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(54) Title: LARGE-AREA, LATERALLY-GROWN EPITAXIAL SEMICONDUCTOR LAYERS

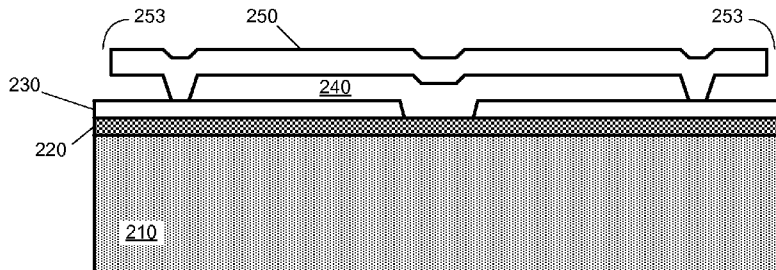


FIG. 3G

(57) Abstract: Structures and methods for confined lateral-guided growth of a large-area semiconductor layer on an insulating layer are described. The semiconductor layer may be formed by heteroepitaxial growth from a selective growth area in a vertically-confined, lateral- growth guiding structure. Lateral-growth guiding structures may be formed in arrays over a region of a substrate, so as to cover a majority of the substrate region with laterally-grown epitaxial semiconductor tiles. Quality regions of low-defect, stress-free GaN may be grown on silicon.



INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2014/029219

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - H01L 21/20 (2014.01)

USPC - 438/479

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)

IPC(8) - H01L 21/20, 21/36, 29/20 (2014.01)

USPC - 438/479, 481, 483, 486, 503; 257/615

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

CPC - H01L 21/02532, 21/0254, 21/0262 (2014.09)

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

Orbit, Google Patents, ProQuest

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2011/0065264 A1 (MOFFATT et al) 17 March 2011 (17.03.2011) entire document	1-34
Y	US 2012/0115293 A1 (NOH et al) 10 May 2012 (10.05.2012) entire document	1-34
Y	US 2010/0187568 A1 (ARENA) 29 July 2010 (29.07.2010) entire document	4-20
Y	US 2012/0043528 A1 (LO et al) 23 February 2012 (23.02.2012) entire document	7
Y	US 2013/0015492 A1 (HASHIMOTO et al) 17 January 2013 (17.01.2013) entire document	15, 19
Y	US 5,587,014 A (IYECHEKA et al) 24 December 1996 (24.12.1996) entire document	16, 20
Y	US 2013/0001682 A1 (TANG et al) 03 January 2013 (03.01.2013) entire document	28-30
Y	US 2004/0175844 A1 (YANG et al) 09 September 2004 (09.09.2004) entire document	32-34
Y	US 2012/0112603 A1 (MASAKI) 10 May 2012 (10.05.2012) entire document	34
A	US 2003/0211713 A1 (SUGURO al) 13 November 2003 (13.11.2003) entire document	1-34
A	US 2010/0171176 A1 (WELLS) 08 July 2010 (08.07.2010) entire document	1-34

Further documents are listed in the continuation of Box C.

* 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

"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

22 September 2014

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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 last page

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 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.:
1-34

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.

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I, claims 1-34, drawn to a method for covering an area of a substrate with a semiconductor, the method comprising removing a sacrificial material between the second insulating layer and first insulating layer region to form a lateral-growth guiding region for at least one selective growth area; heteroepitaxially growing the semiconductor under first growth conditions into the lateral-growth guiding region from the at least one selective growth area; removing the second insulating layer.

Group II, claims 35-45, drawn to a lateral-growth guiding structure comprising the exposed surface area is even with a surface of the seed structure covered by the first insulating layer; a second insulating layer having a second area less than the first area of the seed structure and spaced a distance from the first insulating layer, wherein the second area is substantially centered around the opening in the first insulating layer; and gas inlet openings located at a periphery of the second insulating layer.

Group III, claims 46-57, drawn to a tiled semiconductor substrate comprising a plurality of vias formed through the insulating layer; and a plurality of separated semiconductor tiles laterally grown from each via.

The inventions listed as Groups I, II and III do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

The special technical feature of the Group I invention: "removing a sacrificial material between the second insulating layer and first insulating layer region to form a lateral-growth guiding region for at least one selective growth area; heteroepitaxially growing the semiconductor under first growth conditions into the lateral-growth guiding region from the at least one selective growth area; removing the second insulating layer" as claimed therein is not present in the invention of Groups II and III. The special technical feature of the Group II invention: "the exposed surface area is even with a surface of the seed structure covered by the first insulating layer; a second insulating layer having a second area less than the first area of the seed structure and spaced a distance from the first insulating layer, wherein the second area is substantially centered around the opening in the first insulating layer; and gas inlet openings located at a periphery of the second insulating layer" as claimed therein is not present in the invention of Groups I or III. The special technical feature of the Group III invention: "a plurality of vias formed through the insulating layer; and a plurality of separated semiconductor tiles laterally grown from each via" as claimed therein is not present in the invention of Groups I or II.

Groups I, II and III lack unity of invention because even though the inventions of these groups require the technical feature of forming a first insulating layer to cover a crystal seed structure, wherein the first insulating layer also covers the area of the substrate; opening at least one opening in the first insulating layer to expose at least one selective growth area that exposes a surface area of the seed structure, this technical feature is not a special technical feature as it does not make a contribution over the prior art.

Specifically, US 2011/0065264 A1 (MOFFATT et al) 17 March 2011 (17.03.2011) teaches forming a first insulating layer to cover a crystal seed structure, wherein the first insulating layer also covers the area of the substrate (figs.7A-7D show forming a first insulating layer 402 to cover a crystal seed structure 408, wherein the first insulating layer also covers the area of the substrate 400, para. 0042); opening at least one opening in the first insulating layer to expose at least one selective growth area that exposes a surface area of the seed structure (figs. 7A-7D show opening at least one opening 406 in the first insulating layer 402 to expose at least one selective growth area that exposes a surface area of the seed structure 408, para. 0042).

Since none of the special technical features of the Group I, II or III inventions are found in more than one of the inventions, unity of invention is lacking.