examiner, therefore, has not established that Schonauer '769 remedies the above-discussed deficiency in the teachings of Chen and Grieger as to the independent claims (1 and 17). Accordingly, we reverse the rejection under 35 U.S.C. § 103 of dependent claims 2, 5, 10, 15 and 16.

New ground of rejection

Claims 1, 3, 6, 10-13, 17 and 18 are rejected under the judicially created doctrine of obvious-type double patenting over the claims of Schonauer '727 as follows:

Appellants' claim	Claim of Schonauer '727
1	4
3	4
6	6
10	5
11	28
12	9
13	10
17	16
18	16

Claim 1: Claim 4 of Schonauer '727, which includes the subject matter of claims 1-3, claims a method of manufacturing a semiconductor device on a wafer, comprising forming a Cu or Cu alloy interconnection pattern comprising a dense array of spaced apart Cu or Cu alloy lines bordering an open dielectric

field on a surface of the wafer (claim 1), and immersing (claim 4) the wafer in a chemical agent to remove a sufficient amount of dielectric material from the open dielectric field to prevent or substantially reduce subsequent formation and/or growth of Cu or Cu compound dendrites from the lines into the open dielectric field (claim 2).

Claim 3: Schonauer '727 recites that the interconnection pattern is formed by a damascene technique (claim 1) and that the dielectric layer and the open dielectric field comprise silicon oxide (claim 3).

Claim 6: Schonauer '727 recites that the chemical agent is a solution containing at least about 90 wt% acetic acid and up to about 10 wt% ammonium fluoride (claim 6, which includes the subject matter of claims 1-5).

Claim 10: Schonauer '727 recites immersing the wafer in the solution for about 60 seconds to about 180 seconds (claim 5, which includes the subject matter of claims 1-4).

Claim 11: Claim 28 of Schonauer '727, which includes the subject matter of claims 26 and 27, claims a method of manufacturing a semiconductor device on a wafer, comprising forming a Cu or Cu alloy interconnection pattern comprising a dense array of spaced apart Cu or Cu alloy lines bordering an

open dielectric field on a surface of the wafer by a damascene technique in a silicon oxide layer, wherein the open dielectric field comprises silicon oxide (claim 26), and immersing (claim 27) the wafer in a solution containing at least about 90 wt% acetic acid and up to about 10 wt% ammonium fluoride (claim 28) to remove silicon oxide from the open dielectric field and from between the lines of the dense array. Because these method steps are essentially the same as those recited in the appellants' claim 11, it reasonably appears that the method in claim 28 of Schonauer '727, line that claimed in the appellants' claim 11, prevents or substantially reduces formation and/or growth of Cu or Cu alloy dendrites from the lines into the open dielectric field.

Claim 12: Claim 9 of Schonauer '727, which includes the subject matter of claims 1-3, recites forming trenches in the silicon oxide layer, depositing a barrier layer lining the trenches and on the silicon oxide layer, depositing a Cu or Cu alloy layer on the barrier layer filling the trenches, chemical mechanical polishing the Cu or Cu alloy stopping substantially at the barrier layer, chemical mechanical polishing to substantially remove the barrier layer, immersing the wafer in

the solution, and double sided scrubbing the wafer with water either before or after immersing the wafer in the solution.

Claim 13: Claim 10 of Schonauer '727, which depends from claim 9, recites that the barrier layer comprises tantalum nitride.

Claims 17 and 18: Claim 16 of Schonauer '727, which includes the subject matter of claims 13 and 14, claims a method of preventing the growth of dendrites emanating from Cu or Cu alloy lines into a bordering open dielectric field on a wafer surface, by immersing the wafer in a solution containing at least about 90 wt% acetic acid and up to about 10 wt% ammonium fluoride to remove a portion of dielectric material from the surface of the open dielectric field and from between the lines.

DECISION

The rejections of claims 19 and 20 under 35 U.S.C. § 112, second paragraph, claims 1, 3, 6-9, 11-14 and 17-22 under 35 U.S.C. § 103 over Chen in view of Grieger, and claims 2, 5, 10, 15 and 16 under 35 U.S.C. § 103 over Chen in view of Grieger and Schonauer, are reversed. Under the provisions of 37 CFR § 1.196(b) a new ground of rejection of claims 1, 3, 6, 10-13, 17 and 18 has been entered.

This decision contains a new ground of rejection pursuant to 37 CFR § 1.196(b)(amended effective Dec. 1, 1997, by final rule notice, 62 Fed. Reg. 53,131, 53,197 (Oct. 10, 1997), 1203 Off. Gaz. Pat. & Trademark Office 63, 122 (Oct. 21, 1997)). 37 CFR § 1.196(b) provides that, "A new ground of rejection shall not be considered final for purposes of judicial review."

37 CFR § 1.196(b) also provides that the appellant, WITHIN TWO MONTHS FROM THE DATE OF THE DECISION, must exercise one of the following two options with respect to the new ground of rejection to avoid termination of proceedings (§ 1.197(c)) as to the rejected claims:

> (1) Submit an appropriate amendment of the claims so rejected or a showing of facts relating to the claims so rejected, or both, and have the matter reconsidered by the examiner, in which event the application will be remanded to the examiner. . . .

> (2) Request that the application be reheard under § 1.197(b) by the Board of Patent Appeals and Interferences upon the same record. . . .

REVERSED, 37 CFR § 1.196(b)

TERRY J. OWENS Administrative Patent Judge	)	
CATHERINE TIMM Administrative Patent Judge	)	BOARD OF PATENT APPEALS AND INTERFERENCES
BEVERLY A. PAWLIKOWSKI Administrative Patent Judge	)	

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Appeal No. 2002-1992
Application 09/206,170

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