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(54) Title: MULTI-LEVEL CONTACT TO A 3D MEMORY ARRAY AND METHOD OF MAKING

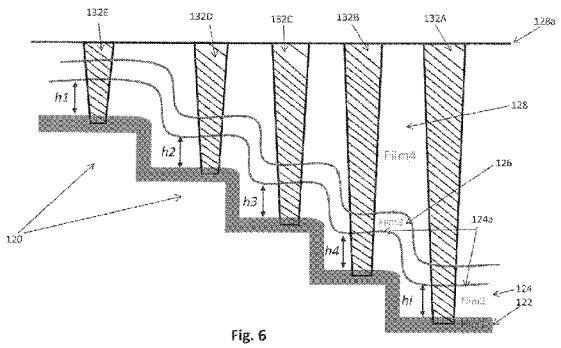


Fig. 6

(57) Abstract: A method of making multi-level contacts. The method includes providing an in-process multilevel device including at least one device region and at least one contact region. The contact region includes a plurality of electrically conductive layers configured in a step pattern. The method also includes forming a conformal etch stop layer (122) over the plurality of electrically conductive layers, forming a first electrically insulating layer (124) over the etch stop layer, forming a conformal sacrificial layer (126) over the first electrically insulating layer and forming a second electrically insulating layer (128) over the sacrificial layer. The method also includes etching a plurality of contact openings (130A-E) through the etch stop layer, the first electrically insulating layer, the sacrificial layer and the second electrically insulating layer in the contact region to the plurality of electrically conductive layers.

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INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
INV. H01L21/768 H01L27/115
ADD.

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)
H01L

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)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011/284943 A1 (HWANG SUNG-MIN [KR] ET AL) 24 November 2011 (2011-11-24)	1-3,9, 18,19, 23,24
A	paragraph [0071] - paragraph [0075] paragraph [0087] paragraph [0094] paragraph [0131] paragraph [0230] - paragraph [0243] paragraph [0248] paragraph [0255] - paragraph [0271]; figures 15,16,17DEGHi	4-8, 20-22

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[X] Further documents are listed in the continuation of Box C.

[X] 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 but published on or after the international filing date

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"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

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Date of the actual completion of the international search	Date of mailing of the international search report
30 August 2013	20/12/2013

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011/169071 A1 (UENAKA TSUNEO [JP] ET AL) 14 July 2011 (2011-07-14) paragraph [0038] - paragraph [0042] paragraph [0052] - paragraph [0053] paragraph [0061] paragraph [0084] paragraph [0091] - paragraph [0098] paragraph [0123] - paragraph [0128]; figures 4,12,18-21,30	1-3,9, 18,19, 23,24

A	US 2011/031546 A1 (UENAKA TSUNEO [JP] ET AL) 10 February 2011 (2011-02-10) paragraph [0037] - paragraph [0039] paragraph [0053] - paragraph [0055] paragraph [0062] - paragraph [0063] paragraph [0079]; figures 4,6b,7ab	4-8, 20-22

A	US 2010/013049 A1 (TANAKA HIROYASU [JP] ET AL) 21 January 2010 (2010-01-21) paragraph [0072] - paragraph [0082] paragraph [0095] - paragraph [0098] paragraph [0114]; figures 3,6,7	1-9, 18-24

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/041410

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:

see additional 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 fees, this Authority did not invite payment of additional fees.

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.:

1-9, 18-24

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-9, 18-24

A method of making a multi-level device comprising at least one device region and at least one contact region, the contact region comprising a plurality of electrically conductive layers configured in a step pattern, forming an ("second", i.e. non-conformal) electrically insulating layer over the plurality of electrically conductive layers, etching a contact opening through the electrically insulating layer,
-wherein a conformal etch stop layer, a (conformal) first electrically insulating layer, and a conformal sacrificial layer are formed prior to forming the (non-conformal) electrically insulating layer, and the contact openings are etched through all these four layers.

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2. claims: 10-17

A method of making a multi-level device comprising at least one device region and at least one contact region, the contact region comprising a plurality of electrically conductive layers configured in a step pattern, forming an ("second", i.e. non-conformal) electrically insulating layer over the plurality of electrically conductive layers, etching a contact opening through the electrically insulating layer,
-wherein a mask with a plurality of openings, and a slimming layer are used, for exposing openings in the mask successively, and etching the electrically insulating layer after each step of exposing.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2013/041410

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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