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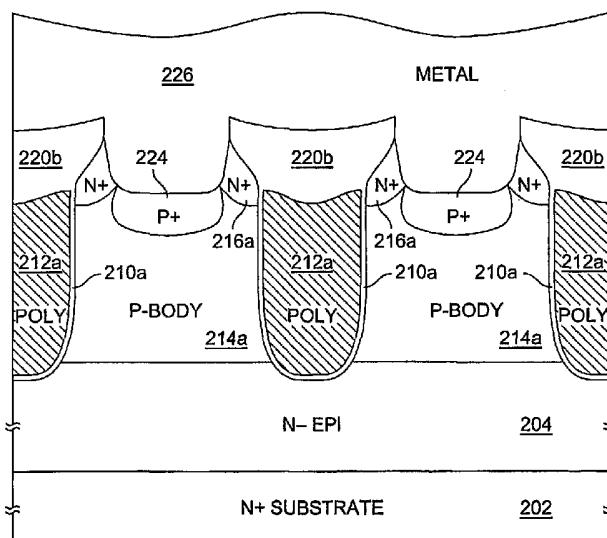
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[Continued on next page]

(54) Title: STRUCTURE AND METHOD FOR FORMING A TRENCH MOSFET HAVING SELF-ALIGNED FEATURES



(57) Abstract: In accordance with an embodiment of the present invention, a semiconductor device is formed as follows. An exposed surface area of a silicon layer where silicon can be removed is defined. A portion of the silicon layer is removed to form a middle section of a trench extending into the silicon layer from the exposed surface area of the silicon layer. Additional exposed surface areas of the silicon layer where silicon can be removed are defined. Additional portions of the silicon layer are removed to form outer sections of the trench such that the outer sections of the trench extend into the silicon layer from the additional exposed surface areas of the silicon layer. The middle section of the trench extends deeper into the silicon layer than the outer sections of the trench.



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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US04/15059

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : H01L 21/44

US CL : 438/597

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 438/597

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2003/0032274 (Daniels et al.) 13 February 2003 (13.02.2003), fig. 5, and paragraph [0171].	1-3, 7-18 nad 19-23
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Y	Applicant Admitted Prior Art, fig. 1.	5-6

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US04/15059

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
Please See Continuation Sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.: 1-23

Remark on Protest

☐
☐

The additional search fees were accompanied by the applicant's protest.

No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US04/15059

BOX III. OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING

Group I: claims 1-32, drawn to process of making dualdamascene in the silicon layer;

Species A: Claims 1-23, drawn to dualdamascene with deep mid-section and shallow outer sections.

Species B: Claims 24-25, drawn to dualdamascene with deep mid-section and shallow outer sections extending under the mask.

Species C: Claims 26-29, drawn to process of making semiconductor device with trenches.

Species D: Claims 30-32, drawn to process of making a semiconductor device with trench having sidewalls fanning out near the top of the trench.

Group II: Claims 33-43, drawn to semiconductor device.