

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

Paper No. 17

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte NICK KEPLER, OLOV KARLSSON, LARRY WANG,
BASAB BANDYOPAHYAY, EFFIONG IBOK
and CHRISTOPHER F. LYONS

Appeal No. 2001-0482
Application No. 09/186,078

ON BRIEF

Before HAIRSTON, RUGGIERO, and BARRY, Administrative Patent Judges.
RUGGIERO, Administrative Patent Judge.

DECISION ON APPEAL

This is a decision on the appeal from the final rejection of claims 1-35. Claims 36-44 have been withdrawn from consideration as being directed to a non-elected invention.

The claimed invention relates to a method of manufacturing a semiconductor device having an insulated trench in which impurities are ion implanted proximate to the edges of the trench.

According to Appellants (specification, pages 3-5), the thickness of the oxide at the trench edges is increased due to the enhanced oxidation rate provided by the implanted impurities.

Claim 1 is illustrative of the invention and reads as follows:

1. A method of manufacturing a semiconductor device having an insulated trench formed in a semiconductor substrate or in an epitaxial layer on the semiconductor substrate, which method comprises:
 - forming a pad oxide layer on a main surface of the substrate or epitaxial layer;
 - forming a barrier nitride layer having an upper surface on the pad oxide layer;
 - providing a mask having an opening on the barrier nitride layer;
 - etching to remove portions of the underlying barrier nitride and pad oxide layers and to form a trench in the substrate or epitaxial layer, which trench has a surface comprising side surfaces intersecting the main surface at edges;
 - ion implanting impurities, at an acute angle, into a portion of the side surfaces and a portion of the main surface proximal to the edges for increasing the oxidation rate of the ion implanted portions;
 - forming an oxide liner on the surface of the trench, on the edges, and in contact with the pad oxide layer, the oxide liner having a thickness at the edges on the ion implanted portions greater than at the remainder of the trench surface;
 - removing the barrier nitride layer and pad oxide layer; and
 - forming a gate oxide layer on the main surface in contact with the oxide liner, the gate oxide layer having a thickness proximal to the edges greater than or equal to that of the remainder of the gate oxide layer.

The Examiner relies on the following prior art:

Fulford, Jr. et al. (Fulford)	5,874,346	Feb. 23, 1999 (filed May 23, 1996)
Gardner et al. (Gardner)	5,891,787	Apr. 06, 1999 (filed Sep. 04, 1997)
Son et al. (Son)	5,904,538	May 18, 1999 (filed Sep. 04, 1997)

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Rho et al. (Rho) ¹	5,904,541	May 18, 1999 (filed Jun. 20, 1997)
Wristers et al. (Wristers)	5,930,620	Jul. 27, 1999 (filed Sep. 12, 1997)
Liaw et al. (Liaw)	5,960,276	Sep. 28, 1999 (filed Sep. 28, 1998)

Stanley Wolf et al. (Wolf), Silicon Processing for the VLSI Era, 212 (Lattice Press, 1986).

Claims 1-35 stand finally rejected under 35 U.S.C. § 103(a). As evidence of obviousness, the Examiner offers Son in view of Fulford with respect to claims 1-3, 5-9, 11, and 16-19. To this basic combination, Liaw is separately added with respect to claims 4, 10, 12, and 13, and Wolf is separately added with respect to claim 14. Further, the combination of Son, Fulford, Wristers, and Liaw is applied against claims 15, 20, and 21. In the rejection against claims 22-24, 26-30, and 35, the Examiner relies on the combination of Rho in view of Gardner. To the Rho and Gardner combination, the Examiner separately adds Liaw with respect to claims 25 and 31-34.

Rather than reiterate the arguments of Appellants and the Examiner, reference is made to the Briefs² and Answer for their respective details.

¹ Although used in the Examiner's prior art rejection, the Rho reference is not listed in the cited prior art at page 3 of the Answer.

² The Appeal Brief was filed October 3, 2000 (Paper No. 12). In response to the Examiner's Answer dated December 20, 2000 (Paper No. 13), a Reply Brief was filed February 20, 2001 (Paper No. 14), which was acknowledged and entered by the Examiner as indicated in the communication dated March 30, 2001 (Paper No. 16).

OPINION

We have carefully considered the subject matter on appeal, the rejections advanced by the Examiner and the evidence of obviousness relied upon by the Examiner as support for the rejections. We have, likewise, reviewed and taken into consideration, in reaching our decision, Appellants' arguments set forth in the Briefs along with the Examiner's rationale in support of the rejections and arguments in rebuttal set forth in the Examiner's Answer.

It is our view, after consideration of the record before us, that the evidence relied upon and the level of skill in the particular art would not have suggested to one of ordinary skill in the art the invention as recited in claims 1-21. We reach the opposite conclusion with respect to the Examiner's obviousness rejection of claims 22-35. Accordingly, we affirm-in-part.

Appellants' arguments in response to the Examiner's obviousness rejection of the appealed claims are organized according to a suggested grouping of claims indicated at page 4 of the Brief. We will consider the appealed claims separately only to the extent separate arguments for patentability are presented. Any dependent claim not separately argued will stand or fall with its base claim. Note In re King, 801 F.2d 1324, 1325, 231 USPQ 136, 137 (Fed. Cir. 1986); In re Sernaker, 702 F.2d 989, 991, 217 USPQ 1, 3 (Fed. Cir. 1983).

In rejecting claims under 35 U.S.C. § 103, it is incumbent upon the Examiner to establish a factual basis to support the legal conclusion of obviousness. See In re Fine, 837 F.2d 1071, 1073, 5 USPQ2d 1596, 1598 (Fed. Cir. 1988). In so doing, the Examiner is expected to make the factual

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determinations set forth in Graham v. John Deere Co., 383 U.S. 1, 17, 148 USPQ 459, 467 (1966), and to provide a reason why one having ordinary skill in the pertinent art would have been led to modify the prior art or to combine prior art references to arrive at the claimed invention. Such reason must stem from some teaching, suggestion or implication in the prior art as a whole or knowledge generally available to one having ordinary skill in the art. Uniroyal Inc. v. Rudkin-Wiley Corp., 837 F.2d 1044, 1051, 5 USPQ2d 1434, 1438 (Fed. Cir.), cert. denied, 488 U.S. 825 (1988); Ashland Oil, Inc. v. Delta Resins & Refractories, Inc., 776 F.2d 281, 293, 227 USPQ 657, 664 (Fed. Cir. 1985), cert. denied, 475 U.S. 1017 (1986); ACS Hospital Systems, Inc. v. Montefiore Hospital, 732 F.2d 1572, 1577, 221 USPQ 929, 933 (Fed. Cir. 1984). These showings by the Examiner are an essential part of complying with the burden of presenting a prima facie case of obviousness. Note In re Oetiker, 977 F.2d 1443, 1445, 24 USPQ2d 1443, 1444 (Fed. Cir. 1992).

With respect to independent claims 1 and 20, the Examiner, as the basis for the obviousness rejection, proposes to modify the semiconductor device manufacturing method disclosure of Son which describes the formation of an insulated trench in the semiconductor substrate. According to the Examiner (Answer, page 3, which makes reference to the Office action mailed November 19, 1999, paper no. 6), Son discloses the claimed invention except for “... the formation of the gate oxide on the main surface of the substrate after the formation of the trench isolation.” To address this deficiency, the Examiner turns to Fulford which discloses the formation of a gate and a gate oxide layer as part of a semiconductor fabrication method employing shallow trench isolation. In the Examiner’s analysis (id.), the skilled artisan would have found it obvious to “... form the gate

oxide (38) on the main surface of the substrate (21) of Son as taught by Fulford so that the MOSFET can be completed.”

Appellants’ arguments in response to the obviousness rejection of independent claim 1 and 20 assert a failure of the Examiner to establish a prima facie case of obviousness since all of the claim limitations are not taught or suggested by the applied Sun and Fulford references. In particular, Appellants assert (Brief, pages 7-11; Reply brief, pages 1-4) that Fulford does not make up for the deficiency of Son in disclosing the step of forming a gate oxide layer on the main surface of a semiconductor substrate with the gate oxide layer “... having a thickness proximal to the edges greater than or equal to that of the remainder of the gate oxide layer” as claimed.

After careful review of the applied Son reference, relied on by the Examiner as providing a teaching of the claimed gate oxide layer thickness feature, we are in general agreement with Appellants’ position as stated in the Briefs. The Examiner has relied on portions of the disclosure of Son (e.g. column 1, lines 63-66) which teach that implanted impurities in the trench corners cause an increase in the oxidation rate at the trench corners to conclude that such a teaching suggests that a subsequently applied gate oxide layer will inherently have a thickness at the corners greater or equal to the remainder of the gate oxide layer. We agree with Appellants, however, that the Examiner has presented no evidence to support the conclusion that this will necessarily occur. “[T]he Board cannot simply reach conclusions based on its own understanding or experience - or on its assessment of what would be basic knowledge or common sense. Rather, the Board must point to some concrete evidence in the record in support of these findings.” In re Zurbo, 258 F.3d 1379, 1386, 59

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USPQ 2d 1693, 1697 (Fed. Cir. 2001). See also In re Lee, 277 F.3d 1338, 1344-45, 61 USPQ2d 1430, 1434-35 (Fed. Cir. 2002), in which the court required evidence for the determination of unpatentability by clarifying that the principles of “common knowledge” and “common sense” may only be applied to analysis of evidence, rather than be a substitute for evidence. The court has also recently expanded their reasoning on this topic in In re Thrift, 298 F. 3d 1357, 1363, 63 USPQ2d 2002, 2008 (Fed. Cir. 2002).

In the present factual situation we find ourselves in agreement with Appellants’ contention that factors such as Son’s complete silence as to the formation of gate oxide layers, as well as the formation of an oxide film 25a at the trench corners after an oxidation process, suggests that any conclusion as to thickness variations of a subsequently formed gate oxide layer could only be based on impermissible speculation. In our view, the Examiner’s conclusion that a gate oxide layer formed on the structure of Son would necessarily have a thickness at the trench edges greater or equal than the remainder of the gate oxide layer could not come from any suggestion or teaching in the Son or Fulford references themselves but rather only from Appellants’ own disclosure.

We have also reviewed the Liaw, Wolf, and Wristers references added to the Examiner’s proposed combination of Son and Fulford to address the particular size, energy, and temperature features of claims 4, 10, 12-15, 20, and 21. We find nothing, however, in any of these references which would overcome the innate deficiencies of Son and Fulford discussed supra.

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In view of the above discussion, since the Examiner has not established a prima facie case of obviousness, the rejection of independent claims 1 and 20, as well as claims 2-19 and 21 dependent thereon, is not sustained.

Turning to a consideration of the Examiner's 35 U.S.C. § 103(a) rejection of claims 22-35, we note that while we found Appellants' arguments to be persuasive with respect to the obviousness rejection of claims 1-21 discussed supra, we reach the opposite conclusion with respect to claims 22-35. In contrast to the previously discussed independent claims 1 and 20, which set forth a method of manufacturing a semiconductor device in which a trench liner is formed after the implantation of impurities, independent claim 22 is directed to an embodiment in which the trench oxide liner is formed prior to the ion implantation of impurities. In addressing the language of independent claim 22, the representative claim for Appellants' suggested grouping (including claims 22-30 and 33-35), the Examiner proposes the combination of Rho and Gardner.

Our review of the Examiner's stated position (Answer, page 3)³ reveals that the Examiner has pointed out the teachings of the Rho and Gardner references, has reasonably indicated the perceived differences between this applied prior art and the claimed invention, and has provided reasons as to how and why this prior art would have been modified and/or combined to arrive at the claimed invention. In our view, the Examiner's analysis is sufficiently reasonable that we find that the Examiner has at least satisfied the burden of presenting a prima facie case of obviousness. The

³ The statement of the grounds of rejection in the Answer makes reference to Office action mailed November 19, 1999, paper no. 6.

burden is, therefore, upon Appellants to come forward with evidence or arguments which persuasively rebut the Examiner's prima facie case of obviousness. Arguments which Appellants could have made but elected not to make in the Briefs have not been considered in this decision (note 37 CFR § 1.192).

Appellants' arguments in response (Brief, pages 15 and 16; Reply brief, page 4) focus on the contention that the Examiner has not established that the combination of Rho and Gardner would necessarily result in a semiconductor structure in which the gate oxide layer has thickness at the trench edges equal to or greater than the remainder of the gate oxide layer. After careful review of the Gardner reference, relied on by the Examiner to provide a teaching of the formation of a gate oxide layer with increased thickness over impurity enhanced areas at trench edges, we are in agreement with the Examiner's position as articulated in the Answer. Our interpretation of the disclosure of Gardner coincides with that of the Examiner, i.e., a clear suggestion exists (column 7, lines 63-65, column 8, lines 14-18, and Figure 14) that the formation of a gate oxide over trench edge regions containing implanted impurities would result in increased oxide growth over these regions. In our view, the skilled artisan, considering the collective teachings of the Rho and Gardner references, would have been motivated and found it obvious to combine the gate oxide formation teachings of Gardner with Rho to thereby arrive at Appellants' claimed invention.

We also find to be unpersuasive Appellants' contention (Brief, page 16) that Gardner grows a multi-thickness gate oxide layer by implanting impurities at right angles, in contrast to the acute angle implantation as claimed. In our view, Appellants' arguments focus on the individual

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differences between the limitations of the appealed claim 22 and each of the Rho and Gardner references. It is apparent, however, from the Examiner's line of reasoning in the Answer, that the basis for the obviousness rejection is the combination of Rho and Gardner. As pointed out by the Examiner (Answer, page 8), while Gardner does implant impurities at right angles, Rho provides a clear teaching of implanting impurities at acute angles. One cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. In re Keller, 642 F. 2d 413, 425, 208 USPQ 871, 881 (CCPA 1981); In re Merck & Co., Inc., 800 F. 2d 1091, 1096, 231 USPQ 375, 380 (Fed. Cir. 1986).

For the above reasons, since the Examiner's prima facie case of obviousness remains unrebutted by any convincing arguments of Appellants, the Examiner's 35 U.S.C. § 103(a) rejection of representative independent claim 22, as well as dependent claims 23-30 and 33-35 which fall with claim 22, is sustained.

We also sustain the Examiner's obviousness rejection of dependent claims 31 and 32, separately argued by Appellants, in which the Liaw reference is added to the combination of Rho and Gardner to address the energy and dosage values limitations of these claims. In our view, as pointed out by the Examiner (Answer, page 9), Liaw provides clear motivation, i.e., increasing the value of threshold voltage V_t for implanting impurities at the particular dosage and energy levels claimed by Appellants in the device of Rho as modified by Gardner. It is not necessary that references be combined for the same reason as Appellants. The reason or motivation to modify a reference may often suggest what the inventor has done, but for a different purpose or to solve a

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different problem. It is not necessary that the prior art suggest the same advantage or result discovered by Appellant. See In re Linter, 458 F.2d 1013, 1015, 173 USPQ 560, 562 (CCPA 1972); In re Dillon, 919 F.2d 688, 692, 16 USPQ2d 1897, 1901 (Fed. Cir. 1990), cert. denied, 500 U.S. 904 (1991).

In summary, with respect to the Examiner's 35 U.S.C. § 103(a) rejection of the appealed claims, we have sustained the rejection of claims 22-35, but have not sustained the rejection of claims 1-21. Therefore, the Examiner's decision rejecting claims 1-35 is affirmed-in-part.

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

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