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INFORMATION DISCLOSURE STATEMENT BY APPLICANT <i>(Use as many sheets as necessary)</i>				Application Number	Not Yet Assigned
				Filing Date	April 8, 2010
				First Named Inventor	Alexander Lidow
				Art Unit	N/A
				Examiner Name	Not Yet Assigned
Sheet	1	of	1	Attorney Docket Number	E0101.0006/P006

U.S. PATENT DOCUMENTS					
Examiner Initials*	Cite No. ¹	Document Number	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		Number-Kind Code ² (if known)			
		2006/0273347	12-07-2006	Hikita et al.	

FOREIGN PATENT DOCUMENTS						
Examiner Initials*	Cite No. ¹	Foreign Patent Document	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T ⁶
		Country Code ³ -Number ⁴ -Kind Code ⁵ (if known)				

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. * CITE NO.: Those application(s) which are marked with an single asterisk (*) next to the Cite No. are not supplied (under 37 CFR 1.98(a)(2)(iii)) because that application was filed after June 30, 2003 or is available in the IFW. ¹ Applicant's unique citation designation number (optional). ² See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. ³ Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). ⁴ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁵ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁶ Applicant is to place a check mark here if English language Translation is attached.

NON PATENT LITERATURE DOCUMENTS				
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		X. Hu, et al. "Enhancement Mode AlGaIn/GaN HFET With Selectively Grown pn Junction Gate", <i>Electronics Letters</i> , Vol 35, No. 8, pp. 753-754, April 13, 2000		
		T. Fuji et al. " High On/Off Ratio in Enhancement-Mode Al _x Gax _{1-n} /GaIn Junction Heterostructure Field-Effect Transistors with P-Type GaN Gate Contact", <i>Japanese Journal of Applied Physics</i> , Vol. 45, No. 39, pp. L1048-L1050, 2006		
		Y. Uemoto et al. "Gate Injection Transistor (GIT) - A Normally-Off AlGaIn/GaN Power Transistor Using Conductivity Modulation, <i>IEEE Transactions on Electron Devices</i> , Vol. 54, No. 12, pp. 3393-3399, December 2007		
		W. Saito, et al. "High Breakdown Voltage AlGaIn-GaN Power-HEMT Design and High Current Density Switching Behavior", <i>IEEE Transactions on Electron Devices</i> , Vol. 50, No. 12, pp. 2528-2531, December 2003		

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹Applicant's unique citation designation mark (optional). ²Applicant is to place a check mark here if English language Translation is attached.

Examiner Signature		Date Considered	
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Electronic Patent Application Fee Transmittal				
Application Number:				
Filing Date:				
Title of Invention:		ENHANCEMENT MODE GaN HEMT DEVICE AND METHOD TO FABRICATE THE SAME		
First Named Inventor/Applicant Name:		Alexander Lidow		
Filer:		Stephen A. Soffen/Teresa Joel		
Attorney Docket Number:		E0101.0006/P006		
Filed as Small Entity				
Utility under 35 USC 111(a) Filing Fees				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Utility filing Fee (Electronic filing)	4011	1	82	82
Utility Search Fee	2111	1	270	270
Utility Examination Fee	2311	1	110	110
Pages:				
Claims:				
Claims in excess of 20	2202	3	26	78
Independent claims in excess of 3	2201	3	110	330
Miscellaneous-Filing:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				870

Electronic Acknowledgement Receipt	
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Application Number:	12756960
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Title of Invention:	ENHANCEMENT MODE GaN HEMT DEVICE AND METHOD TO FABRICATE THE SAME
First Named Inventor/Applicant Name:	Alexander Lidow
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
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1		6.PDF	4068094	yes	70
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	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Transmittal of New Application		1	1	
	Specification		2	12	
	Claims		13	20	
	Abstract		21	21	
	Drawings-only black and white line drawings		22	46	
	Oath or Declaration filed		47	51	
	Transmittal Letter		52	53	
	Information Disclosure Statement (IDS) Filed (SB/08)		54	54	
	NPL Documents		55	70	
Warnings:					
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2	Fee Worksheet (PTO-875)	fee-info.pdf	38079	no	2
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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UTILITY PATENT APPLICATION TRANSMITTAL <small>(ONLY FOR NEW NONPROVISIONAL APPLICATIONS UNDER 37 CFR 1.53(B))</small>		Attorney Docket No. E0101.0006/P006	
		First Inventor Alexander Lidow	
		Title ENHANCEMENT MODE GAN HEMT DEVICE AND METHOD TO FABRICATE THE SAME	
		Express Mail Label No. _____	

APPLICATION ELEMENTS <small>See MPEP chapter 600 concerning utility patent application contents.</small> 1. ☐ Fee Transmittal Form (e.g., PTO/SB/17) 2. ☒ Applicant claims small entity status. See 37 CFR 1.27. 3. ☒ Specification [Total Pages 20] <small>Both the claims and abstract must start on a new page (For information on the preferred arrangement, see MPEP 608.01(a))</small> 4. ☒ Drawing(s) (35 U.S.C. 113) [Total Sheets 25] 5. Oath or Declaration [Total Sheets 5] a. ☒ Newly executed (original or copy) b. ☐ A copy from a prior application (37 CFR 1.63(d)) <small>(for continuation/divisional with Box 18 completed)</small> i. ☐ DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) name in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b). 6. ☐ Application Data Sheet. See 37 CFR 1.76 7. ☐ CD-ROM or CD-R in duplicate, large table or Computer Program (Appendix) ☐ Landscape Table on CD 8. Nucleotide and/or Amino Acid Sequence Submission <small>(if applicable, items a. – c. are required)</small> a. ☐ Computer Readable Form (CRF) b. Specification Sequence Listing on: i. ☐ CD-ROM or CD-R (2 copies); or ii. ☐ Paper c. ☐ Statements verifying identity of above copies 18. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in the first sentence of the specification following the title, or in an Application Data Sheet under 37 CFR 1.76: ☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No.: _____ Prior application information: Examiner _____ Art Unit: _____	ADDRESS TO: Commissioner for Patents P.O. Box 1450 Alexandria, VA 22313-1450 ACCOMPANYING APPLICATION PARTS 9. ☒ Assignment Papers (cover sheet & document(s)) Name of Assignee <div style="border: 1px solid black; height: 20px; width: 100%;"></div> 10. ☐ 37 CFR 3.73(b) Statement ☐ Power of Attorney <small>(when there is an assignee)</small> 11. ☐ English Translation Document (if applicable) 12. ☒ Information Disclosure Statement (PTO/SB/08 or PTO-1449) ☒ Copies of citations attached 13. ☐ Preliminary Amendment 14. ☐ Return Receipt Postcard (MPEP 503) <small>(Should be specifically itemized)</small> 15. ☐ Certified Copy of Priority Document(s) <small>(if foreign priority is claimed)</small> 16. ☐ Nonpublication Request under 35 U.S.C. 122 (b)(2)(B)(i). Applicant must attach form PTO/SB/35 or equivalent. 17. ☐ Other: <div style="border: 1px solid black; height: 40px; width: 100%;"></div>
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Registration No. (Attorney/Agent)	31,063

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICATION FOR U.S. LETTERS PATENT

Title:

ENHANCEMENT MODE GaN HEMT DEVICE AND
METHOD FOR FABRICATING THE SAME

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DSMDB-2771739

ENHANCEMENT MODE GaN HEMT DEVICE AND METHOD FOR FABRICATING THE SAME

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority from U.S. Provisional Application No. 61/167,777, filed on April 8, 2009, which is hereby incorporated by reference in its entirety.

FIELD OF THE INVENTION

[0002] The present invention relates to the field of enhancement mode gallium nitride (GaN) high electron mobility transistor (HEMT) devices. In particular, the invention relates to a method and apparatus for providing an enhancement type HEMT device.

BACKGROUND OF THE INVENTION

[0003] Gallium nitride (GaN) semiconductor devices are increasingly desirable for power semiconductor devices because of their ability to carry large current and support high voltages. Development of these devices has generally been aimed at high power/high frequency applications. Devices fabricated for these types of applications are based on general device structures that exhibit high electron mobility and are referred to variously as heterojunction field effect transistors (HFET), high electron mobility transistors (HEMT), or modulation doped field effect transistors (MODFET).

[0004] A GaN HEMT device includes a nitride semiconductor with at least two nitride layers. Different materials formed on the semiconductor or on a buffer layer cause the layers to have different band gaps. The different material in the adjacent nitride layers also causes polarization, which contributes to a conductive two dimensional electron gas (2DEG) region near the junction of the two layers, specifically in the layer with the narrower band gap.

[0005] The nitride layers that cause polarization typically include a barrier layer of AlGaN adjacent to a layer of GaN to include the 2DEG, which allows charge to flow through the device. This barrier layer may be doped or undoped. Because the 2DEG region exists under the

gate at zero gate bias, most nitride devices are normally on, or depletion mode devices. If the 2DEG region is depleted, i.e. removed, below the gate at zero applied gate bias, the device can be an enhancement mode device. Enhancement mode devices are normally off and are desirable because of the added safety they provide and because they are easier to control with simple, low cost drive circuits. An enhancement mode device requires a positive bias applied at the gate in order to conduct current.

[0006] In conventional enhancement mode GaN transistors, the gate metal and the p-type GaN material or p-type AlGaIn material are defined by using separate photo masks. For example, FIG. 1 (prior art) shows the gate metal and gate pGaIn were processed with two different photo masks. FIG. 1 illustrates a conventional enhancement mode GaN transistor device 100 which includes substrate 101 which can be either sapphire or silicon, transition layers 102, un-doped GaN material 103, un-doped AlGaIn material 104, source ohmic contact metal 109, drain ohmic contact metal 110, p-type AlGaIn or p-type GaN material 105, heavily doped p-type GaN material 106, and gate metal 111.

[0007] As shown in FIG. 1, the gate metal, p-type GaN, or p-type AlGaIn material are defined by two separate photo masks. The first mask is used to form the p-type GaN or p-type AlGaIn, either by patterning a hard mask and selectively growing the p-type GaN or by patterning and etching the p-type GaN. The second mask is used to form the gate metal either by patterning and lifting off the gate metal or by patterning and etching the gate metal. The two mask process leads to wider gate length than photo/etch minimum CD. This causes high gate charge, wider cell pitch, and higher R_{dson} ("on resistance"). The conventional method of fabrication also increases manufacturing costs. Another disadvantage is that the highest electric field is located at the p-type GaN material or p-type AlGaIn material gate corner toward the drain ohmic contact metal. This high electric field leads to high gate leakage current and a gate reliability risk.

[0008] It would be desirable to provide an enhancement mode GaN transistor structure with a self-aligned gate which avoids the above-mentioned disadvantages of the prior art. It would also be desirable to provide a feature to relieve the high electric field at the gate corner of the p-type GaN or AlGaN.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 illustrates a cross-sectional view of a conventional enhancement mode GaN transistor.

[0010] FIG. 2 illustrates an enhancement mode GaN HEMT device formed according to a first embodiment of the present invention described herein.

[0011] FIGS. 3A-3E schematically illustrate the formation of an enhancement mode GaN HEMT device according to the first embodiment of the present invention.

[0012] FIG. 4 illustrates an enhancement mode GaN HEMT device formed according to a second embodiment of the present invention.

[0013] FIGS. 5A-5E schematically illustrate the formation of an enhancement mode GaN HEMT device according to the second embodiment of the present invention.

[0014] FIG. 6 illustrates an enhancement mode GaN HEMT device formed according to a third embodiment of the present invention.

[0015] FIGS. 7A-7F schematically illustrate the formation of an enhancement mode GaN HEMT device according to the third embodiment of the present invention.

[0016] FIG. 8 illustrates an enhancement mode GaN HEMT device formed according to a fourth embodiment of the present invention.

[0017] FIG. 9 illustrates an enhancement mode GaN HEMT device formed according to a fifth embodiment of the present invention.

[0018] FIG. 10 illustrates an enhancement mode GaN HEMT device formed according to a sixth embodiment of the present invention.

[0019] FIG. 11 illustrates an enhancement mode GaN HEMT device formed according to a seventh embodiment of the present invention.

[0020] FIG. 12 illustrates an enhancement mode GaN HEMT device formed according to an eighth embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0021] In the following detailed description, reference is made to certain embodiments. These embodiments are described with sufficient detail to enable those skilled in the art to practice them. It is to be understood that other embodiments may be employed and that various structural, logical, and electrical changes may be made.

[0022] The present invention is an enhancement mode GaN HEMT device with a gate metal material and a doped GaN or AlGa_N material that are self-aligned, and a method for making such a device. The materials are patterned and etched using a single photo mask, which reduces manufacturing costs. Furthermore, a field plate at source potential is patterned and etched together with drain and source ohmic contact metal. The field plate reduces the electric field at the gate corner of this enhancement mode GaN HEMT device.

[0023] Referring to FIGS. 2 and 3A-3E, a first embodiment is now described for forming an enhancement mode GaN HEMT device with a self-aligned gate, wherein like reference numbers are used consistently for like features throughout the drawings. FIG. 2 illustrates an enhancement mode GaN HEMT device 200 formed by the method described below with respect to FIGS. 3A-3E, which has a gate metal 17 and a p-type GaN material 15 that are self-aligned. Device 200 includes a silicon substrate 11, transition layers 12, un-doped GaN buffer material 13, un-doped AlGa_N barrier material 14, p-type GaN gate layer 15, gate metal 17, dielectric material 18, drain ohmic contact 19, and source ohmic contact 20. The source metal 20 also serves as a field plate that

extends over the gate and toward the drain contact. Layers 13, 14, and 15 are made of a III Nitride material. A III Nitride material can be composed of $\text{In}_x\text{Al}_y\text{Ga}_{1-x-y}\text{N}$, where $x + y \leq 1$.

[0024] FIG. 3A illustrates the EPI structure of GaN HEMT device 200a, including, from bottom up, silicon substrate 11, transition layers 12, un-doped GaN buffer material 13, un-doped AlGaN barrier layer 14, and p-type GaN gate layer 15. The un-doped GaN buffer material 13 preferably has a thickness of about 0.5 to about 5 μm . The un-doped AlGaN barrier layer 14 preferably has a thickness of about 50Å to about 300Å. The un-doped AlGaN barrier layer 14 includes Al from about 12 to 100 percent of the metallic content of the AlGaN material. The p-type GaN gate layer 15 may have a thickness of about 100Å to about 2000Å. Additionally, the p-type GaN gate layer may have a doping concentration between about 10^{18} to about 10^{21} atoms per cm^3 .

[0025] As shown in FIG. 3B, a gate metal 17 is deposited on the EPI structure shown in FIG. 3A. The gate metal 17, alternatively, can be grown at the end of EPI growth. Gate metal 17 can be made of a refractory metal or its compound, e.g., tantalum (Ta), tantalum nitride (TaN), titanium nitride (TiN), palladium (Pd), tungsten (W), tungsten silicide (WSi_2).

[0026] Subsequently, a single photo mask is used to pattern and etch the gate metal 17 and the p-type GaN gate layer 15, resulting in the structure shown in FIG. 3C. The gate metal 17 and the p-type GaN gate layer 15 are etched by any known technique, e.g., plasma etching, followed by a photoresist strip. The p-type GaN gate layer 15 can be under-etched, leaving about 0 to about 10 nm of the gate material outside of the gate region. The gate layer 15 can also be over-etched, removing about 0 to about 3 nm of the barrier layer 14 outside of the gate region. In the over-etching case, the barrier layer 14 is about 0 to about 3 nm thinner outside of the gate region than that in the gate region.

[0027] Referring now to FIG. 3D, a dielectric material 18, such as silicon nitride (Si_3N_4), is deposited. After deposition of the dielectric material 18, a contact photo mask is used to pattern and etch the dielectric material 18, followed by a photoresist strip, resulting in the structure shown in FIG. 3D.

[0028] Referring now to FIG. 3E, ohmic contact metal is deposited. Ohmic contact metal can be made of titanium (Ti), aluminum (Al), and a capping metal stack. After ohmic metal deposition, a metal mask is used to pattern and etch the ohmic contact metal, resulting in the drain ohmic contact 19 and the source ohmic contact 20, as shown in FIG. 3E. Rapid thermal anneal (RTA) is performed to form ohmic contacts to AlGaIn/GaN 2DEG. The source ohmic contact metal 20 is provided over the gate and acts as a field plate. It reduces the electric field at the corner of the p-type GaN material gate 15 closest to the drain ohmic contact 19.

[0029] In accordance with the above-described method, gate metal 17 and the p-type GaN material 15 are patterned and etched using a single photo mask and are thus automatically self-aligned. This reduces manufacturing cost. Minimum gate length can be the same as the photo/etch minimum CD, thereby minimizing gate charge. Cell pitch is reduced, thereby achieving lower R_{dsON} . Because the source ohmic contact metal 20 is used as a field plate to relieve the electric field at the p-type GaN material gate corner closest to the drain ohmic contact 19, lower gate leakage current and improved gate reliability are achieved. In addition, the field plate at source potential shields the gate from the drain bias, such that gate-drain charge (Q_{gd}) is reduced.

[0030] Referring to FIGS. 4 and 5A-5E, a second embodiment of the invention is now described. FIG. 4 illustrates an enhancement mode GaN HEMT device 200 formed by the method shown in FIGS. 5A-5E, which results in a gate metal 17, a p-type GaN gate layer 15, and a p-type AlGaIn material 21 that are self-aligned. Device 200 in FIG. 4 differs from device 200 of FIGS. 2 and 3A-3E in that it includes an additional layer, namely the layer formed of p-type AlGaIn material 21.

[0031] FIG. 5A illustrates the EPI structure, including, from bottom to top, silicon substrate 11, transition layers 12, un-doped GaN buffer material 13, un-doped AlGaIn barrier material 14, p-type AlGaIn material 21, and p-type GaN material 15. The dimensions and compositions of the various layers are similar to that of the first embodiment. The additional layer of p-type AlGaIn material 21 preferably has a thickness of about 20Å to about 300Å, and includes Al from about 12 to about 100 percent of the AlGaIn material.

[0032] As shown in FIG. 5B, as in the first embodiment, a gate metal 17 is deposited or grown on the EPI structure shown in FIG. 5A.

[0033] Subsequently, a single photo mask is used to pattern and etch the gate metal 17, the p-type GaN material 15, and, in this case, also the p-type AlGaN material 21, resulting in the structure shown in FIG. 5C.

[0034] Referring to FIG. 5D, as before, a dielectric, silicon nitride (Si_3N_4), is deposited, and a contact photo mask is used to pattern and etch the dielectric material 18, followed by a photoresist strip, resulting in the structure shown in FIG. 5D.

[0035] In FIG. 5E, as before, an ohmic contact metal is deposited, and a metal mask is used to pattern and etch the ohmic contact metal, resulting in the drain ohmic contact 19 and the source ohmic contact 20, as shown in FIG. 5E. Rapid thermal anneal (RTA) is performed to form ohmic contacts to AlGaN/GaN 2DEG.

[0036] In accordance with the above-described method, gate metal 17, the p-type GaN material 15, and the p-type AlGaN material are patterned and etched using a single photo mask and are thus self-aligned, with the same advantages as the first embodiment.

[0037] Referring to FIGS. 6 and 7A-7F, a third embodiment of the present invention is now described. This embodiment of the invention is similar to the second embodiment described above, but in this embodiment the p-type AlGaN material 21 extends from the gate towards a drain ohmic contact 19. The presence of the p-type AlGaN material 21 extending from the gate towards the drain ohmic contact 19 forms a region with reduced 2DEG density. This further reduces the electric field at the gate corner and at the corner of the field plate, leading to higher breakdown voltage and reduced gate-drain charge (Q_{gd}).

[0038] FIG. 7A-7C are similar to FIGS. 5A-5C described above. However, in 7C, a photo mask is used to pattern and etch only the gate metal 17 and the p-type GaN material 15 (and not the p-type AlGaN material 21), resulting in the self-aligned structure shown in FIG. 7C. Then, a photo mask is used to pattern and etch the p-type AlGaN material 21 in the pattern shown in FIG.

7D, such that the p-AlGa_N material 21 extends outwardly from the gate (in the direction where the drain contacts will be formed).

[0039] Referring now to FIG. 7E, the dielectric material 18, silicon nitride (Si₃N₄), is patterned and etched as before, and in FIG. 7F, the ohmic contact metal is formed as before.

[0040] In accordance with the above-described method, gate metal 17 and the p-type Ga_N material 15 are self-aligned. Additionally, the presence of the p-type AlGa_N material extension from the gate towards drain contact in this embodiment further reduces the electric field at the gate corner and at the corner of the field plate, leading to higher breakdown voltage and reduced gate-drain charge (Q_{gd}).

[0041] Referring to FIG. 8, a fourth embodiment of the present invention is now described. This embodiment of the invention is similar to the first embodiment described above, except that the p-type Ga_N material 15 has been etched such that the bottom of the material is more than 10% wider than the top of the material, leading to sloped edges.

[0042] To achieve the sloped edges of p-type Ga_N material 15, the etching chemistry is modified. In a preferred embodiment, plasma etch is used and the power settings are modified to control the slope of the p-type Ga_N material. Thus, in accordance with the above-described method, the p-type Ga_N has a base that is more than 10% wider than the top. The wider base causes a longer path for electrons to travel between the gate metal 17 and the 2DEG along the pGa_N side wall. This longer path results in lower gate leakage.

[0043] Referring to FIG. 9, a fifth embodiment of the present invention is now described. This embodiment of the invention is similar to the first embodiment described above, except that the device has been etched to create a stepped gate.

[0044] The method of this embodiment follows the process in FIGS. 3A-3C. Following the step shown in FIG. 3C, the wafer is placed back in an etching machine that only etches the gate metal layer 17, without etching any other part of the device. The resulting structure, as shown in FIG. 9, has a stepped profile, which creates a longer resistance path for electrons to flow from the

gate metal 17 to the 2DEG along the p-type GaN edge. This reduces the undesirable gate leakage current while maintaining all the desirable characteristics of a self-aligned structure.

[0045] Referring to FIG. 10, a sixth embodiment of the present invention is now described. This embodiment is essentially a combination of the fourth and fifth embodiments described above, and includes both a stepped gate profile and a p-type GaN material with sloped edges. The method used to create this structure is similar to that as described above with respect to the fourth and fifth embodiments. This embodiment increases the gate current path along the gate edges, thereby reducing gate leakage current.

[0046] Referring to FIG. 11, a seventh embodiment of the present invention is now described. This embodiment is similar to the first embodiment except that the p-type GaN material 15 has a symmetric ledge next to the AlGaIn barrier. The method follows the process in FIGS. 3A-3B. Following the step shown in FIG. 3B, the self-aligned gate etch is conducted so that the etching conditions are changed during the etching process. One way of doing this is to change the temperature of the chuck upon which the wafer is placed during the etching process. A higher chuck temperature causes more polymers to be formed as a consequence of the plasma reacting with photoresist. These polymers effectively slow down the etch in close proximity to the sidewall of the gate metal thus creating a ledge. Low chuck temperatures do not produce a significant ledge, while higher temperatures produce a wide ledge. The seventh embodiment also has the benefit of the third embodiment. The p-type GaN ledge acts like the p-type AlGaIn in the third embodiment to reduce 2DEG density, reduce the electric field at the gate corner, and improve device breakdown voltage.

[0047] Referring to FIG. 12, an eighth embodiment of the present invention is now described. This embodiment is essentially a combination of the fifth and seventh embodiments described above, and includes both a stepped gate profile and a symmetric ledge. The method used to create this structure is similar to that as described above with respect to the fifth and seventh embodiments. This embodiment has the advantage of both the fifth and seventh embodiments, thereby providing a structure that reduces gate leakage current.

[0048] In a ninth embodiment, the p-GaN material 15 is formed by introducing magnesium (Mg) impurities during the growth of the top EPI layer, for example, in FIG. 3A. Magnesium is the most common impurity atom used to create acceptor-rich (p-type) GaN.

[0049] In a tenth embodiment, magnesium impurities are compensated with hydrogen resulting in a semi-insulating p-type GaN layer instead of a conducting layer. There are several advantages to having a semi-insulating gate. One of the advantages is that the leakage current between the gate and source or drain is reduced. Another advantage is that the diode that is formed between the p-type GaN and the AlGaN has a lower forward drop than the diode formed between semi-insulating GaN and AlGaN. In devices of this embodiment, the diode forward drop is so high that it does not significantly conduct until the 2DEG is fully enhanced (between 1V and 5V).

[0050] In an eleventh embodiment, carbon impurities are introduced during the growth of the GaN gate layer 15 and no magnesium is used. Carbon impurities have a similar impact on the electrical characteristics of the GaN gate layer as magnesium compensated with hydrogen.

[0051] In a twelfth embodiment, magnesium impurities compensated with hydrogen are used with carbon impurities. This results in a semi-insulating GaN gate with improved electrical characteristics.

[0052] The above description and drawings are only to be considered illustrative of specific embodiments, which achieve the features and advantages described herein. Modifications and substitutions to specific process conditions can be made. Accordingly, the embodiments of the invention are not considered as being limited by the foregoing description and drawings.

CLAIMS

1. An enhancement-mode GaN transistor comprising:

a substrate,

transition layers,

a buffer layer comprised of a III Nitride material,

a barrier layer comprised of a III Nitride material,

drain and source contacts,

a gate III-V compound containing acceptor type dopant elements, and

a gate metal, wherein the gate III-V compound and the gate metal are formed with a single photo mask process to be self-aligned.
2. The transistor of claim 1, wherein the buffer layer is comprised of InAlGa_N.
3. The transistor of claim 1, wherein the barrier layer is comprised of InAlGa_N with a larger band gap than the buffer layer.
4. The transistor of claim 1, wherein the bottom of the gate metal and the top of the gate III-V compound have the same dimension, and the side walls of the gate III-V compound have an angle of about 80 to about 90 degrees.

5. The transistor of claim 1, wherein side walls of the gate III-V compound have an angle of about 30 to about 80 degrees.

6. The transistor of claim 1, wherein the gate III-V compound and the gate metal are formed with a single photo mask process to be self-aligned and the gate metal is narrower than the gate III-V compound so that there are symmetric ledges at the top of the gate compound.

7. The transistor of claim 6, wherein side walls of the gate III-V compound have an angle of about 80 to about 90 degrees.

8. The transistor of claim 6, wherein side walls of the gate III-V compound are sloped having an angle of 30 to 80 degrees.

9. The transistor of claim 1, wherein the gate III-V compound and the gate metal are formed with a single photo mask process to be self-aligned, the bottom of the gate metal and the top of the gate III-V compound have nearly the same dimension, and the bottom of the gate III-V compound contains symmetric ledges just above the barrier layer.

10. The transistor of claim 1, wherein the gate III-V compound and the gate metal are formed with a single photo mask process to be self-aligned, the gate metal is narrower than the gate III-V compound so that there are symmetric ledges at the top of the gate III-V compound, and the bottom of the gate III-V compound contains symmetric ledges just above the barrier layer.

11. The transistor of claim 1, wherein the gate III-V compound is GaN doped with acceptor type dopants such Mg, C, Zn, Ca and the p-type dopants are activated.
12. The transistor of claim 1, wherein the gate III-V compound is GaN doped with acceptor type dopants such Mg, C, Zn, Ca and the p-type dopants are compensated with hydrogen.
13. The transistor of claim 1, wherein the gate III-V compound contains an AlGaN layer and a GaN layer doped with acceptor type dopants such as Mg, C, Zn, Ca.
14. The transistor of claim 1, wherein the gate III-V compound contains an AlGaN layer and a GaN layer, the gate metal and the gate GaN are etched with a single photo mask process, and the gate AlGaN extends towards the drain due to a second photo mask process.
15. The transistor of claim 1, wherein the gate metal is TiN.
16. The transistor of claim 1, wherein the gate metal contains one or more refractory metals, metallic compounds and alloys, such as Ta, W, TaN, TiN, WN, WSi.
17. An enhancement-mode GaN transistor comprising:

a substrate,

transition layers,

a buffer layer comprised of a III Nitride material,
a barrier layer comprised of a III Nitride material,
drain and source contacts,
a gate III-V compound containing acceptor type dopant elements,
a gate metal, and
a field plate made of Ohmic metal, wherein a drain Ohmic metal, a source Ohmic metal, and the field plate are formed by a single photo mask process.

18. A method of forming an enhancement mode GaN transistor, the method comprising:
nucleating and growing transition layers on a substrate;
growing an III Nitride EPI layer over the transistor layers;
growing an III Nitride barrier layer over the EPI layer;
growing a GaN layer with acceptor type dopants over the barrier layer;
depositing a gate contact layer on the doped GaN layer;
applying a gate photo resistant pattern;
etching away the gate contact layer outside the gate region;
etching away the doped GaN layer, except a portion of the doped GaN layer beneath the gate contact;
removing the gate photo resistant pattern;

depositing a dielectric layer;

applying a contact photo resistant pattern;

etching the dielectric layer to open the drain and source contact area;

removing the contact photo resistant pattern;

depositing an Ohmic contact metal;

applying a metal photo resistant pattern;

etching the Ohmic contact metal;

removing the metal photo resistant pattern; and

performing rapid thermal annealing to form Ohmic drain and source contacts.

19. The method of claim 18, wherein the EPI layer is comprised of InAlGa_N.

20. The method of claim 18, wherein the barrier layer is comprised of InAlGa_N with a larger band gap than the buffer layer.

21. A method of forming an enhancement mode GaN transistor, the method comprising:

nucleating and growing transition layers on a substrate;

growing an InAlGa_N EPI layer over the transistor layers;

growing an InAlGa_N barrier layer over the InAlGa_N EPI layer;

growing an InAlGa_N layer with acceptor type dopants over the InAlGa_N barrier layer;

growing a GaN layer with acceptor type dopants over the doped InAlGa_N layer;

depositing a gate contact layer on the doped GaN layer

applying a gate photo resistant pattern;

etching away the gate contact layer outside the gate region;

etching away the doped GaN layer and the doped InAlGa_N layer, except for portions of the doped GaN layer and the doped InAlGa_N layer beneath gate contact;

removing the gate photo resistant pattern;

depositing a dielectric layer;

applying a contact photo resistant pattern;

etching the dielectric layer to open the drain and source contact area;

removing the contact photo resistant pattern;

depositing an Ohmic contact metal;

applying a metal photo resistant pattern;

etching the Ohmic contact metal;

removing the metal photo resistant pattern; and

performing rapid thermal annealing to form Ohmic drain and source contacts.

22. A method of forming an enhancement mode GaN transistor, the method comprising:

- nucleating and growing transition layers on a substrate;
- growing an InAlGa_N EPI layer over the transistor layers;
- growing an AlGa_N barrier layer over the InAlGa_N EPI layer;
- growing an AlGa_N layer with acceptor type dopants over the AlGa_N barrier layer;
- growing a Ga_N layer with acceptor type dopants over the doped AlGa_N layer;
- depositing a gate contact layer on the doped Ga_N layer
- applying a gate photo resistant pattern;
- etching away the gate contact layer outside the gate region;
- etching away the doped Ga_N layer, except for portions of the doped Ga_N layer and the doped AlGa_N layer beneath gate contact;
- removing the gate photo resistant pattern;
- applying another photo resistant pattern;
- etching the doped AlGa_N layer such that the doped AlGa_N extends outside the gate region towards the drain;
- removing the photo resistant pattern;
- depositing a dielectric layer;
- applying a contact photo resistant pattern;
- etching the dielectric layer to open the drain and source contact area;

removing the contact photo resistant pattern;
depositing an Ohmic contact metal;
applying a fourth photo resistant pattern;
etching the Ohmic contact metal
removing the fourth photo resistant pattern; and
performing rapid thermal annealing to form Ohmic drain and source contacts.

23. An enhancement-mode GaN transistor comprising:

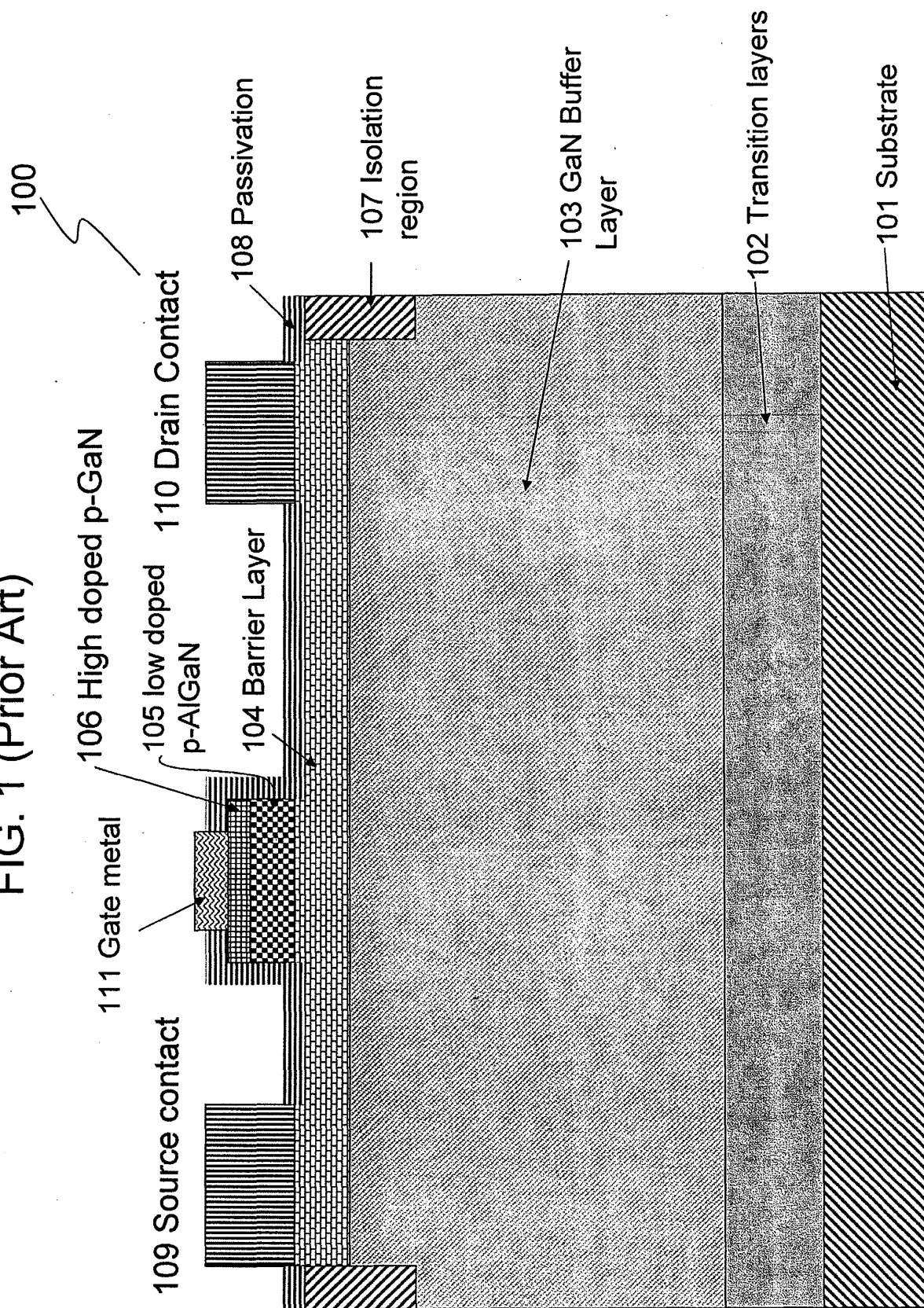
a substrate,
transition layers,
a buffer layer comprised of a III Nitride material,
a barrier layer comprised of a III Nitride material,
drain and source contacts comprised of Ohmic metal,
a gate III-V compound containing acceptor type dopant elements,
a gate metal, and
a field plate comprised of Ohmic metal,

wherein the gate III-V compound and the gate metal are formed with a single photo mask process to be self-aligned, and wherein the field plate, drain Ohmic metal, and source Ohmic metal are formed by a single photo mask process.

ABSTRACT

An enhancement-mode GaN transistor and a method of forming it. The enhancement-mode GaN transistor includes a substrate, transition layers, a buffer layer comprised of a III Nitride material, a barrier layer comprised of a III Nitride material, drain and source contacts, a gate III-V compound containing acceptor type dopant elements, and a gate metal, where the gate III-V compound and the gate metal are formed with a single photo mask process to be self-aligned and the bottom of the gate metal and the top of the gate compound have the same dimension. The enhancement mode GaN transistor may also have a field plate made of Ohmic metal, where a drain Ohmic metal, a source Ohmic metal, and the field plate are formed by a single photo mask process.

FIG. 1 (Prior Art)



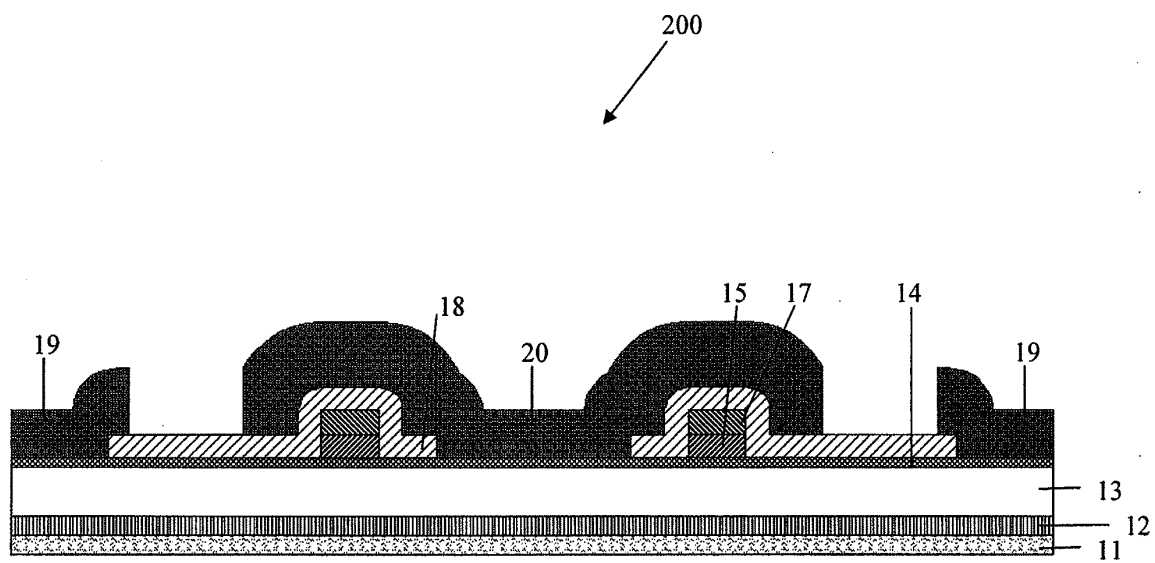


FIG. 2

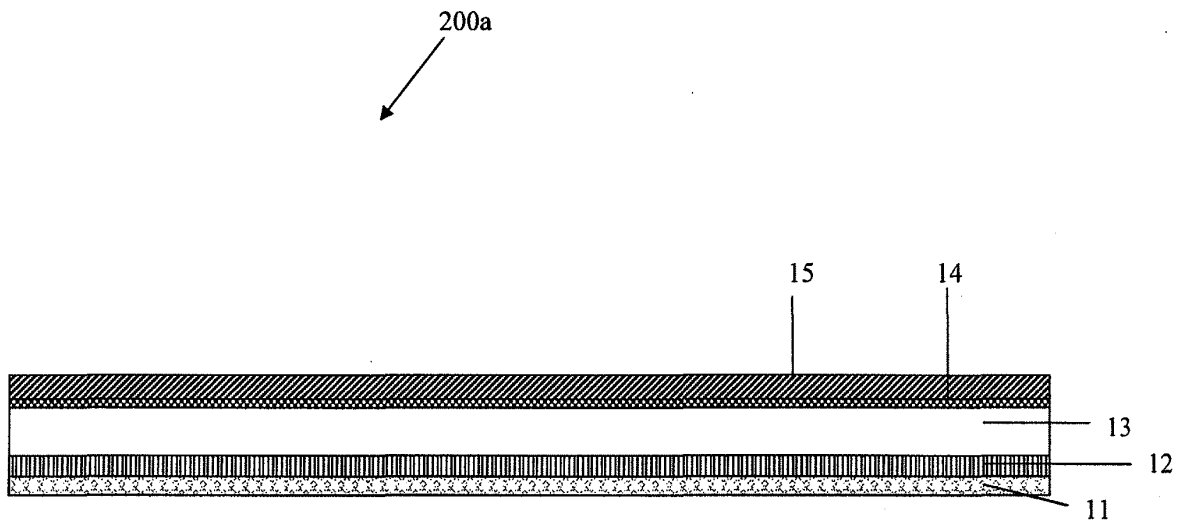


FIG. 3A

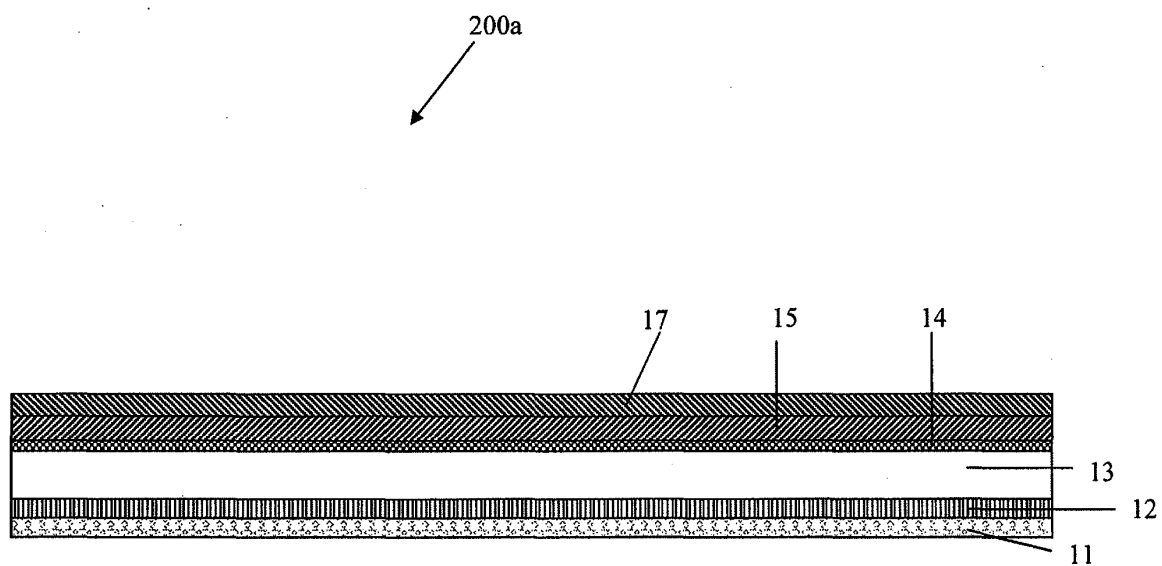


FIG. 3B

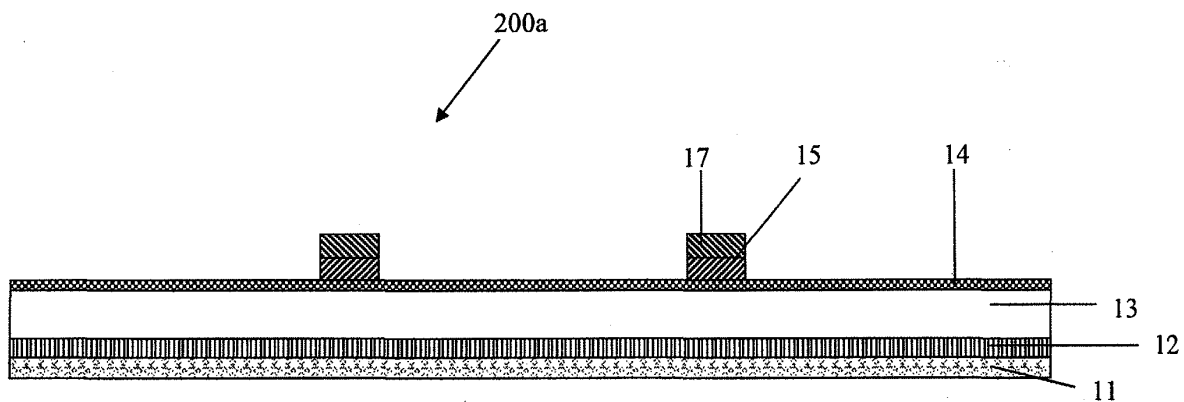


FIG. 3C

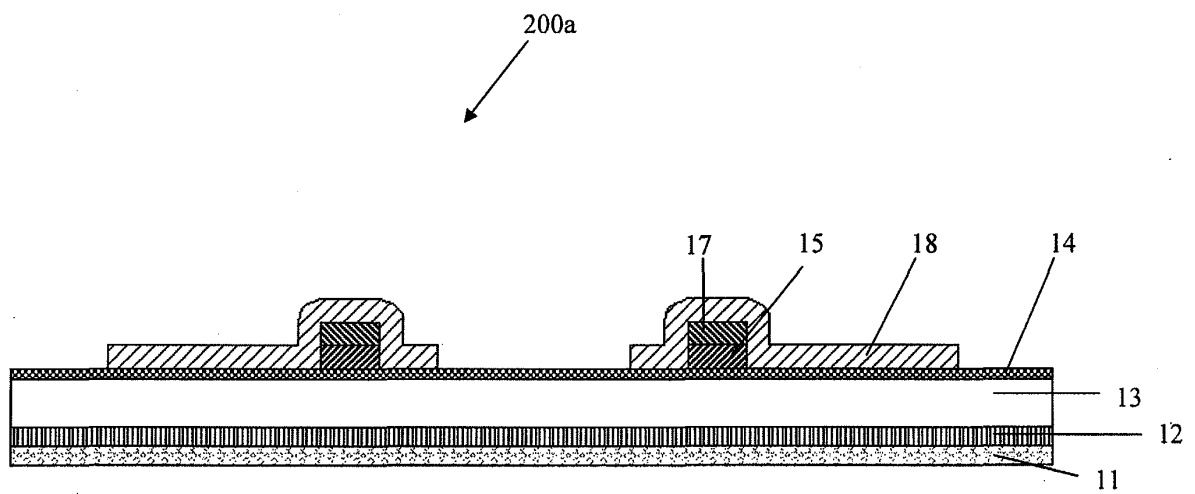


FIG. 3D

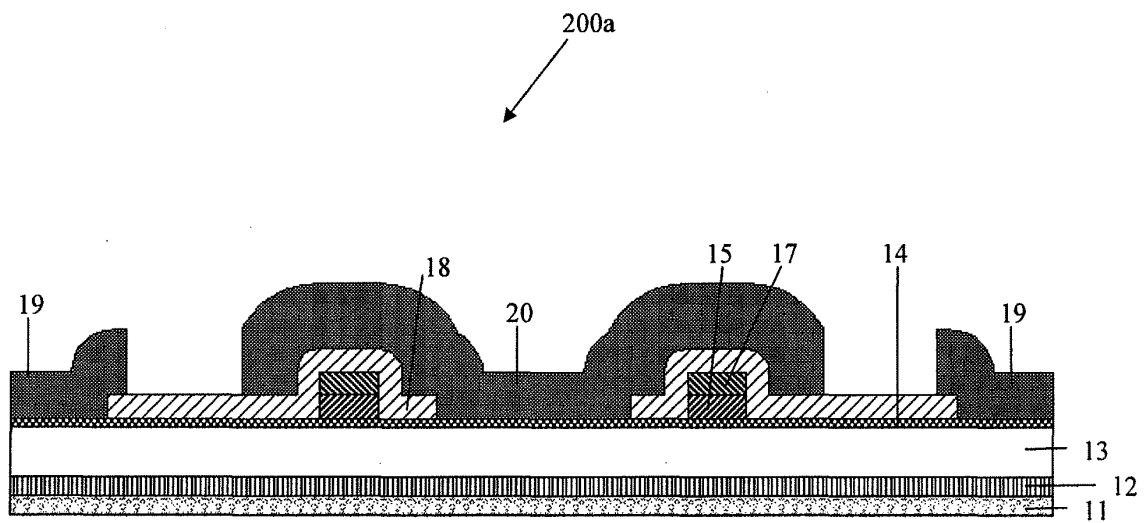


FIG. 3E

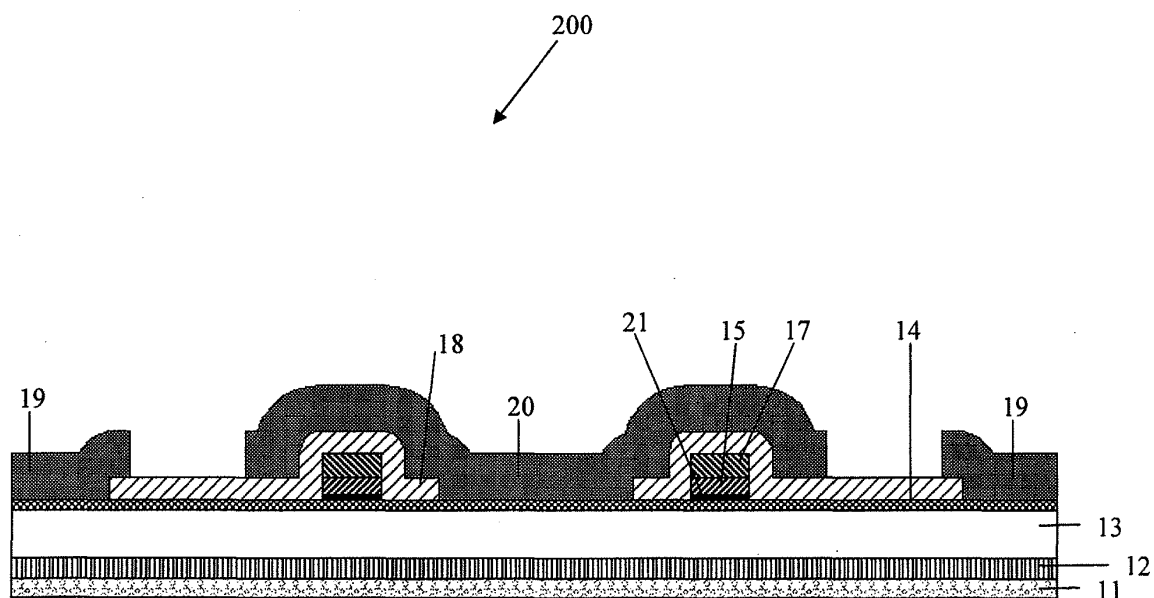


FIG. 4

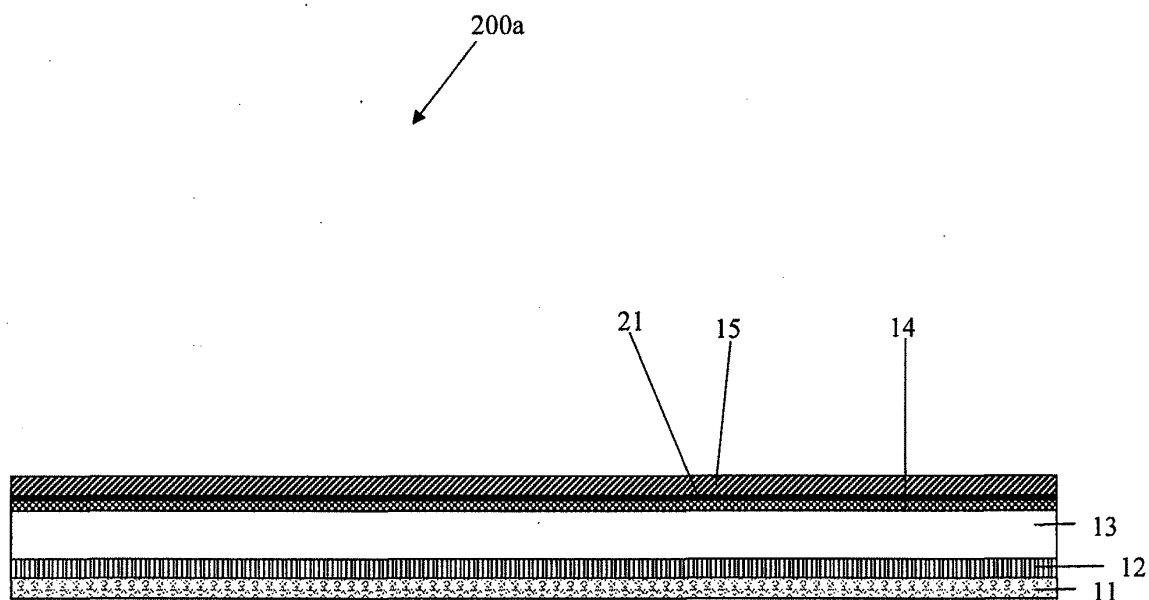


FIG. 5A

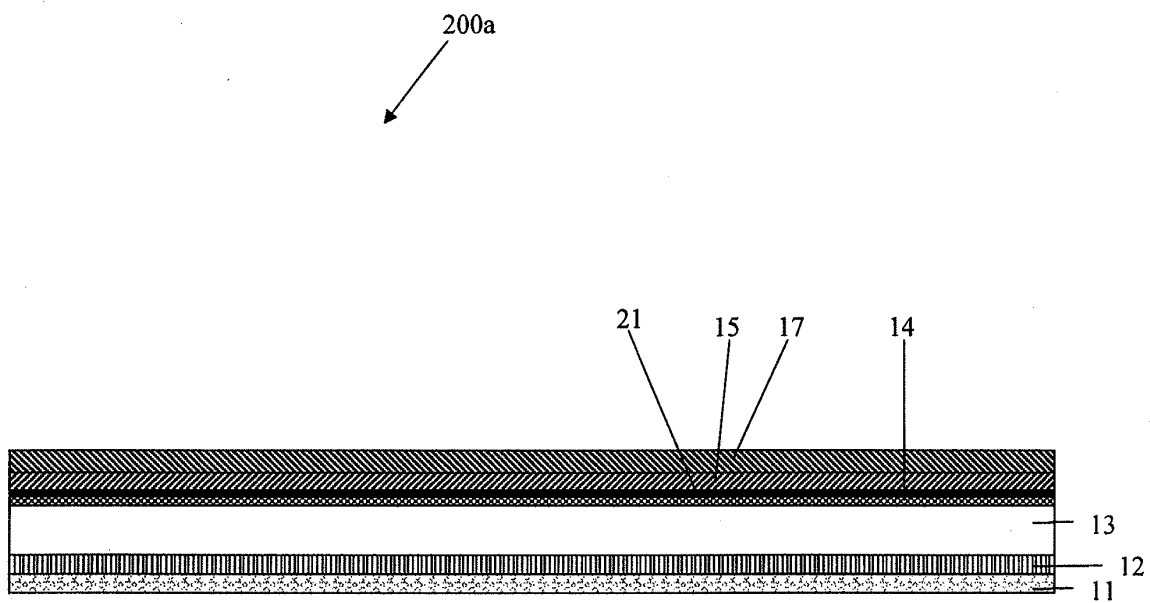


FIG. 5B

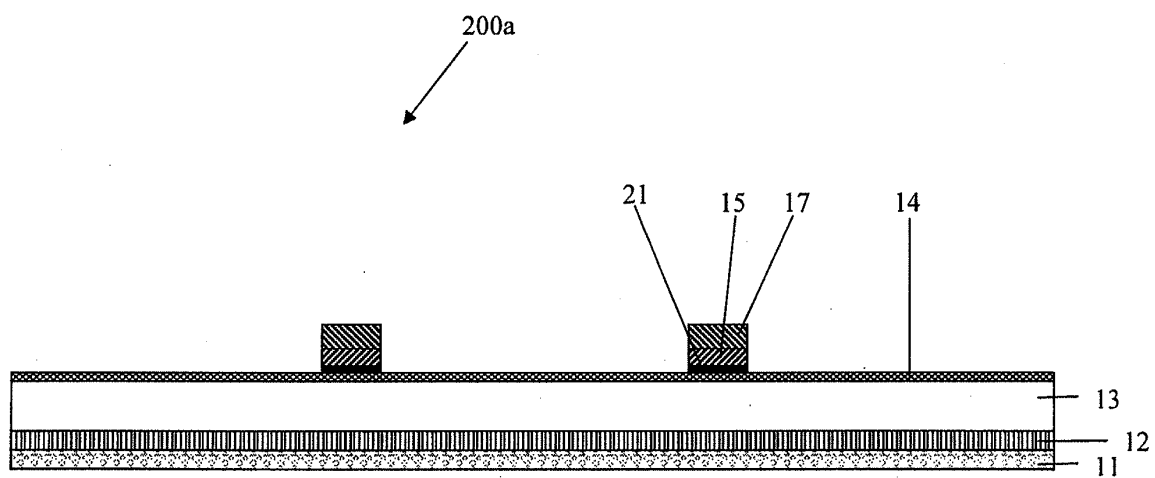


FIG. 5C

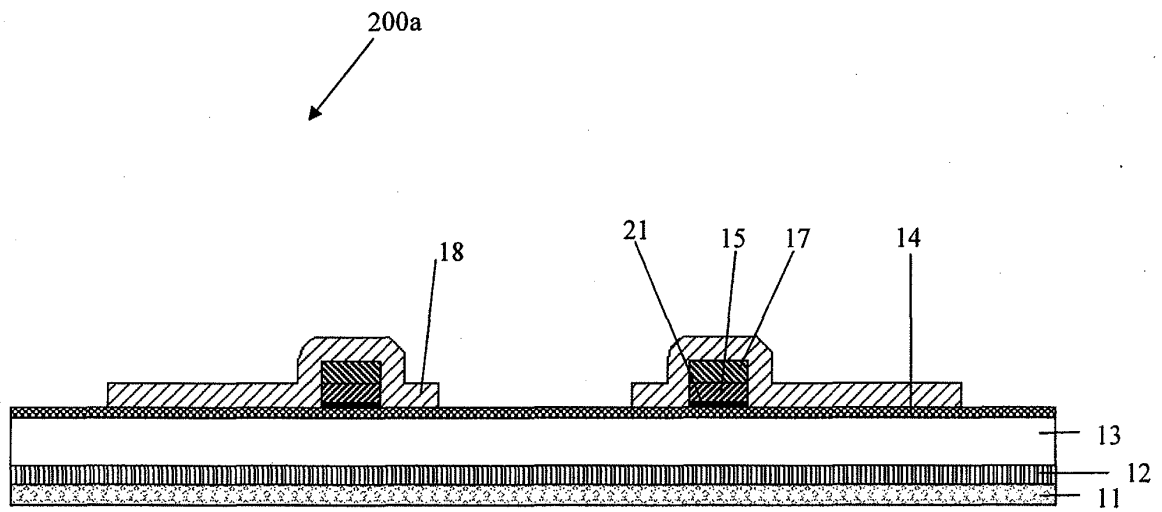


FIG. 5D

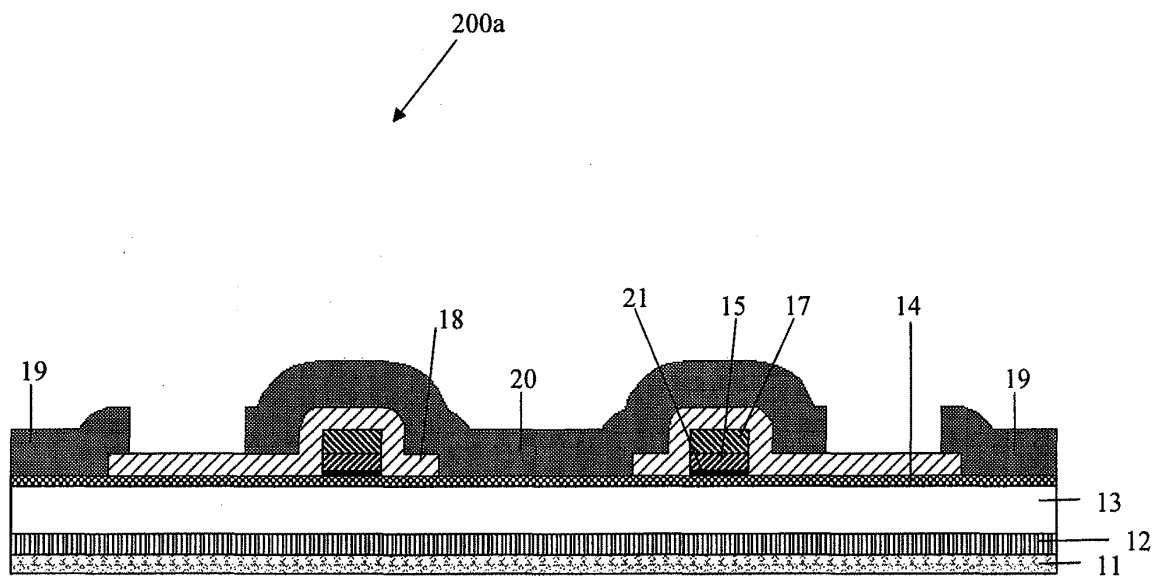


FIG. 5E

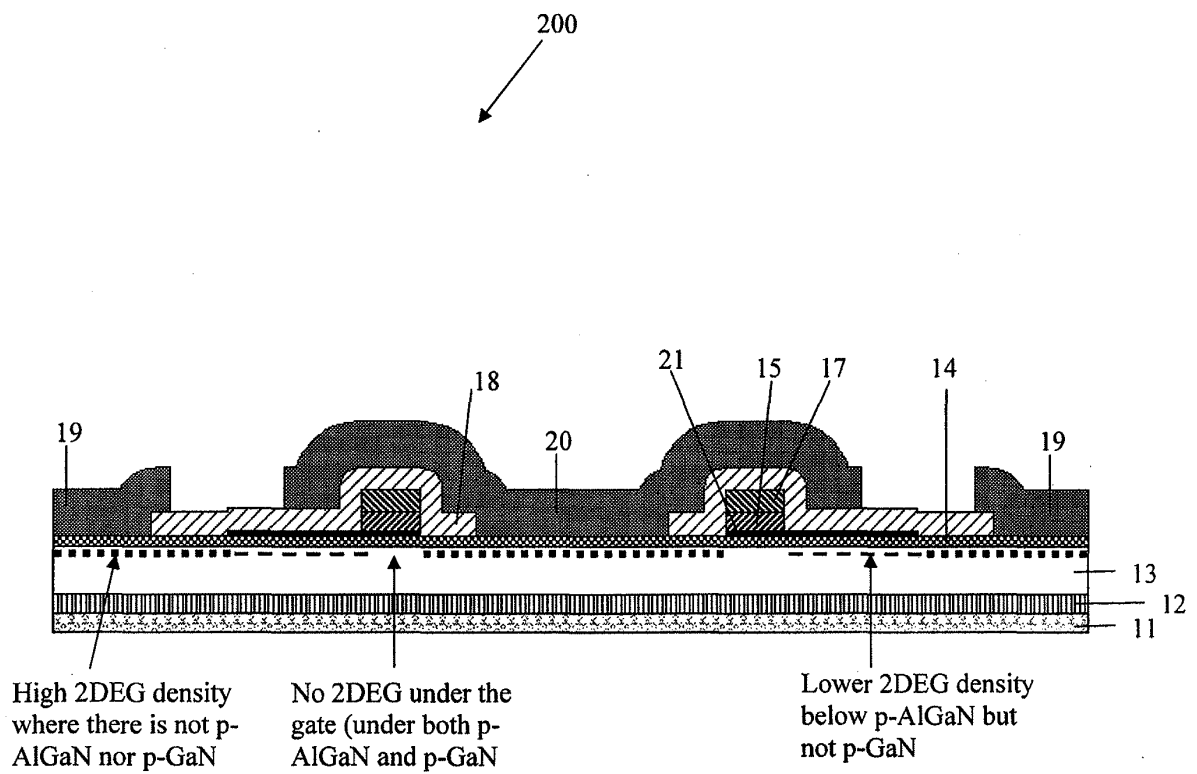


FIG. 6

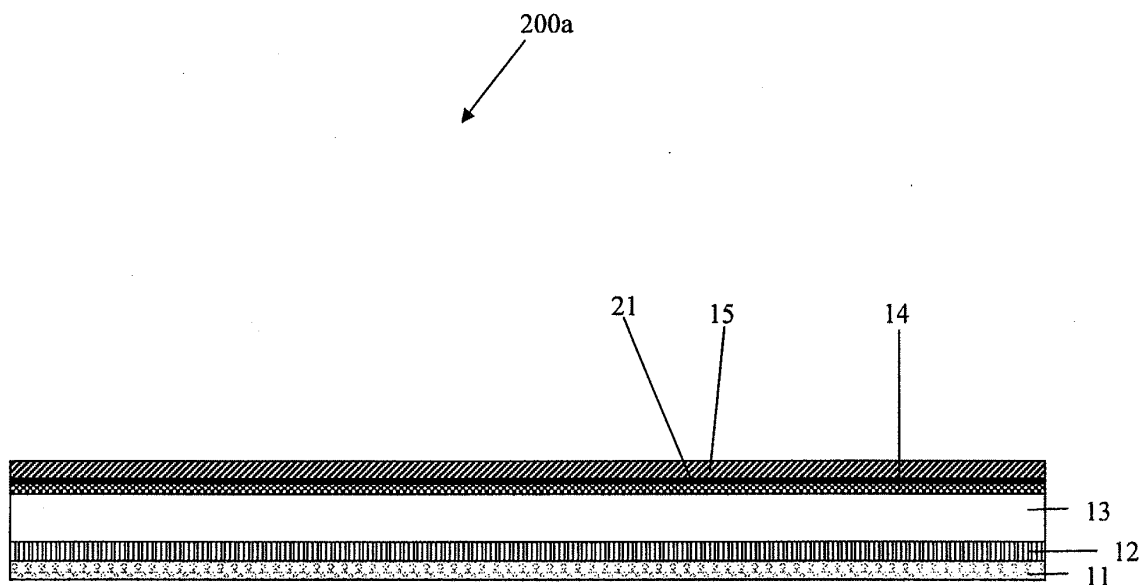


FIG. 7A

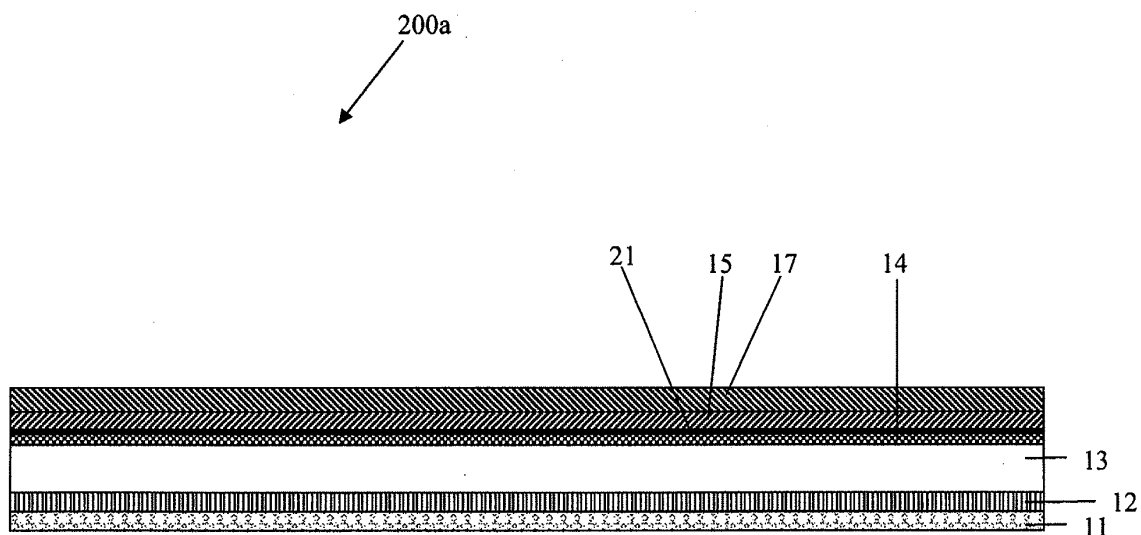


FIG. 7B

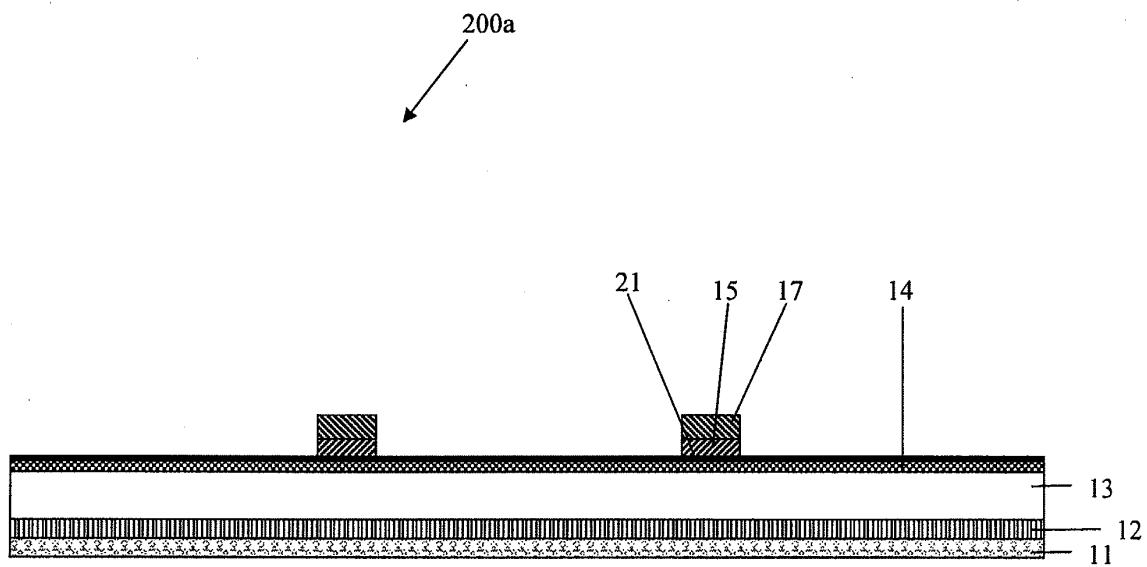


FIG. 7C

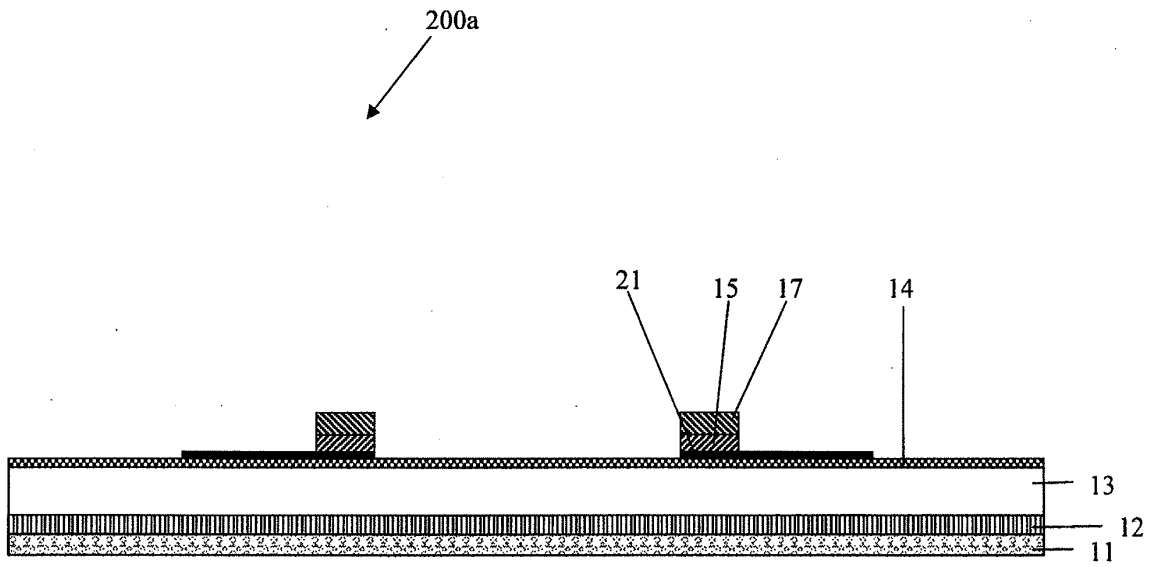


FIG. 7D

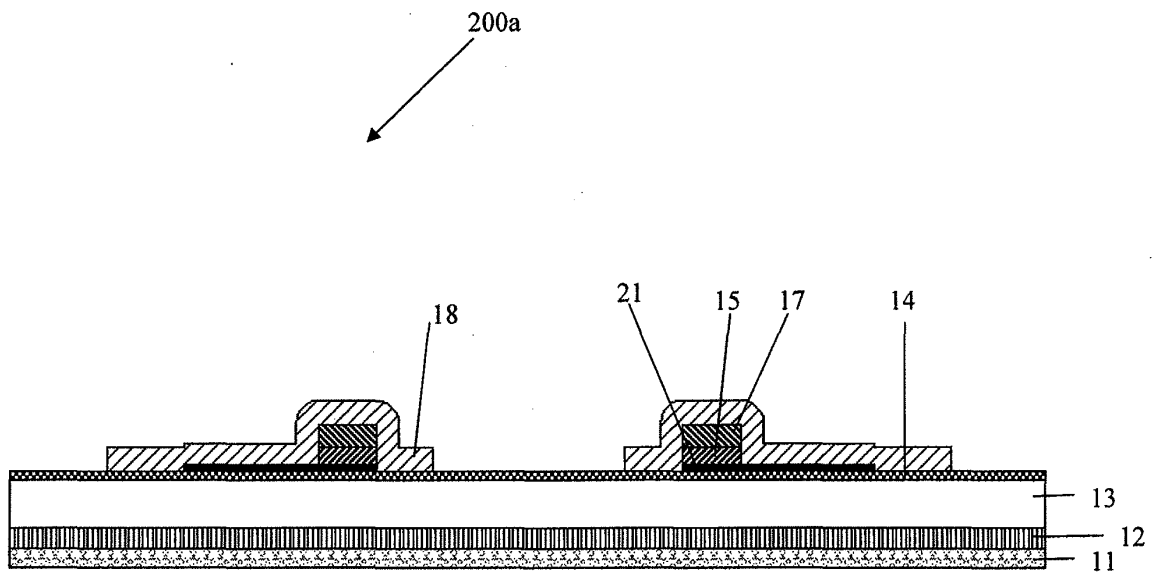


FIG. 7E

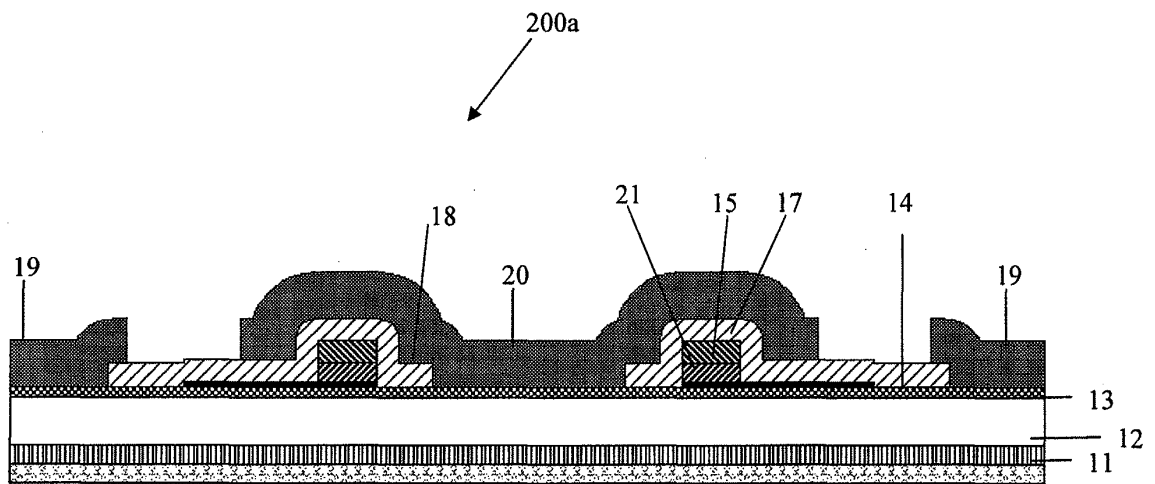


FIG. 7F

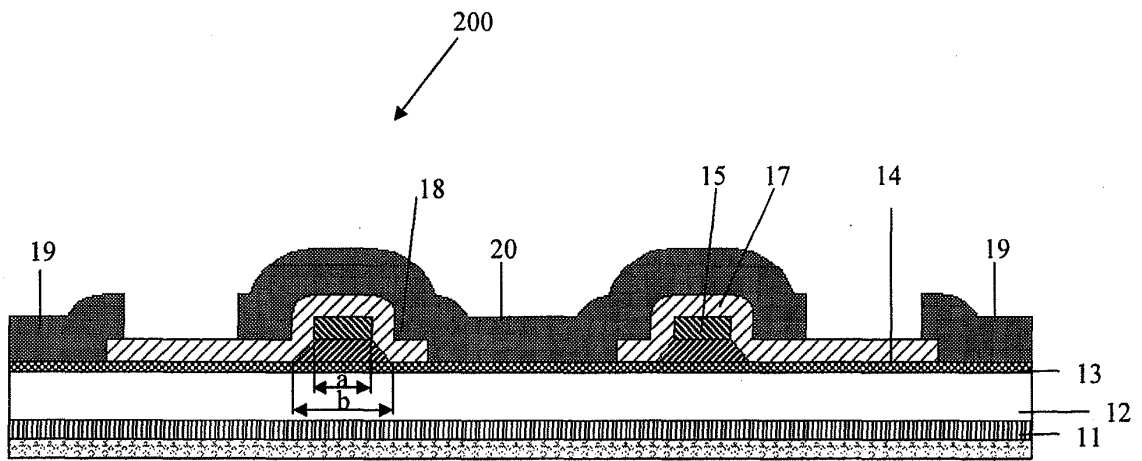


FIG. 8

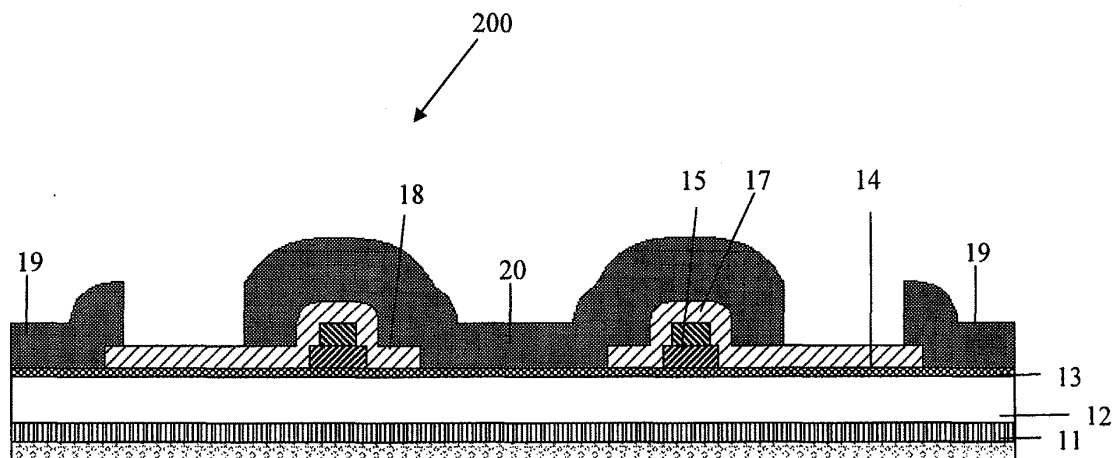


FIG. 9

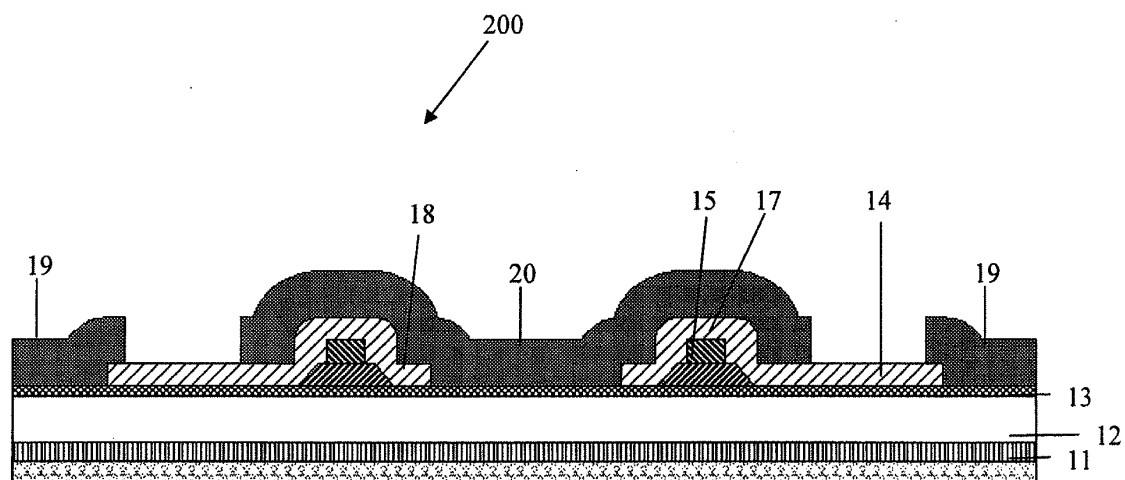


FIG. 10

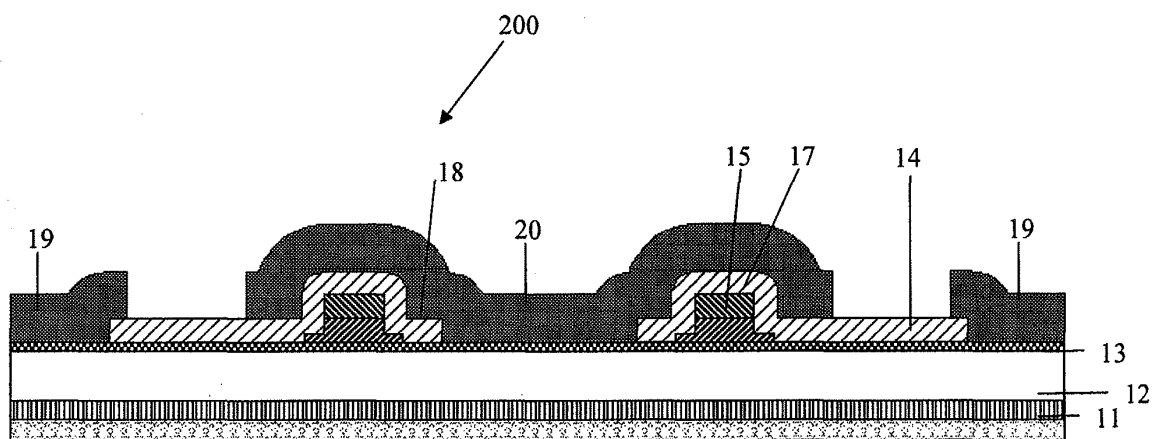


FIG. 11

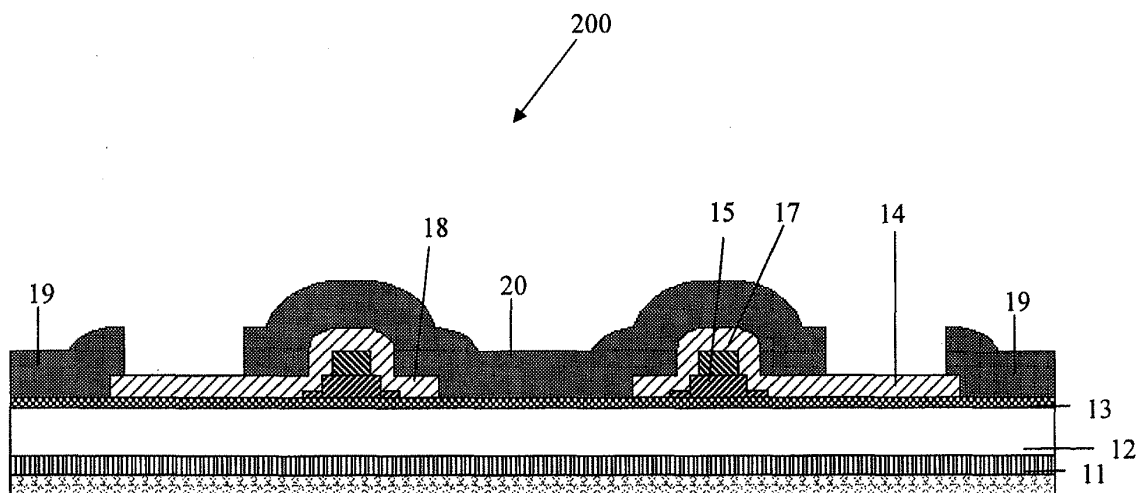


FIG. 12

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
DECLARATION FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am an original, first and joint inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled:

ENHANCEMENT MODE GaN HEMT DEVICE AND METHOD FOR FABRICATING
THE SAME

the specification of which is attached hereto.

In the event that the filing date and/or Application No. are not entered above at the time I execute this document, and if such information is deemed necessary, I hereby authorize and request my attorneys/agent(s) at **Dickstein Shapiro LLP**, 1825 Eye Street, NW, Washington, DC 20006-5403, to insert above the filing date and/or Application No. of said application.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by an amendment, if any, specifically referred to herein.

I acknowledge the duty to disclose all information known to me that is material to patentability as defined in 37 CFR 1.56.

FOREIGN PRIORITY CLAIM

I hereby claim foreign priority benefits under Title 35, United States Code § 119(a)-(d) of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

☒ no such foreign applications have been filed

☐ such foreign applications have been filed as follows:

**EARLIEST FOREIGN APPLICATION(S), IF ANY FILED WITHIN 12 MONTHS
(6 MONTHS FOR DESIGN) PRIOR TO THIS U.S. APPLICATION**

Application Number	Country	Date of Filing	Priority Claimed Under 35 USC 119

**ALL FOREIGN APPLICATION(S), IF ANY FILED MORE THAN 12 MONTHS
(6 MONTHS FOR DESIGN) PRIOR TO THIS U.S. APPLICATION**

Application Number	Country	Date of Filing

CLAIM FOR BENEFIT OF EARLIER U.S. PROVISIONAL APPLICATIONS

I hereby claim priority benefits under Title 35, United States Code §119(e), of any United States provisional patent application(s) listed below:

- ☐ no such U.S. provisional applications have been filed.
- ☒ such U.S. provisional applications have been filed as follows:

Application Number	Date of Filing	Priority Claimed Under 35 USC 119
61/167,777	April 8, 2009	Yes

CLAIM FOR BENEFIT OF EARLIER U.S./PCT APPLICATION(S)

I hereby claim the benefit under Title 35, United States Code, §120 of the United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose all information that is material to patentability as defined in 37 CFR 1.56 which became available to me between the filing date of the prior application and the national or PCT international filing date of this application:

- ☒ no such U.S./PCT applications have been filed.
- ☐ such U.S./PCT applications have been filed as follows:

Application Number	Relationship	Parent Application	Date of Filing

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

I hereby appoint:

All practitioners at Customer Number 24998

all of **Dickstein Shapiro LLP**, 1825 Eye Street, NW, Washington, DC 20006-5403, jointly, and each of them severally, my attorneys at law/patent agent(s), with full power of substitution, delegation and revocation, to prosecute this application, to make alterations and amendments therein, to receive the patent, and to transact all business in the U.S. Patent and Trademark Office connected therewith.

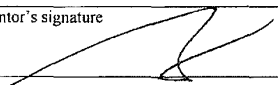
The undersigned hereby authorizes the U.S. attorney or agent named herein to accept and follow instructions from Efficient Power Conversion Corporation as to any action to be taken in the United States Patent and Trademark Office regarding this application without direct communication between the U.S. attorney or agent and the undersigned. In the event of a change in the persons from whom instructions may be taken, the U.S. attorney or agent named herein will be so notified by the undersigned.

Please mail all correspondence to Stephen A. Soffen, whose address is:

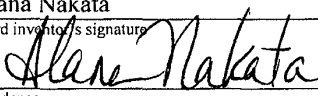
Dickstein Shapiro LLP
1825 Eye Street, NW
Washington, DC 20006-5403

Please direct telephone calls to: Stephen A. Soffen at (202) 420-4879.

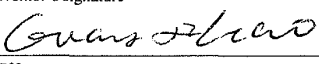
Please direct facsimiles to: (202) 420-2201

Full name of sole or first inventor Alexander Lidow	
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Citizenship US	
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Second inventor's signature 	Date 4/6/2010
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Citizenship US	
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Citizenship US	
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Fourth inventor's signature 	Date 4/6/2010
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Fifth inventor's signature 	Date 4/6/2010
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Full name of sixth inventor, if any	
Sixth inventor's signature	Date
Residence	
Citizenship	
Mailing Address	

Full name of seventh inventor, if any	
Seventh inventor's signature	Date
Residence	
Citizenship	
Mailing Address	

Full name of eighth inventor, if any	
Eighth inventor's signature	Date
Residence	
Citizenship	
Mailing Address	

Docket No.: E0101.0006/P006
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Alexander Lidow et al.

Application No.: Not Yet Assigned

Confirmation No.: N/A

Filed: April 8, 2010

Art Unit: N/A

For: ENHANCEMENT MODE GAN HEMT
DEVICE AND METHOD TO FABRICATE
THE SAME

Examiner: Not Yet Assigned

INFORMATION DISCLOSURE STATEMENT (IDS)

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

Pursuant to 37 CFR 1.56, 1.97 and 1.98, the attention of the Patent and Trademark Office is hereby directed to the references listed on the attached PTO/SB/08. It is respectfully requested that the information be expressly considered during the prosecution of this application, and that the references be made of record therein and appear among the "References Cited" on any patent to issue therefrom.

This Information Disclosure Statement accompanies the new patent application submitted herewith.

In accordance with 37 CFR 1.98(a)(2)(ii), Applicant has not submitted copies of U.S. patents and U.S. patent applications. Applicant submits herewith copies of foreign patents and non-patent literature in accordance with 37 CFR 1.98(a)(2).

DSMDB-2776866v01

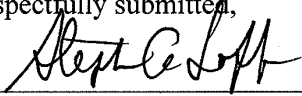
In accordance with 37 CFR 1.97(g), the filing of this Information Disclosure Statement shall not be construed to mean that a search has been made or that no other material information as defined in 37 CFR 1.56(a) exists. In accordance with 37 CFR 1.97(h), the filing of this Information Disclosure Statement shall not be construed to be an admission that any patent, publication or other information referred to therein is "prior art" for this invention unless specifically designated as such.

It is submitted that the Information Disclosure Statement is in compliance with 37 CFR 1.98 and the Examiner is respectfully requested to consider the listed references.

The Director is hereby authorized to charge any deficiency in the fees filed, asserted to be filed or which should have been filed herewith (or with any paper hereafter filed in this application by this firm) to our Deposit Account No. 04-1073, under Order No. E0101.0006/P006.

Dated: April 8, 2010

Respectfully submitted,

By 

Stephen A. Soffen

Registration No.: 31,063

DICKSTEIN SHAPIRO LLP

1825 Eye Street, NW

Washington, DC 20006-5403

(202) 420-2200

Attorney for Applicant

Date: 04/08/10

Approved for use through 7/31/2006. OMB 0651-0032

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875					Application or Docket Number 12/756,960	
APPLICATION AS FILED – PART I						
(Column 1)		(Column 2)		SMALL ENTITY		OR
OTHER THAN SMALL ENTITY						
FOR	NUMBER FILED	NUMBER EXTRA	RATE (\$)	FEE (\$)	RATE (\$)	FEE (\$)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	82	N/A	
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A	270	N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	110	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	23	minus 20 = *	X 26 =	78	X 52 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	6	minus 3 = *	X 110 =	330	X 220 =	
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$270 (\$135 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR					
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))			N/A		N/A	
			TOTAL	870	TOTAL	
* If the difference in column 1 is less than zero, enter "0" in column 2.						
APPLICATION AS AMENDED – PART II						
(Column 1)		(Column 2)		SMALL ENTITY		OR
OTHER THAN SMALL ENTITY						
AMENDMENT A	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)	RATE (\$)
Total (37 CFR 1.16(i))	*	Minus **	=	X =		X =
Independent (37 CFR 1.16(h))	*	Minus ***	=	X =		X =
Application Size Fee (37 CFR 1.16(s))				N/A		N/A
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))				TOTAL ADD'T FEE		TOTAL ADD'T FEE
(Column 1)		(Column 2)		SMALL ENTITY		OR
OTHER THAN SMALL ENTITY						
AMENDMENT B	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)	RATE (\$)
Total (37 CFR 1.16(i))	*	Minus **	=	X =		X =
Independent (37 CFR 1.16(h))	*	Minus ***	=	X =		X =
Application Size Fee (37 CFR 1.16(s))				N/A		N/A
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))				TOTAL ADD'T FEE		TOTAL ADD'T FEE
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3. ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20". *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3". The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.						

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.



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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO.	TOT CLAIMS	IND CLAIMS
12/756,960	04/08/2010	2811	870	E0101.0006/P006	23	6

CONFIRMATION NO. 1677

24998
DICKSTEIN SHAPIRO LLP
1825 EYE STREET NW
Washington, DC 20006-5403

FILING RECEIPT



OC000000041259908

Date Mailed: 04/23/2010

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Applicant(s)

Alexander Lidow, Marina Del Ray, CA;
Robert Beach, La Crescenta, CA;
Alana Nakata, Redondo Beach, CA;
Jianjun Cao, Torrance, CA;
Guang Yuan Zhao, Torrance, CA;

Power of Attorney: The patent practitioners associated with Customer Number 24998

Domestic Priority data as claimed by applicant

This appln claims benefit of 61/167,777 04/08/2009

Foreign Applications

If Required, Foreign Filing License Granted: 04/22/2010

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 12/756,960**

Projected Publication Date: 10/14/2010

Non-Publication Request: No

Early Publication Request: No

**** SMALL ENTITY ****

Title

ENHANCEMENT MODE GaN HEMT DEVICE AND METHOD FOR FABRICATING THE SAME

Preliminary Class

257

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at <http://www.uspto.gov/web/offices/pac/doc/general/index.html>.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, <http://www.stopfakes.gov>. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4158).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

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page 2 of 3

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Substitute for form 1449/PTO				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT <i>(Use as many sheets as necessary)</i>				Application Number	12/756,960-Conf. #1677
				Filing Date	April 8, 2010
				First Named Inventor	Alexander Lidow
				Art Unit	N/A
				Examiner Name	Not Yet Assigned
Sheet	1	of	1	Attorney Docket Number	E0101.0006/P006

U.S. PATENT DOCUMENTS					
Examiner Initials*	Cite No. ¹	Document Number	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		Number-Kind Code ² (if known)			
	AA*	2007/0254418 A1	11-01-2007	Sheppard et al.	
	AB*	2006/0192218 A1	08-31-2006	Kyono et al.	
	AC*	6,833,161	12-21-2004	Wang et al.	
	AD*	6,537,838	03-25-2003	Stockman	
	AE*	6,001,716	12-14-1999	Liao	
	AF*	2008/0116492 A1	05-22-2008	Wu et al.	
	AG*	5,474,946	12-12-1995	Ajit et al.	
	AH*	7,470,941	12-30-2008	Micovic et al.	

FOREIGN PATENT DOCUMENTS						
Examiner Initials*	Cite No. ¹	Foreign Patent Document	Publication Date	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T ⁶
		Country Code ³ -Number ⁴ -Kind Code ⁵ (if known)	MM-DD-YYYY			

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. * CITE NO.: Those application(s) which are marked with an single asterisk (*) next to the Cite No. are not supplied (under 37 CFR 1.98(a)(2)(iii)) because that application was filed after June 30, 2003 or is available in the IFW. ¹ Applicant's unique citation designation number (optional). ² See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. ³ Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). ⁴ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁵ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁶ Applicant is to place a check mark here if English language Translation is attached.

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials	Cite No. ¹	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T ²

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹Applicant's unique citation designation number (optional). ²Applicant is to place a check mark here if English language Translation is attached.

Examiner Signature		Date Considered	
-----------------------	--	--------------------	--

DSMDB-2838574v1

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference E01010006P006PC	FOR FURTHER ACTION see Form PCT/ISA/220 as well as, where applicable, item 5 below.	
International application No. PCT/US2010/030173	International filing date (<i>day/month/year</i>) 07 April 2010	(Earliest) Priority Date (<i>day/month/year</i>) 08 April 2009
Applicant EFFICIENT POWER CONVERSION CORPORATION		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 2 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

a. With regard to the language, the international search was carried out 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))

b. ☐ With regard to any nucleotide and/or amino acid sequence disclosed in the international application, see Box No. I.

2. ☐ Certain claims were found unsearchable (see Box No. II)

3. ☐ Unity of invention is lacking (see Box No. III)

4. With regard to the title,

- ☒ the text is approved as submitted by the applicant
☐ the text has been established by this Authority to read as follows:

5. With regard to the abstract,

- ☒ the text is approved as submitted by the applicant
☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority

6. With regard to the drawings,

- a. the figure of the drawings to be published with the abstract is Figure No. 2
☒ as suggested by the applicant
☐ as selected by this Authority, because the applicant failed to suggest a figure
☐ as selected by this Authority, because this figure better characterizes the invention
- b. ☐ none of the figures is to be published with the abstract

Form PCT/ISA/210 (first sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2010/030173

A. CLASSIFICATION OF SUBJECT MATTER IPC(8) - H01L 21/335 (2010.01) USPC - 438/172 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 21/334, 335, 337, 338; 29/778 (2010.01) USPC - 257/189, 192, 194, 195; 438/167, 172, 184, 597, 603, 604, 607 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) PatBase, Google Patent		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Applicant's Admitted Prior Art, Pg 2, figure 1	1-23
Y	US 2007/254418 A1 (SHEPPARD et al) 01 November 2007 (01.11.2007) entire document	1-16, 23
Y	US 2006/192218 A1 (KYONO et al) 31 August 2006 (31.08.2006) entire document	2-3
Y	US 6,833,161 B2 (WANG et al) 21 December 2004 (21.12.2004) entire document	4
Y	US 6,537,838 B2 (STOCKMAN) 25 March 2003 (25.03.2003) entire document	11-13
Y	US 6,001,716 A (LIAO) 14 December 1999 (14.12.1999) entire document	15
Y	US 2008/116492 A1 (WU et al) 22 May 2008 (22.05.2008) entire document	17, 23
Y	US 5,474,946 A (AJIT et al) 12 December 1995 (12.12.1995) entire document	17, 23
Y	US 7,470,941 B2 (MICOVIC et al) 30 December 2008 (30.12.2008) entire document	18-22
☐ 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 02 June 2010		Date of mailing of the international search report 16 JUN 2010
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201		Authorized officer: Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (April 2005)

Electronic Acknowledgement Receipt	
EFS ID:	8416543
Application Number:	12756960
International Application Number:	
Confirmation Number:	1677
Title of Invention:	ENHANCEMENT MODE GaN HEMT DEVICE AND METHOD FOR FABRICATING THE SAME
First Named Inventor/Applicant Name:	Alexander Lidow
Customer Number:	24998
Filer:	Stephen A. Soffen/Deborah Proctor
Filer Authorized By:	Stephen A. Soffen
Attorney Docket Number:	E0101.0006/P006
Receipt Date:	14-SEP-2010
Filing Date:	08-APR-2010
Time Stamp:	16:26:11
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		E01010006.PDF	271418	yes	5
			94ca5aa94762ab32f708014127b069f57b472180		

	Multipart Description/PDF files in .zip description		
	Document Description	Start	End
	Transmittal Letter	1	2
	Information Disclosure Statement (IDS) Filed (SB/08)	3	3
	NPL Documents	4	5
Warnings:			
Information:			
Total Files Size (in bytes):		271418	
<p>This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.</p> <p><u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.</p> <p><u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.</p> <p><u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.</p>			

Docket No.: E0101.0006/P006
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Alexander Lidow et al.

Application No.: 12/756,960

Confirmation No.: 1677

Filed: April 8, 2010

Art Unit: N/A

For: ENHANCEMENT MODE GAN HEMT
DEVICE AND METHOD TO FABRICATE
THE SAME

Examiner: Not Yet Assigned

INFORMATION DISCLOSURE STATEMENT (IDS)

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

Pursuant to 37 CFR 1.56, 1.97 and 1.98, the attention of the Patent and Trademark Office is hereby directed to the references listed on the attached PTO/SB/08. It is respectfully requested that the information be expressly considered during the prosecution of this application, and that the references be made of record therein and appear among the "References Cited" on any patent to issue therefrom.

This Information Disclosure Statement is filed before the mailing date of a first Office Action on the merits as far as is known to the undersigned (37 CFR 1.97(b)(3)).

Copies of the references on the PTO/SB/08 are not provided.

The references listed on the attached PTO/SB/08 form were cited in the enclosed Intl. Search Report dated June 16, 2010.

DSMDB-2838573v1

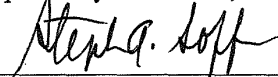
In accordance with 37 CFR 1.97(g), the filing of this Information Disclosure Statement shall not be construed to mean that a search has been made or that no other material information as defined in 37 CFR 1.56(a) exists. In accordance with 37 CFR 1.97(h), the filing of this Information Disclosure Statement shall not be construed to be an admission that any patent, publication or other information referred to therein is "prior art" for this invention unless specifically designated as such.

It is submitted that the Information Disclosure Statement is in compliance with 37 CFR 1.98, and the Examiner is respectfully requested to consider the listed references.

The Director is hereby authorized to charge any deficiency in the fees filed, asserted to be filed or which should have been filed herewith (or with any paper hereafter filed in this application by this firm) to our Deposit Account No. 04-1073, under Order No. E0101.0006/P006.

Dated: September 14, 2010

Respectfully submitted,

By 

Stephen A. Soffen

Registration No.: 31,063

DICKSTEIN SHAPIRO LLP

1825 Eye Street, NW

Washington, DC 20006-5403

(202) 420-2200

Attorney for Applicant



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
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Alexandria, Virginia 22313-1450
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
12/756,960	04/08/2010	Alexander Lidow	E0101.0006/P006

CONFIRMATION NO. 1677

24998
DICKSTEIN SHAPIRO LLP
1825 EYE STREET NW
Washington, DC 20006-5403

PUBLICATION NOTICE



OC000000043986876

Title:ENHANCEMENT MODE GaN HEMT DEVICE AND METHOD FOR FABRICATING THE SAME

Publication No.US-2010-0258843-A1

Publication Date:10/14/2010

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently <http://www.uspto.gov/patft/>.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently <http://pair.uspto.gov/>. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

Docket No.: E0101.0006/P006
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Alexander Lidow et al.

Application No.: 12/756,960

Confirmation No.: 1677

Filed: April 8, 2010

Art Unit: 2829

For: ENHANCEMENT MODE GaN HEMT DEVICE
AND METHOD FOR FABRICATING THE
SAME

Examiner: M. Lebentribb

FIRST PRELIMINARY AMENDMENT UNDER 37 C.F.R. 1.115

MS Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

INTRODUCTORY COMMENTS

Prior to examination on the merits, please amend the above-identified U.S. patent application as follows:

Amendments to the Claims are reflected in the listing of claims which begins on page 2 of this paper.

Remarks begin on page 11 of this paper.

AMENDMENTS TO THE CLAIMS

1. (Original): An enhancement-mode GaN transistor comprising:

a substrate,

transition layers,

a buffer layer comprised of a III Nitride material,

a barrier layer comprised of a III Nitride material,

drain and source contacts,

a gate III-V compound containing acceptor type dopant elements, and

a gate metal, wherein the gate III-V compound and the gate metal are formed with a single photo mask process to be self-aligned.
2. (Original): The transistor of claim 1, wherein the buffer layer is comprised of InAlGaN.
3. (Original): The transistor of claim 1, wherein the barrier layer is comprised of InAlGaN with a larger band gap than the buffer layer.

4. (Original): The transistor of claim 1, wherein the bottom of the gate metal and the top of the gate III-V compound have the same dimension, and the side walls of the gate III-V compound have an angle of about 80 to about 90 degrees.

5. (Original): The transistor of claim 1, wherein side walls of the gate III-V compound have an angle of about 30 to about 80 degrees.

6. (Original): The transistor of claim 1, wherein the gate III-V compound and the gate metal are formed with a single photo mask process to be self-aligned and the gate metal is narrower than the gate III-V compound so that there are symmetric ledges at the top of the gate compound.

7. (Original): The transistor of claim 6, wherein side walls of the gate III-V compound have an angle of about 80 to about 90 degrees.

8. (Original): The transistor of claim 6, wherein side walls of the gate III-V compound are sloped having an angle of 30 to 80 degrees.

9. (Original): The transistor of claim 1, wherein the gate III-V compound and the gate metal are formed with a single photo mask process to be self-aligned, the bottom of the gate metal and the top of the gate III-V compound have nearly the same dimension, and the bottom of the gate III-V compound contains symmetric ledges just above the barrier layer.

10. (Original): The transistor of claim 1, wherein the gate III-V compound and the gate metal are formed with a single photo mask process to be self-aligned, the gate metal is narrower than the gate III-V compound so that there are symmetric ledges at the top of the gate III-V compound, and the bottom of the gate III-V compound contains symmetric ledges just above the barrier layer.

11. (Original): The transistor of claim 1, wherein the gate III-V compound is GaN doped with acceptor type dopants such Mg, C, Zn, Ca and the p-type dopants are activated.

12. (Original): The transistor of claim 1, wherein the gate III-V compound is GaN doped with acceptor type dopants such Mg, C, Zn, Ca and the p-type dopants are compensated with hydrogen.

13. (Original): The transistor of claim 1, wherein the gate III-V compound contains an AlGaIn layer and a GaN layer doped with acceptor type dopants such as Mg, C, Zn, Ca.

14. (Original): The transistor of claim 1, wherein the gate III-V compound contains an AlGaIn layer and a GaN layer, the gate metal and the gate GaN are etched with a single photo mask process, and the gate AlGaIn extends towards the drain due to a second photo mask process.

15. (Original): The transistor of claim 1, wherein the gate metal is TiN.

16. (Original): The transistor of claim 1, wherein the gate metal contains one or more refractory metals, metallic compounds and alloys, such as Ta, W, TaN, TiN, WN, WSi.

17. (Original): An enhancement-mode GaN transistor comprising:

a substrate,

transition layers,

a buffer layer comprised of a III Nitride material,

a barrier layer comprised of a III Nitride material,

drain and source contacts,

a gate III-V compound containing acceptor type dopant elements,

a gate metal, and

a field plate made of Ohmic metal, wherein a drain Ohmic metal, a source Ohmic metal, and the field plate are formed by a single photo mask process.

18. (Original): A method of forming an enhancement mode GaN transistor, the method comprising:

nucleating and growing transition layers on a substrate;

growing an III Nitride EPI layer over the transistor layers;

growing an III Nitride barrier layer over the EPI layer;

growing a GaN layer with acceptor type dopants over the barrier layer;

depositing a gate contact layer on the doped GaN layer;

applying a gate photo resistant pattern;

etching away the gate contact layer outside the gate region;

etching away the doped GaN layer, except a portion of the doped GaN layer beneath the gate contact;

removing the gate photo resistant pattern;

depositing a dielectric layer;

applying a contact photo resistant pattern;

etching the dielectric layer to open the drain and source contact area;

removing the contact photo resistant pattern;

depositing an Ohmic contact metal;

applying a metal photo resistant pattern;

etching the Ohmic contact metal;

removing the metal photo resistant pattern; and

performing rapid thermal annealing to form Ohmic drain and source contacts.

19. (Original): The method of claim 18, wherein the EPI layer is comprised of InAlGaN.

20. (Original): The method of claim 18, wherein the barrier layer is comprised of InAlGaN with a larger band gap than the buffer layer.

21. (Original): A method of forming an enhancement mode GaN transistor, the method comprising:

nucleating and growing transition layers on a substrate;

growing an InAlGaN EPI layer over the transistor layers;

growing an InAlGaN barrier layer over the InAlGaN EPI layer;

growing an InAlGaN layer with acceptor type dopants over the InAlGaN barrier layer;

growing a GaN layer with acceptor type dopants over the doped InAlGaN layer;

depositing a gate contact layer on the doped GaN layer

applying a gate photo resistant pattern;

etching away the gate contact layer outside the gate region;

etching away the doped GaN layer and the doped InAlGaN layer, except for portions of the doped GaN layer and the doped InAlGaN layer beneath gate contact;

removing the gate photo resistant pattern;

depositing a dielectric layer;

applying a contact photo resistant pattern;

etching the dielectric layer to open the drain and source contact area;

removing the contact photo resistant pattern;

depositing an Ohmic contact metal;

applying a metal photo resistant pattern;

etching the Ohmic contact metal;

removing the metal photo resistant pattern; and

performing rapid thermal annealing to form Ohmic drain and source contacts.

22. (Original): A method of forming an enhancement mode GaN transistor, the method comprising:

nucleating and growing transition layers on a substrate;

growing an InAlGaN EPI layer over the transistor layers;

growing an AlGa_N barrier layer over the InAlGa_N EPI layer;

growing an AlGa_N layer with acceptor type dopants over the AlGa_N barrier layer;

growing a Ga_N layer with acceptor type dopants over the doped AlGa_N layer;

depositing a gate contact layer on the doped Ga_N layer

applying a gate photo resistant pattern;

etching away the gate contact layer outside the gate region;

etching away the doped Ga_N layer, except for portions of the doped Ga_N layer and the doped AlGa_N layer beneath gate contact;

removing the gate photo resistant pattern;

applying another photo resistant pattern;

etching the doped AlGa_N layer such that the doped AlGa_N extends outside the gate region towards the drain;

removing the photo resistant pattern;

depositing a dielectric layer;

applying a contact photo resistant pattern;

etching the dielectric layer to open the drain and source contact area;

removing the contact photo resistant pattern;

depositing an Ohmic contact metal;

applying a fourth photo resistant pattern;

etching the Ohmic contact metal

removing the fourth photo resistant pattern; and

performing rapid thermal annealing to form Ohmic drain and source contacts.

23. (Currently amended): An enhancement-mode GaN transistor comprising:

a substrate,

transition layers,

a buffer layer comprised of a III Nitride material,

a barrier layer comprised of a III Nitride material,

drain and source contacts comprised of Ohmic metal,

a gate III-V compound containing acceptor type dopant elements,

a gate metal, and

a field plate comprised of Ohmic metal,

wherein the gate III-V compound and the gate metal are formed with a single photo mask process to be self-aligned, and wherein the field plate, drain Ohmic metal, and source Ohmic metal are made of the same metal layer and are formed by a single photo mask process.

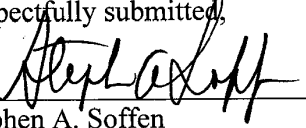
REMARKS

Claim 23 has been amended. No new matter has been introduced by the amendment.
Applicants reserve the right to pursue the original and other claims in this and in other applications.

In view of the above, Applicants believe that the pending application is in condition for allowance. Allowance of the application is respectfully solicited.

Dated: April 30, 2012

Respectfully submitted,

By 
Stephen A. Soffen

Registration No.: 31,063

Gianni Minutoli

Registration No.: 41,198

DICKSTEIN SHAPIRO LLP

1825 Eye Street, NW

Washington, DC 20006-5403

(202) 420-2200

Attorneys for Applicants

Electronic Acknowledgement Receipt	
EFS ID:	12664574
Application Number:	12756960
International Application Number:	
Confirmation Number:	1677
Title of Invention:	ENHANCEMENT MODE GaN HEMT DEVICE AND METHOD FOR FABRICATING THE SAME
First Named Inventor/Applicant Name:	Alexander Lidow
Customer Number:	24998
Filer:	Stephen A. Soffen/Cheryl deLopez
Filer Authorized By:	Stephen A. Soffen
Attorney Docket Number:	E0101.0006/P006
Receipt Date:	30-APR-2012
Filing Date:	08-APR-2010
Time Stamp:	16:13:00
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		amendmentp006.pdf	266547	yes	11
			121906d75ece38cd4ba4811db2b76acaf9e d69dc		

	Multipart Description/PDF files in .zip description		
	Document Description	Start	End
	Preliminary Amendment	1	1
	Claims	2	10
	Applicant Arguments/Remarks Made in an Amendment	11	11
Warnings:			
Information:			
Total Files Size (in bytes):		266547	
<p>This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.</p> <p><u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.</p> <p><u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.</p> <p><u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.</p>			

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875					Application or Docket Number 12/756,960		Filing Date 04/08/2010		☐ To be Mailed	
APPLICATION AS FILED – PART I										
(Column 1)			(Column 2)			SMALL ENTITY ☒ OR		OTHER THAN SMALL ENTITY		
FOR	NUMBER FILED	NUMBER EXTRA	RATE (\$)	FEE (\$)	OR	RATE (\$)	FEE (\$)			
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A				
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A				
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A				
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X \$ =		OR	X \$ =				
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X \$ =			X \$ =				
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$250 (\$125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).									
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))										
* If the difference in column 1 is less than zero, enter "0" in column 2.										
APPLICATION AS AMENDED – PART II										
(Column 1)			(Column 2)			SMALL ENTITY OR		OTHER THAN SMALL ENTITY		
AMENDMENT	04/30/2012	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)	OR	RATE (\$)	ADDITIONAL FEE (\$)	
Total (37 CFR 1.16(i))	*	23	Minus	** 23	=	X \$ =		OR	X \$ =	
Independent (37 CFR 1.16(h))	*	6	Minus	*** 6	=	X \$ =		OR	X \$ =	
☐ Application Size Fee (37 CFR 1.16(s))										
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))										
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE		
(Column 1)			(Column 2)			SMALL ENTITY OR		OTHER THAN SMALL ENTITY		
AMENDMENT	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)	OR	RATE (\$)	ADDITIONAL FEE (\$)		
Total (37 CFR 1.16(i))	*	Minus	**	=	X \$ =		OR	X \$ =		
Independent (37 CFR 1.16(h))	*	Minus	***	=	X \$ =		OR	X \$ =		
☐ Application Size Fee (37 CFR 1.16(s))										
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))										
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE		
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3. ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20". *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3". The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.										

 Legal Instrument Examiner:
 /PEGGY YARBOROUGH/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/756,960	04/08/2010	Alexander Lidow	E0101.0006/P006	1677
24998 7590 10/15/2012 DICKSTEIN SHAPIRO LLP 1825 EYE STREET NW Washington, DC 20006-5403			EXAMINER LEBENTRITT, MICHAEL	
			ART UNIT 2829	PAPER NUMBER
			MAIL DATE 10/15/2012	DELIVERY MODE PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	12/756,960	LIDOW ET AL.	
	Examiner	Art Unit	
	MICHAEL LEBENTRITT	2829	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 1 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1) ☐ Responsive to communication(s) filed on ____.

2a) ☐ This action is **FINAL**. 2b) ☐ This action is non-final.

3) ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on ____; the restriction requirement and election have been incorporated into this action.

4) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

5) ☒ Claim(s) 1-23 is/are pending in the application.

5a) Of the above claim(s) ____ is/are withdrawn from consideration.

6) ☐ Claim(s) ____ is/are allowed.

7) ☐ Claim(s) ____ is/are rejected.

8) ☐ Claim(s) ____ is/are objected to.

9) ☒ Claim(s) 1-23 are subject to restriction and/or election requirement.

Application Papers

10) ☐ The specification is objected to by the Examiner.

11) ☐ The drawing(s) filed on ____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
 Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
 Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

12) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a) ☐ All b) ☐ Some * c) ☐ None of:

1. ☐ Certified copies of the priority documents have been received.

2. ☐ Certified copies of the priority documents have been received in Application No. ____.

3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO/SB/08)
 Paper No(s)/Mail Date ____.

4) ☐ Interview Summary (PTO-413)
 Paper No(s)/Mail Date. ____.

5) ☐ Notice of Informal Patent Application

6) ☐ Other: ____.

DETAILED ACTION

Election/Restrictions

Restriction to one of the following inventions is required under 35 U.S.C. 121:

- I. Claims 1- 17 and 23, drawn to device, classified in class 257, subclass 345+.
- II. Claims 18-22, drawn to method, classified in class 438, subclass 234+.

The inventions are distinct, each from the other because of the following reasons:

Inventions II and I are related as process of making and product made. The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make another and materially different product or (2) that the product as claimed can be made by another and materially different process (MPEP § 806.05(f)). In the instant case because the product as claimed can be made by another and materially different process, for example it is possible to use laser ablation instead of etching.

Restriction for examination purposes as indicated is proper because all these inventions listed in this action are independent or distinct for the reasons given above and there would be a serious search and/or examination burden if restriction were not required because at least the following reason(s) apply:

An undue burden is placed upon the examiner to search both independent and distinct inventions as evidenced by their separate and distinct classifications in the art.

Applicant is advised that the reply to this requirement to be complete must include (i) an election of a invention to be examined even though the requirement may be traversed (37 CFR 1.143) and (ii) identification of the claims encompassing the elected invention.

The election of an invention may be made with or without traverse. To reserve a right to petition, the election must be made with traverse. If the reply does not distinctly and specifically point out supposed errors in the restriction requirement, the election shall be treated as an election without traverse. Traversal must be presented at the time of election in order to be considered timely. Failure to timely traverse the requirement will result in the loss of right to petition under 37 CFR 1.144. If claims are added after the election, applicant must indicate which of these claims are readable upon the elected invention.

Should applicant traverse on the ground that the inventions are not patentably distinct, applicant should submit evidence or identify such evidence now of record showing the inventions to be obvious variants or clearly admit on the record that this is the case. In either instance, if the examiner finds one of the inventions unpatentable over the prior art, the evidence or admission may be used in a rejection under 35 U.S.C. 103(a) of the other invention.

A telephone call was made to Steven on Soffen to request an oral election to the above restriction requirement, but did not result in an election being made.

Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one

or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. Any amendment of inventorship must be accompanied by a request under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

The examiner has required restriction between product or apparatus claims and process claims. Where applicant elects claims directed to the product/apparatus, and all product/apparatus claims are subsequently found allowable, withdrawn process claims that include all the limitations of the allowable product/apparatus claims should be considered for rejoinder. All claims directed to a nonelected process invention must include all the limitations of an allowable product/apparatus claim for that process invention to be rejoined.

In the event of rejoinder, the requirement for restriction between the product/apparatus claims and the rejoined process claims will be withdrawn, and the rejoined process claims will be fully examined for patentability in accordance with 37 CFR 1.104. Thus, to be allowable, the rejoined claims must meet all criteria for patentability including the requirements of 35 U.S.C. 101, 102, 103 and 112. Until all claims to the elected product/apparatus are found allowable, an otherwise proper restriction requirement between product/apparatus claims and process claims may be maintained. Withdrawn process claims that are not commensurate in scope with an allowable product/apparatus claim will not be rejoined. See MPEP § 821.04. Additionally, in order for rejoinder to occur, applicant is advised that the process claims should be amended during prosecution to require the limitations of the

product/apparatus claims. **Failure to do so may result in no rejoinder.** Further, note that the prohibition against double patenting rejections of 35 U.S.C. 121 does not apply where the restriction requirement is withdrawn by the examiner before the patent issues. See MPEP § 804.01.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MICHAEL LEBENTRITT whose telephone number is (571)272-1873. The examiner can normally be reached on 5/4/9.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Ha Nguyen can be reached on 571-272-1678. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Michael S. Lebentritt
Primary Examiner
Art Unit 2829

/Michael S. Lebentritt/

Application/Control Number: 12/756,960

Page 6

Art Unit: 2829

Primary Examiner, Art Unit 2829

<p align="center"><i>Index of Claims</i></p> 	Application/Control No. 12756960	Applicant(s)/Patent Under Reexamination LIDOW ET AL.
	Examiner MICHAEL LEBENTRITT	Art Unit 2829

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant
☐ CPA
☐ T.D.
☐ R.1.47

CLAIM		DATE									
Final	Original	10/10/2012									
	1	÷									
	2	÷									
	3	÷									
	4	÷									
	5	÷									
	6	÷									
	7	÷									
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	22	÷									
	23	÷									

Docket No.: E0101.0006/P006
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Alexander Lidow et al.

Application No.: 12/756,960

Confirmation No.: 1677

Filed: April 8, 2010

Art Unit: 2829

For: ENHANCEMENT MODE GaN HEMT DEVICE Examiner: Lebentritt, M.
AND METHOD FOR FABRICATING THE
SAME

RESPONSE TO RESTRICTION REQUIREMENT

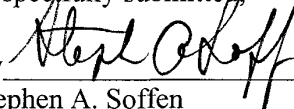
MS Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Madam:

In response to the restriction requirement set forth in the Office Action mailed
October 15, 2012, Applicant hereby elects Group II, claims 18-22, for continued examination.

Dated: October 25, 2012

Respectfully submitted,

By 
Stephen A. Soffen

Registration No.: 31,063
DICKSTEIN SHAPIRO LLP
1825 Eye Street, NW
Washington, DC 20006-5403
(202) 420-2200
Attorney for Applicant

DSMDB-3109784v1

Electronic Acknowledgement Receipt	
EFS ID:	14078303
Application Number:	12756960
International Application Number:	
Confirmation Number:	1677
Title of Invention:	ENHANCEMENT MODE GaN HEMT DEVICE AND METHOD FOR FABRICATING THE SAME
First Named Inventor/Applicant Name:	Alexander Lidow
Customer Number:	24998
Filer:	Stephen A. Soffen/Kanessa Howard
Filer Authorized By:	Stephen A. Soffen
Attorney Docket Number:	E0101.0006/P006
Receipt Date:	25-OCT-2012
Filing Date:	08-APR-2010
Time Stamp:	16:47:56
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Response to Election / Restriction Filed	E0101_0006_Resp_RR.pdf	26080 29feed3d84b6586146e2a845f4fb112c471e ce9f	no	1

Warnings:

Information:

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.



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NOTICE OF ALLOWANCE AND FEE(S) DUE

24998 7590 11/28/2012
DICKSTEIN SHAPIRO LLP
1825 EYE STREET NW
Washington, DC 20006-5403

EXAMINER

LEBENTRITT, MICHAEL

ART UNIT

PAPER NUMBER

2829

DATE MAILED: 11/28/2012

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/756,960	04/08/2010	Alexander Lidow	E0101.0006/P006	1677

TITLE OF INVENTION: ENHANCEMENT MODE GAN HEMT DEVICE AND METHOD FOR FABRICATING THE SAME

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	YES	\$885	\$300	\$0	\$1185	02/28/2013

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the SMALL ENTITY status shown above.

If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

A. If the status is the same, pay the TOTAL FEE(S) DUE shown above.

B. If the status above is to be removed, check box 5b on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and twice the amount of the ISSUE FEE shown above, or

If the SMALL ENTITY is shown as NO:

A. Pay TOTAL FEE(S) DUE shown above, or

B. If applicant claimed SMALL ENTITY status before, or is now claiming SMALL ENTITY status, check box 5a on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and 1/2 the ISSUE FEE shown above.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

**Complete and send this form, together with applicable fee(s), to: Mail Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885**

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

24998 7590 11/28/2012
DICKSTEIN SHAPIRO LLP
1825 EYE STREET NW
Washington, DC 20006-5403

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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12/756,960	04/08/2010	Alexander Lidow	E0101.0006/P006	1677
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TITLE OF INVENTION: ENHANCEMENT MODE GAN HEMT DEVICE AND METHOD FOR FABRICATING THE SAME

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	YES	\$885	\$300	\$0	\$1185	02/28/2013

EXAMINER	ART UNIT	CLASS-SUBCLASS
LEBENTRITT, MICHAEL	2829	257-205000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

- (1) the names of up to 3 registered patent attorneys or agents OR, alternatively, 1 _____
- (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed. 2 _____
- 3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.111. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:

- ☐ Issue Fee
- ☐ Publication Fee (No small entity discount permitted)
- ☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): (Please first reapply any previously paid issue fee shown above)

- ☐ A check is enclosed.
- ☐ Payment by credit card. Form PTO-2038 is attached.
- ☐ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. Change in Entity Status (from status indicated above)

- ☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27. ☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature _____

Date _____

Typed or printed name _____

Registration No. _____

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/756,960	04/08/2010	Alexander Lidow	E0101.0006/P006	1677
24998	7590	11/28/2012	EXAMINER	
DICKSTEIN SHAPIRO LLP			LEBENTRITT, MICHAEL	
1825 EYE STREET NW			ART UNIT	
Washington, DC 20006-5403			PAPER NUMBER	

2829

DATE MAILED: 11/28/2012

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (application filed on or after May 29, 2000)

The Patent Term Adjustment to date is 495 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 495 day(s).

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (<http://pair.uspto.gov>).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No.	Applicant(s)	
	12/756,960	LIDOW ET AL.	
	Examiner	Art Unit	
	MICHAEL LEBENTRITT	2829	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to 10/25/12.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on ____; the restriction requirement and election have been incorporated into this action.

3. ☒ The allowed claim(s) is/are 18-22.

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
 a) ☐ All b) ☐ Some* c) ☐ None of the:
 1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. ____ .
 3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).
 * Certified copies not received: ____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.

6. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
 (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
 1) ☐ hereto or 2) ☐ to Paper No./Mail Date ____.

 (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date ____.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

7. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892) 2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948) 3. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date <u>4/8/2010,9/14/2010</u> 4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material	5. ☐ Notice of Informal Patent Application 6. ☐ Interview Summary (PTO-413), Paper No./Mail Date ____ . 7. ☒ Examiner's Amendment/Comment 8. ☒ Examiner's Statement of Reasons for Allowance 9. ☐ Other ____ .
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/Michael S. Lebentritt/ Primary Examiner, Art Unit 2829	
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DETAILED ACTION

Information Disclosure Statement

The information disclosure statement (IDS) submitted on 4/8/2010 and 9/14/2010 was filed before the mailing date of the first action on the merits. The submission is in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statement is being considered by the examiner.

Election/Restrictions

Applicant's election of group II, claims 18- 22 in the reply filed on 10/25/12 is acknowledged. Because applicant did not distinctly and specifically point out the supposed errors in the restriction requirement, the election has been treated as an election without traverse (MPEP § 818.03(a)).

Claims 1- 17 and 23 are withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected Group I, there being no allowable generic or linking claim. Election was made **without** traverse in the reply filed on 10/25/12.

EXAMINER'S AMENDMENT

An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it **MUST** be submitted no later than the payment of the issue fee.

The application has been amended as follows:

This application is in condition for allowance except for the presence of claims 1-17 and 23 directed to Group I non-elected without traverse. Accordingly, claims 1-17 and 23 have been cancelled.

The following is an examiner's statement of reasons for allowance: the prior art fail to show: growing an III Nitride EPI layer over the transistor layers; growing an III Nitride barrier layer over the EPI layer; growing a GaN layer with acceptor type dopants over the barrier layer; depositing a gate contact layer on the doped GaN layer; applying a gate photo resistant pattern; etching away the gate contact layer outside the gate region; etching away the doped GaN layer, except a portion of the doped GaN layer beneath the gate contact; removing the gate photo resistant pattern; depositing a dielectric layer; applying a contact photo resistant pattern; etching the dielectric layer to open the drain and source contact area; removing the contact photo resistant pattern; depositing an Ohmic contact metal; applying a metal photo resistant pattern; etching the Ohmic contact metal as stated in claim 18. Also: further growing an InAlGaN EPI layer over the transistor layers; growing an InAlGaN barrier layer over the InAlGaN EPI layer; growing an InAlGaN layer with acceptor type dopants over the InAlGaN barrier layer; growing a GaN layer with acceptor type dopants over the doped InAlGaN layer; depositing a gate contact layer on the doped GaN layer applying a gate photo resistant pattern; etching away the gate contact layer outside the gate region; etching away the doped GaN layer and the doped InAlGaN layer, except for portions of the doped GaN layer and the doped InAlGaN layer beneath gate contact; removing the gate photo

resistant pattern; depositing a dielectric layer; applying a contact photo resistant pattern; etching the dielectric layer to open the drain and source contact area; removing the contact photo resistant pattern; depositing an Ohmic contact metal as stated in claim 21. And further: nucleating and growing transition layers on a substrate; growing an InAlGaN EPI layer over the transistor layers; growing an AlGaN barrier layer over the InAlGaN EPI layer; growing an AlGaN layer with acceptor type dopants over the AlGaN barrier layer; growing a GaN layer with acceptor type dopants over the doped AlGaN layer; depositing a gate contact layer on the doped GaN layer applying a gate photo resistant pattern; etching away the gate contact layer outside the gate region; etching away the doped GaN layer, except for portions of the doped GaN layer and the doped AlGaN layer beneath gate contact; removing the gate photo resistant pattern; applying another photo resistant pattern; etching the doped AlGaN layer such that the doped AlGaN extends outside the gate region towards the drain; removing the photo resistant pattern; depositing a dielectric layer; applying a contact photo resistant pattern; etching the dielectric layer to open the drain and source contact area as stated in claim 22.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MICHAEL LEBENTRITT whose telephone number is (571)272-1873. The examiner can normally be reached on 5/4/9.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Ha Nguyen can be reached on 571-272-1678. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Michael S. Lebentritt
Primary Examiner
Art Unit 2829

/Michael S. Lebentritt/
Primary Examiner, Art Unit 2829

Notice of References Cited	Application/Control No. 12/756,960		Applicant(s)/Patent Under Reexamination LIDOW ET AL.	
	Examiner MICHAEL LEBENTRITT		Art Unit 2829	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-2005/0277218	12-2005	Nakajo et al.	438/046
*	B	US-2009/0045438	02-2009	Inoue et al.	257/192
*	C	US-2009/0072272	03-2009	Suh et al.	257/194
*	D	US-2009/0289330	11-2009	SHIBATA, Masatomo	257/615
*	E	US-2009/0318698	12-2009	Hartmann et al.	546/4
*	F	US-2010/0171150	07-2010	Smith et al.	257/194
*	G	US-2011/0272665	11-2011	Yamaguchi et al.	257/12
*	H	US-2011/0278644	11-2011	Gao et al.	257/190
*	I	US-2012/0076968	03-2012	Dmitriev et al.	428/64.1
*	J	US-2012/0175631	07-2012	Lidow et al.	257/76
*	K	US-7,544,963	06-2009	Saxler, Adam William	257/20
*	L	US-7,932,539	04-2011	Chen et al.	257/194
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

<i>Search Notes</i> 	Application/Control No. 12756960	Applicant(s)/Patent Under Reexamination LIDOW ET AL.
	Examiner MICHAEL LEBENTRITT	Art Unit 2829

SEARCHED			
Class	Subclass	Date	Examiner
438	046-052,172-177,285-299,481	11/1/12	ml
257	E21.409;E29.074,089,091,194,242,246,252,315	11/1/12	ml

SEARCH NOTES		
Search Notes	Date	Examiner
See search history	11/1/12	ML

INTERFERENCE SEARCH			
Class	Subclass	Date	Examiner
	see search history	11/1/12	ML

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Receipt date: 09/14/2010

12756960 - GAU: 2829

Used in Lieu of PTO/SB/08A/B
(Based on PTO 10-07 version)

Substitute for form 1449/PTO				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT <i>(Use as many sheets as necessary)</i>				Application Number	12/756,960-Conf. #1677
				Filing Date	April 8, 2010
				First Named Inventor	Alexander Lidow
				Art Unit	N/A
				Examiner Name	Not Yet Assigned
Sheet	1	of	1	Attorney Docket Number	E0101.0006/P006

U.S. PATENT DOCUMENTS					
Examiner Initials*	Cite No. ¹	Document Number	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		Number-Kind Code ² (if known)			
	AA*	2007/0254418 A1	11-01-2007	Sheppard et al.	
	AB*	2006/0192218 A1	08-31-2006	Kyono et al.	
	AC*	6,833,161	12-21-2004	Wang et al.	
	AD*	6,537,838	03-25-2003	Stockman	
	AE*	6,001,716	12-14-1999	Liao	
	AF*	2008/0116492 A1	05-22-2008	Wu et al.	
	AG*	5,474,946	12-12-1995	Ajit et al.	
	AH*	7,470,941	12-30-2008	Micovic et al.	

FOREIGN PATENT DOCUMENTS					
Examiner Initials*	Cite No. ¹	Foreign Patent Document	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear
		Country Code ³ -Number ⁴ -Kind Code ⁵ (if known)			

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. * CITE NO.: Those application(s) which are marked with an single asterisk (*) next to the Cite No. are not supplied (under 37 CFR 1.98(a)(2)(iii)) because that application was filed after June 30, 2003 or is available in the IFW. ¹ Applicant's unique citation designation number (optional). ² See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. ³ Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). ⁴ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁵ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁶ Applicant is to place a check mark here if English language Translation is attached.

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials	Cite No. ¹	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T ²

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹Applicant's unique citation designation number (optional). ²Applicant is to place a check mark here if English language Translation is attached.

Examiner Signature	/Michael Lebentritt/	Date Considered	11/01/2012
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DSMDB-2838574v1

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.L./

<p align="center"><i>Index of Claims</i></p> 	Application/Control No. 12756960	Applicant(s)/Patent Under Reexamination LIDOW ET AL.
	Examiner MICHAEL LEBENTRITT	Art Unit 2829

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☒ Claims renumbered in the same order as presented by applicant
 ☐ CPA
 ☐ T.D.
 ☐ R.1.47

CLAIM		DATE									
Final	Original	10/10/2012	11/01/2012								
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BIB DATA SHEET

CONFIRMATION NO. 1677

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.		
12/756,960	04/08/2010	257	2829	E0101.0006/P006		
APPLICANTS Alexander Lidow, Marina Del Ray, CA; Robert Beach, La Crescenta, CA; Alana Nakata, Redondo Beach, CA; Jianjun Cao, Torrance, CA; Guang Yuan Zhao, Torrance, CA;						
** CONTINUING DATA ***** This appln claims benefit of 61/167,777 04/08/2009						
** FOREIGN APPLICATIONS *****						
** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ** ** SMALL ENTITY ** 04/22/2010						
Foreign Priority claimed	☐ Yes ☒ No	☐ Met after Allowance	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
35 USC 119(a-d) conditions met	☐ Yes ☒ No		CA	25	23	6
Verified and	/MICHAEL LEBENTRITT/ Examiner's Signature		Initials			
Acknowledged						
ADDRESS DICKSTEIN SHAPIRO LLP 1825 EYE STREET NW Washington, DC 20006-5403 UNITED STATES						
TITLE ENHANCEMENT MODE GaN HEMT DEVICE AND METHOD FOR FABRICATING THE SAME						
FILING FEE RECEIVED 870	FEES: Authority has been given in Paper No. _____ to charge/credit DEPOSIT ACCOUNT No. _____ for following:			☐ All Fees		
				☐ 1.16 Fees (Filing)		
				☐ 1.17 Fees (Processing Ext. of time)		
				☐ 1.18 Fees (Issue)		
				☐ Other _____		
				☐ Credit		

Used in Lieu of PTO/SB/08A/B
(Based on PTO 10-07 version)

Substitute for form 1449/PTO INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Use as many sheets as necessary)				Complete if Known	
				Application Number	Not Yet Assigned
				Filing Date	April 8, 2010
				First Named Inventor	Alexander Lidow
				Art Unit	N/A
				Examiner Name	Not Yet Assigned
Sheet	1	of	1	Attorney Docket Number	E0101.0006/P006

U.S. PATENT DOCUMENTS					
Examiner Initials*	Cite No. ¹	Document Number	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		Number-Kind Code ² (if known)			
		2006/0273347	12-07-2006	Hikita et al.	

FOREIGN PATENT DOCUMENTS						
Examiner Initials*	Cite No. ¹	Foreign Patent Document	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T ⁶
		Country Code ³ -Number ⁴ -Kind Code ⁵ (if known)				

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. * CITE NO.: Those application(s) which are marked with an single asterisk (*) next to the Cite No. are not supplied (under 37 CFR 1.98(a)(2)(iii)) because that application was filed after June 30, 2003 or is available in the IFW. ¹ Applicant's unique citation designation number (optional). ² See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. ³ Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). ⁴ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁵ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁶ Applicant is to place a check mark here if English language Translation is attached.

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No. ¹	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T ²
		X. Hu, et al. "Enhancement Mode AlGaIn/GaN HFET With Selectively Grown pn Junction Gate", <i>Electronics Letters</i> , Vol 35, No. 8, pp. 753-754, April 13, 2000	
		T. Fuji et al. "High On/Off Ratio in Enhancement-Mode Al _x Gax _{1-x} N/GaN Junction Heterostructure Field-Effect Transistors with P-Type GaN Gate Contact", <i>Japanese Journal of Applied Physics</i> , Vol. 45, No. 39, pp. L1048-L1050, 2006	
		Y. Uemoto et al. "Gate Injection Transistor (GIT) - A Normally-Off AlGaIn/GaN Power Transistor Using Conductivity Modulation", <i>IEEE Transactions on Electron Devices</i> , Vol. 54, No. 12, pp. 3393-3399, December 2007	
		W. Saito, et al. "High Breakdown Voltage AlGaIn-GaN Power-HEMT Design and High Current Density Switching Behavior", <i>IEEE Transactions on Electron Devices</i> , Vol. 50, No. 12, pp. 2528-2531, December 2003	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹ Applicant's unique citation designation number (optional). ² Applicant is to place a check mark here if English language Translation is attached.

Examiner Signature	/Michael Lebentritt/	Date Considered	11/01/2012
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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.L./

DSMDB-2776871v01

EAST Search History**EAST Search History (Prior Art)**

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	0	("grow\$4adj4groupadj4nitrideadj4epitaxial\$3").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/10/31 12:38
L2	0	("grow\$4adj4groupadj4nitrideadj4epitaxial\$3").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/10/31 12:38
L3	104	grow\$4 adj4 group adj4 nitride adj4 epitaxial	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/10/31 12:39
L4	745	grow\$4 adj4 group adj4 nitride same epitaxial	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/10/31 12:46
L5	134	4 and ohmic adj4 contact	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/10/31 12:46
L6	36	Ga adj4 N same HEMT	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/10/31 13:16
L7	13	HEMT and lidow.inv.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/10/31 13:19

10/ 31/ 2012 1:21:54 PM

C:\Users\mlbentritt\Documents\EAST\Workspaces\12756960.wsp

Issue Classification 	Application/Control No. 12756960	Applicant(s)/Patent Under Reexamination LIDOW ET AL.
	Examiner MICHAEL LEBENTRITT	Art Unit 2829

ORIGINAL						INTERNATIONAL CLASSIFICATION												
CLASS		SUBCLASS				CLAIMED					NON-CLAIMED							
438		46				H	0	1	L	21 / 00 (2006.01.01)								
CROSS REFERENCE(S)																		
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)																	
438	172	285																
257	E21.409	E29.091	E29.194	E29.252	E29.315													

☒ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47															
Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	4	
/MICHAEL LEBENTRITT/ Primary Examiner.Art Unit 2829	11/1/12	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	18	2

PART B -FEE(S) TRANSMITTAL

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Commissioner for Patents
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I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/756,960	04/08/2010	Alexander Lidow	E0101.0006/P006	1677

TITLE OF INVENTION: ENHANCEMENT MODE GaN HEMT DEVICE AND METHOD FOR FABRICATING THE SAME

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	yes	\$885.00	\$300.00		\$1,200.00	02/28/2013
EXAMINER		ART UNIT		CLASS-SUBCLASS		
Lebentritt, Michael		2829				

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached.
Use of a Customer Number is required.

2. For printing on the patent front page, list

- (1) the names of up to 3 registered patent attorneys or agents OR, alternatively,
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3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

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(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Efficient Power Conversion Corporation

El Segundo, California

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:

- ☒ Issue Fee
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☒ Advance Order - # of Copies 5

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5. Change in Entity Status (from status indicated above)

- ☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27. ☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature Stephen A. Soffen
 Typed or printed name Stephen A. Soffen

Date February 25, 2013
 Registration No. 31,063

Electronic Patent Application Fee Transmittal				
Application Number:		12756960		
Filing Date:		08-Apr-2010		
Title of Invention:		ENHANCEMENT MODE GAN HEMT DEVICE AND METHOD FOR FABRICATING THE SAME		
First Named Inventor/Applicant Name:		Alexander Lidow		
Filer:		Stephen A. Soffen/Kanessa Howard		
Attorney Docket Number:		E0101.0006/P006		
Filed as Small Entity				
Utility under 35 USC 111(a) Filing Fees				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Utility Appl issue fee	2501	1	885	885
Publ. Fee- early, voluntary, or normal	1504	1	300	300

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension-of-Time:				
Miscellaneous:				
Printed copy of patent - no color	8001	5	3	15
Total in USD (\$)				1200

Electronic Acknowledgement Receipt	
EFS ID:	15043183
Application Number:	12756960
International Application Number:	
Confirmation Number:	1677
Title of Invention:	ENHANCEMENT MODE GAN HEMT DEVICE AND METHOD FOR FABRICATING THE SAME
First Named Inventor/Applicant Name:	Alexander Lidow
Customer Number:	24998
Filer:	Stephen A. Soffen/Kanessa Howard
Filer Authorized By:	Stephen A. Soffen
Attorney Docket Number:	E0101.0006/P006
Receipt Date:	25-FEB-2013
Filing Date:	08-APR-2010
Time Stamp:	16:55:28
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	\$1200
RAM confirmation Number	18562
Deposit Account	041073
Authorized User	SOFFEN, STEPHEN A.
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Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	E0101_0006_Issue_Fee_Transmittal.pdf	82018	no	1
			4a7cc657af144153018141fffd01b43850dc b8d1		

Warnings:

Information:

2	Fee Worksheet (SB06)	fee-info.pdf	33756	no	2
			53ed469e5d572add63af600a6d62ad4b35f 01fdd		

Warnings:

Information:

Total Files Size (in bytes): 115774

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.



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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/756,960	03/26/2013	8404508	E0101.0006/P006	1677

24998 7590 03/06/2013
DICKSTEIN SHAPIRO LLP
1825 EYE STREET NW
Washington, DC 20006-5403

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (application filed on or after May 29, 2000)

The Patent Term Adjustment is 495 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (<http://pair.uspto.gov>).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site <http://pair.uspto.gov> for additional applicants):

Alexander Lidow, Marina Del Ray, CA;
Robert Beach, La Crescenta, CA;
Alana Nakata, Redondo Beach, CA;
Jianjun Cao, Torrance, CA;
Guang Yuan Zhao, Torrance, CA;

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