

PATENT COOPERATION TREATY

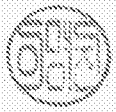
From the
INTERNATIONAL SEARCHING AUTHORITY

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

To: HOWARD, JAMES GREEN, HOWARD AND MUGHAL LLP 5 CENTERPOINTE DRIVE SUITE 400 LAKE OSWEGO OR 97035 USA		Date of mailing (day/month/year) 27 June 2018 (27.06.2018)	
Applicant's or agent's file reference 01P117320PCT		FOR FURTHER ACTION See paragraph 2 below	
International application No. PCT/US2017/053584	International filing date (day/month/year) 27 September 2017 (27.09.2017)	Priority date(day/month/year)	
International Patent Classification (IPC) or both national classification and IPC H01L 29/778(2006.01)i, H01L 29/06(2006.01)i, H01L 29/45(2006.01)i			
Applicant INTEL CORPORATION			
<p>1. This opinion contains indications relating to the following items:</p> <p><input checked="" type="checkbox"/> Box No. I Basis of the opinion</p> <p><input type="checkbox"/> Box No. II Priority</p> <p><input type="checkbox"/> Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p><input type="checkbox"/> Box No. IV Lack of unity of invention</p> <p><input checked="" type="checkbox"/> Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement</p> <p><input type="checkbox"/> Box No. VI Certain documents cited</p> <p><input type="checkbox"/> Box No. VII Certain defects in the international application</p> <p><input checked="" type="checkbox"/> Box No. VIII Certain observations on the international application</p> <p>2. FURTHER ACTION</p> <p>If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.</p> <p>If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.</p> <p>For further options, see Form PCT/ISA/220.</p>			

Name and mailing address of the ISA/KR International Application Division Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea Facsimile No. +82-42-481-8578	Date of completion of this opinion 27 June 2018 (27.06.2018)	Authorized officer LEE, Myung Jin Telephone No. +82-42-481-8474	
---	---	---	---

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.

PCT/US2017/053584

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of :
 - the international application in the language in which it was filed
 - a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))
2. This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43bis.1(a))
3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:
 - a. forming part of the international application as filed:
 - in the form of an Annex C/ST.25 text file.
 - on paper or in the form of an image file.
 - b. furnished together with the international application under PCT Rule 13ter.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.
 - c. furnished subsequent to the international filing date for the purposes of international search only:
 - in the form of an Annex C/ST.25 text file (Rule 13ter.1(a)).
 - on paper or in the form of an image file (Rule 13ter.1(b) and Administrative Instructions, Section 713).
4. In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
5. Additional comments:

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.

PCT/US2017/053584

Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	<u>1-25</u>	YES
	Claims	<u>NONE</u>	NO
Inventive step (IS)	Claims	<u>4-6,17,19,22</u>	YES
	Claims	<u>1-3,7-16,18,20-21,23-25</u>	NO
Industrial applicability (IA)	Claims	<u>1-25</u>	YES
	Claims	<u>NONE</u>	NO

2. Citations and explanations :

Reference is made to the following documents:

- D1: US 2012-0074524 A1 (TROY J. BAKER et al.) 29 March 2012
- D2: WO 2017-111852 A1 (INTEL CORPORATION) 29 June 2017
- D3: US 2017-0012130 A1 (INTERNATIONAL BUSINESS MACHINES CORPORAION et al.) 12 January 2017
- D4: US 2012-0119218 A1 (JIE SU) 17 May 2012
- D5: US 2012-0319127 A1 (SRABANTI CHOWDHURY et al.) 20 December 2012

1. Novelty and Inventive Step (PCT Article 33(2) and (3))

1.1 Concerning Claims 1-11

1.1.1 Independent Claim 1

D1, which is considered to be the closest prior art to the subject matter of **claim 1**, discloses a semiconductor structure, comprising:

a template (50) and ridges (51), wherein it is quite common to first start with a GaN template instead of a bare foreign substrate (see paragraph [0050]; and figures 5(a)-5(b) in D1); and

a grown nitride material (54) laterally growing over gaps (56) between the ridges (51) (see paragraph [0054]; and figures 5(a)-5(b) in D1).

The subject matter of claim 1 differs from that of D1 in that an island has a sloped sidewall. However, the feature can be easily derived from the feature of D2 (sidewall facets (326) may have a normal vector that is approximately 60° from a c-axis (see page 10, lines 5-6; and figure 4 in D2)). Accordingly, claim 1 would have been obvious over D1 in view of D2. Therefore, claim 1 lacks an inventive step under PCT Article 33(3).

Continued on Supplemental Box

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.

PCT/US2017/053584

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

Claim 5 is worded in reference to "first and second separations" of any one of claims 3 or 4. However, said 'first and second separations' has not been worded previously in claim 3. Therefore, claim 5 does not meet the requirement of PCT Article 6.

(Note: The international search report and the written opinion have been established on the assumption that claim 5 refers to claim 4.)

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of : Box No. V

1.1.2 Dependent Claims 2-3 and 7-11

The additional feature of **claim 2** can be easily derived from the combined features of D1 and D2 (a grown nitride material (54) starts on the ridge tops (52) (see paragraph [0054]; and figures 5(a)-5(b) in D1); and an III-N semiconductor island extends laterally beyond the trench (see claim 8; and figure 4 in D2)).

The additional feature of **claim 3** can be easily derived from the features of D1 (a template (50) and ridges (51), wherein it is quite common to first start with a GaN template instead of a bare foreign substrate (see paragraph [0050]; and figures 5(a)-5(b) in D1)).

The additional feature of **claim 7** is virtually suggested by the combined features of D1 and D2 (one could do cantilever epitaxy of AlN, do LEO of InGaN, or grow GaN (see paragraph [0076] in D1); and a heavily-doped III-N semiconductor (310) is grown primarily on a seeding surface (309) (see page 8, lines 1-2; and figure 3C in D2); and crystal quality in heavily-doped III-N semiconductor may vary as a function of the III-N material composition (e.g., Al, In, Ga, %), properties of the seeding surface, and III-N growth conditions (see page 8, lines 12-14 in D2)).

The additional feature of **claim 8** can be easily derived from the combined features of D1 and D2 (one could do cantilever epitaxy of AlN, do LEO of InGaN, or grow GaN (see paragraph [0076] in D1); and a semiconductor polarization layer (535) comprises AlGaN (see page 12, lines 16-17; and figure 5B in D2)).

The additional feature of **claim 9** can be easily derived from the feature of D1 (a template on a substrate is first coated with a masking material such as SiO₂ or silicon nitride (SiN_x) (see paragraph [0052] in D1)).

The additional feature of **claim 10** is virtually suggested by the combined features of D1 and D2 (for each of growth orientations, a crystal's c-axis will point towards the substrate, and all of planes within a single crystallographic family are equivalent (see paragraph [0062] in D1); and a substrate received is a substantially monocrystalline silicon substrate (see page 5, lines 16-17 in D2)).

Continued on The Next Page

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of : Previous Page

The additional feature of **claim 11** can be easily derived from the feature of D1 (one could do cantilever epitaxy of AlN, do LEO of InGaN, or grow GaN (see paragraph [0076] in D1)).

Accordingly, claims 2-3 and 7-11 would have been obvious over D1 in view of D2. Therefore, claims 2-3 and 7-11 lack an inventive step under PCT Article 33(3).

1.1.3 Dependent Claims 4-6

The additional feature of **claim 4** differs from the feature of the prior art document in that a cap extends laterally over a first separation between a first island and a second island, and extends laterally over a second separation between the first island and a third island, and it is not obvious to a person skilled in the art by the documents, taken alone or in combination.

Claim 5 is dependent on claim 4.

(Note: The international search report and the written opinion have been established on the assumption that claim 5 refers to claim 4)

The additional feature of **claim 6** differs from the feature of the prior art document in that a second and a third island have a first sidewall adjacent to a first island, and the first sidewall has a steeper slope than the sidewall of the first island, and it is not obvious to a person skilled in the art by the documents, taken alone or in combination.

Therefore, claims 4-6 meet the requirements of PCT Article 33(2) and (3) with respect to novelty and inventive step.

1.2 Concerning Claims 12-19

1.2.1 Independent Claim 12

D1, which is considered to be the closest prior art to the subject matter of **claim 12**, discloses a semiconductor materials system (see paragraph [0024] in D1), comprising:

a semiconductor film (see claim 1 in D1);

a template (50) and ridges (51), wherein it is quite common to first start with a GaN template instead of a bare foreign substrate (see paragraph [0050]; and figures 5(a)-5(b) in

Continued on The Next Page

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of : Previous Page

D1); and

a grown nitride material (54) laterally growing over gaps (56) between the ridges (51) (see paragraph [0054]; and figures 5(a)-5(b) in D1).

The subject matter of claim 12 differs from that of D1 in a memory, and a processor coupled to the memory; and one or more device terminals coupled to a cap ('A first feature'); and an island comprising a sloped sidewall ('A second feature'). However, the first feature can be easily derived from the feature of D2 (a memory chip (e.g., RAM), or a processor chip (e.g., a microprocessor, a multi-core microprocessor, graphics processor, or the like) (see page 15, lines 17-18 in D2); and a formation of transistor terminals (see page 13, lines 26-27 in D2)). In addition, the second feature can be easily derived from the feature of D2 (sidewall facets (326) may have a normal vector that is approximately 60° from a c-axis (see page 10, lines 5-6; and figure 4 in D2)). Accordingly, claim 12 would have been obvious over D1 in view of D2. Therefore, claim 12 lacks an inventive step under PCT Article 33(3).

1.2.2 Dependent Claims 13-16 and 18

The additional feature of **claim 13** can be easily derived from the feature of D2 (a pair of vertical III-N power transistors (601A, 601B) (see figure 6A in D2)).

The additional feature of **claim 14** can be easily derived from the combined features of D1 and D2 (one could do cantilever epitaxy of AlN, do LEO of InGaN, or grow GaN (see paragraph [0076] in D1); and a pair of vertical III-N power transistors (601A, 601B) (see figure 6A in D2); and a semiconductor polarization layer (535) comprising AlGaN (see page 12, lines 16-17; and figures 5B, 6A in D2)).

The additional feature of **claim 15** is virtually suggested by the features of D2 (gate electrode (650) being recessed, with no polarization layer (535) between a channel semiconductor and the gate electrode (650), and an interlayer dielectric (680) (see page 14, lines 4-5; and figure 6A in D2); and a source contact (660) and drain contacts (671, 672), wherein a polarization layer is grown over GaN layer forming a two-degree electron gas spanning a lateral spacing Li between the gate electrode, source electrode, and drain electrode (see page 1, lines 12-14; and figure 6B in D2)).

The additional feature of **claim 16** can be easily derived from the features of D2 (a substrate

Continued on The Next Page

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of : Previous Page

is silicon (see claim 13; and figure 6A in D2); and aIII-N semiconductor island is laterally expanded to be of sufficient size to host gate and source terminals (see page 11, lines 24-26 in D2)).

The additional feature of **claim 18** is merely a matter of design option from the combined features of D1 and D2 (Nitride light emitting diodes (LEDs) (see paragraph [0020] in D1); and a substrate is silicon (see claim 13; and figure 6A in D2); and a III-N semiconductor island is laterally expanded to be of sufficient size to host gate and source terminals (see page 11, lines 24-26 in D2)).

Accordingly, claims 13-16 and 18 would have been obvious over D1 in view of D2. Therefore, claims 13-16 and 18 lack an inventive step under PCT Article 33(3).

1.2.3 Dependent Claims 17 and 19

The additional feature of **claim 17** differs from the feature of the prior art document in that a layer of a III-N material comprising magnesium extends over a quantum well layer, and one or more device terminals coupled to a cap include a transparent electrode disposed over the layer of a III-N material comprising magnesium, and it is not obvious to a person skilled in the art by the documents, taken alone or in combination.

The additional feature of **claim 19** differs from the feature of the prior art document in that a semiconductor structure comprises a resonator, and one or more device terminals coupled to a cap include regions of an island comprising silicon that couple to the cap through the top of the island, wherein the cap comprises AlN, and it is not obvious to a person skilled in the art by the documents, taken alone or in combination.

Therefore, claims 17 and 19 meet the requirements of PCT Article 33(2) and (3) with respect to novelty and inventive step.

1.3 Concerning Claims 20-25

1.3.1 Independent Claim 20

D1, which is considered to be the closest prior art to the subject matter of **claim 20**,

Continued on The Next Page

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of : Previous Page

discloses a method for growing a semiconductor film (see claim 1 in D1), comprising:

etching windows (40) in a mask (41) to open, then etching a template (42) itself to form ridge structures (43) (see paragraph [0053]; and figures 4(a)-4(b) in D1), wherein it is quite common to first start with a GaN template instead of a bare foreign substrate (see paragraph [0050] in D1); and

growing a grown nitride material (54) laterally over gaps (56) between ridges (51) (see paragraph [0054]; and figures 5(a)-5(b) in D1).

The subject matter of claim 20 differs from that of D1 in islands extending over a length of a substrate and extending over a portion of a first dielectric layer ('A first feature'); and sloping a sidewall of the island by decomposing a first III-N material ('A second feature'). However, the first feature can be easily derived from the feature of D2 (an III-N semiconductor island extends laterally beyond a trench (see claim 8; and figure 4 in D2); and continued epitaxial growth of an n-GaN semiconductor (325) forms inclined, semi-polar sidewall facets (326) as a III-N crystal expands laterally over a dielectric layer (315) (see page 10, lines 3-5; and figure 4 in D2)). In addition, the second feature can be easily derived from the feature of D2 (sidewall facets (326) may have a normal vector that is approximately 60° from a c-axis (see page 10, lines 5-6; and figure 4 in D2)). Accordingly, claim 20 would have been obvious over D1 in view of D2. Therefore, claim 20 lacks an inventive step under PCT Article 33(3).

1.3.2 Dependent Claims 21 and 23-25

The additional feature of **claim 21** can be easily derived from the features of D2 (an interlayer dielectric (680) over a dielectric layer (315) (see figure 6A in D2); and a 2DEG (540) disposed between a polarization layer (535) and an interface with an n-III-N semiconductor (325) (see page 12, lines 22-24; and figure 5B in D2)).

The additional feature of **claim 23** can be easily derived from the feature of D1 (a template (50) and ridges (51), wherein it is quite common to first start with a GaN template instead of a bare foreign substrate (see paragraph [0050]; and figures 5(a)-5(b) in D1)

The additional feature of **claim 24** is virtually suggested by the feature of D1 (GaN is a refractory material and must be synthesized at elevated temperatures, and a very high over-pressure of nitrogen is required to prevent GaN from decomposing at elevated

Continued on The Next Page

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of : Previous Page

temperatures (see paragraph [0024] in D1)

The additional feature of **claim 25** can be easily derived from the feature of D1 (a grown nitride material (54) starts on ridge tops (52) and laterally grows over gaps (56) between ridges (51) (see paragraph [0054]; and figures 5(a)-5(b) in D1)

Accordingly, claims 21 and 23-25 would have been obvious over D1 in view of D2. Therefore, claims 21 and 23-25 lack an inventive step under PCT Article 33(3).

1.3.3 Dependent Claim 22

The additional feature of **claim 22** differs from the feature of the prior art document in that forming a second dielectric layer over a first dielectric layer comprises depositing a tensile-stressed dielectric material, and it is not obvious to a person skilled in the art by the documents, taken alone or in combination.

Therefore, claim 22 meets the requirements of PCT Article 33(2) and (3) with respect to novelty and inventive step.

2. Industrial Applicability (PCT Article 33(4))

Claims 1-25 are industrially applicable under PCT Article 33(4).