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# **CHANGE OF CORRESPONDENCE ADDRESS** *Patent*

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

|                        |                  |
|------------------------|------------------|
| Patent Number          | 9812363          |
| Issue Date             | 11/7/2017        |
| Application Number     | 15/436,568       |
| Filing Date            | 2/17/2017        |
| First Named Inventor   | Chih-Teng Liao   |
| Attorney Docket Number | TSPM20160591US00 |

Please change the Correspondence Address for the above-identified patent to:

☐ The address associated with Customer Number:

**OR**

☒ **Firm or  
Individual Name**

Intellectual Property Division  
Taiwan Semiconductor Manufacturing Company, Ltd.  
8, Li-Hsin Rd. 6, Hsinchu Science Park

**Address**

**City** Hsinchu

**State**

**ZIP** 300-78

**Country** Taiwan

**Telephone** 886-03-6665106

**Email**

This form cannot be used to change the data associated with a Customer Number. To change the data associated with an existing Customer Number use "Request for Customer Number Data Change" (PTO/SB/124).

This form will not affect any "fee address" provided for the above-identified patent. To change a "fee address" use the "Fee Address Indication Form" (PTO/SB/47).

I am the:

☐ Patentee.

☐ If the Patentee was not the applicant for patent (37 CFR 1.42), then a Statement under 37 CFR 3.73(c) (Form PTO/AIA/96 or equivalent) is enclosed or was filed on \_\_\_\_\_. See 37 CFR 3.71.

☒ Attorney or agent of record. Registration Number 35,361.

☐ Patent practitioner acting in a representative capacity whose correspondence address is the correspondence address of record. Notice has been given to the patentee or owner. Registration Number 35,361.

**Signature** /Steven H. Slater/

**Typed or  
Printed Name** Steven H. Slater

**Date** 2017-12-21

**Telephone** (972) 732-1001

**NOTE:** This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below\*.

☐ \*Total of \_\_\_\_\_ forms are submitted.

This collection of information is required by 37 CFR 1.33. 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 1.11 and 1.14. This collection is estimated to take 3 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: Mail Stop Post Issue, 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.

## 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.

## Electronic Acknowledgement Receipt

|                                             |                                          |
|---------------------------------------------|------------------------------------------|
| <b>EFS ID:</b>                              | 31349907                                 |
| <b>Application Number:</b>                  | 15436568                                 |
| <b>International Application Number:</b>    |                                          |
| <b>Confirmation Number:</b>                 | 1892                                     |
| <b>Title of Invention:</b>                  | FinFET Device and Method of Forming Same |
| <b>First Named Inventor/Applicant Name:</b> | Chih-Teng Liao                           |
| <b>Customer Number:</b>                     | 43859                                    |
| <b>Filer:</b>                               | Steven Howard Slater/Cheri McCollam      |
| <b>Filer Authorized By:</b>                 | Steven Howard Slater                     |
| <b>Attorney Docket Number:</b>              | TSMP20160591US00                         |
| <b>Receipt Date:</b>                        | 28-DEC-2017                              |
| <b>Filing Date:</b>                         | 17-FEB-2017                              |
| <b>Time Stamp:</b>                          | 09:06:01                                 |
| <b>Application Type:</b>                    | Utility under 35 USC 111(a)              |

### Payment information:

|                        |    |
|------------------------|----|
| Submitted with Payment | no |
|------------------------|----|

### File Listing:

| Document Number | Document Description | File Name                | File Size(Bytes)/<br>Message Digest      | Multi Part /.zip | Pages (if appl.) |
|-----------------|----------------------|--------------------------|------------------------------------------|------------------|------------------|
| 1               | Change of Address    | TSMP20160591US00_COA.pdf | 270267                                   | no               | 2                |
|                 |                      |                          | db2ea5acdd6c328c30185fb1dc25fd9ecc92730e |                  |                  |

### Warnings:

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| <b>Information:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |
| <b>Total Files Size (in bytes):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 270267 |
| <p><b>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.</b></p> <p><b><u>New Applications Under 35 U.S.C. 111</u></b><br/>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><b><u>National Stage of an International Application under 35 U.S.C. 371</u></b><br/>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><b><u>New International Application Filed with the USPTO as a Receiving Office</u></b><br/>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> |        |



# 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. | ISSUE DATE | PATENT NO. | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|-----------------|------------|------------|---------------------|------------------|
| 15/436,568      | 11/07/2017 | 9812363    | TSMP20160591US00    | 1892             |

43859 7590 10/18/2017  
SLATER MATSIL, LLP/TSMC  
17950 PRESTON ROAD, SUITE 1000  
DALLAS, TX 75252

## 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 0 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):

Chih-Teng Liao, Hsin-Chu, TAIWAN;  
Taiwan Semiconductor Manufacturing Company, Ltd., Hsin-Chu, TAIWAN;  
Chih-Shan Chen, New Taipei City, TAIWAN;  
Yi-Wei Chiu, Kaohsiung City, TAIWAN;  
Ying Ting Hsia, Kaohsiung City, TAIWAN;  
Tzu-Chan Weng, Kaohsiung City, TAIWAN;

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## 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)

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.

43859 7590 07/05/2017  
SLATER MATSIL, LLP/TSMC  
17950 PRESTON ROAD, SUITE 1000  
DALLAS, TX 75252

## 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. |
|-----------------|-------------|----------------------|---------------------|------------------|
| 15/436,568      | 02/17/2017  | Chih-Teng Liao       | TSMP20160591US00    | 1892             |

TITLE OF INVENTION: FinFET Device and Method of Forming Same

| APPLN. TYPE    | ENTITY STATUS | ISSUE FEE DUE | PUBLICATION FEE DUE | PREV. PAID ISSUE FEE | TOTAL FEE(S) DUE | DATE DUE   |
|----------------|---------------|---------------|---------------------|----------------------|------------------|------------|
| nonprovisional | UNDISCOUNTED  | \$960         | \$0                 | \$0                  | \$960            | 10/05/2017 |

| EXAMINER              | ART UNIT | CLASS-SUBCLASS |
|-----------------------|----------|----------------|
| FOURSON III, GEORGE R | 2823     | 257-401000     |

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,
- (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.

1 Slater Matsil, LLP

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 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

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

Taiwan Semiconductor Manufacturing Company, Ltd. Hsin-Chu, Taiwan

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 credits any overpayment, to Deposit Account Number 501065 ~~(enclose an extra copy of this form).~~

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

- ☐ Applicant certifying micro entity status. See 37 CFR 1.29
- ☐ Applicant asserting small entity status. See 37 CFR 1.27
- ☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature /Roger C. Knapp/

Date 2017-10-04

Typed or printed name Roger C. Knapp

Registration No. 46836

| Electronic Patent Application Fee Transmittal |          |                                          |        |                      |
|-----------------------------------------------|----------|------------------------------------------|--------|----------------------|
| Application Number:                           |          | 15436568                                 |        |                      |
| Filing Date:                                  |          | 17-Feb-2017                              |        |                      |
| Title of Invention:                           |          | FinFET Device and Method of Forming Same |        |                      |
| First Named Inventor/Applicant Name:          |          | Chih-Teng Liao                           |        |                      |
| Filer:                                        |          | Roger Clark Knapp/Dana Brown             |        |                      |
| Attorney Docket Number:                       |          | TSMP20160591US00                         |        |                      |
| Filed as Large Entity                         |          |                                          |        |                      |
| Filing Fees for Utility under 35 USC 111(a)   |          |                                          |        |                      |
| 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                        | 1501     | 1                                        | 960    | 960                  |

| Description        | Fee Code | Quantity | Amount | Sub-Total in USD(\$) |
|--------------------|----------|----------|--------|----------------------|
| Extension-of-Time: |          |          |        |                      |
| Miscellaneous:     |          |          |        |                      |
| Total in USD (\$)  |          |          |        | 960                  |

## Electronic Acknowledgement Receipt

|                                             |                                          |
|---------------------------------------------|------------------------------------------|
| <b>EFS ID:</b>                              | 30566609                                 |
| <b>Application Number:</b>                  | 15436568                                 |
| <b>International Application Number:</b>    |                                          |
| <b>Confirmation Number:</b>                 | 1892                                     |
| <b>Title of Invention:</b>                  | FinFET Device and Method of Forming Same |
| <b>First Named Inventor/Applicant Name:</b> | Chih-Teng Liao                           |
| <b>Customer Number:</b>                     | 43859                                    |
| <b>Filer:</b>                               | Roger Clark Knapp/Dana Brown             |
| <b>Filer Authorized By:</b>                 | Roger Clark Knapp                        |
| <b>Attorney Docket Number:</b>              | TSMP20160591US00                         |
| <b>Receipt Date:</b>                        | 04-OCT-2017                              |
| <b>Filing Date:</b>                         | 17-FEB-2017                              |
| <b>Time Stamp:</b>                          | 16:04:51                                 |
| <b>Application Type:</b>                    | Utility under 35 USC 111(a)              |

### Payment information:

|                                          |                       |
|------------------------------------------|-----------------------|
| Submitted with Payment                   | yes                   |
| Payment Type                             | CARD                  |
| Payment was successfully received in RAM | \$960                 |
| RAM confirmation Number                  | 100517INTEFSW16051000 |
| Deposit Account                          |                       |
| Authorized User                          |                       |

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

| <b>File Listing:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                             |                                                |                                          |                  |                  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|------------------------------------------------|------------------------------------------|------------------|------------------|
| Document Number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Document Description        | File Name                                      | File Size(Bytes)/<br>Message Digest      | Multi Part /.zip | Pages (if appl.) |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Issue Fee Payment (PTO-85B) | TSMP20160591US00_Issue_Fee<br>_Transmittal.PDF | 101675                                   | no               | 1                |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                             |                                                | 876fd3c76159d8f6525b35e6d57a5ecd9f1fb153 |                  |                  |
| <b>Warnings:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                             |                                                |                                          |                  |                  |
| <b>Information:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                             |                                                |                                          |                  |                  |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Fee Worksheet (SB06)        | fee-info.pdf                                   | 30757                                    | no               | 2                |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                             |                                                | 8e9b941ad071c6fb6f190bce8e17d5af39e6f917 |                  |                  |
| <b>Warnings:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                             |                                                |                                          |                  |                  |
| <b>Information:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                             |                                                |                                          |                  |                  |
| <b>Total Files Size (in bytes):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                             |                                                | 132432                                   |                  |                  |
| <p><b>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.</b></p> <p><b><u>New Applications Under 35 U.S.C. 111</u></b><br/> 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><b><u>National Stage of an International Application under 35 U.S.C. 371</u></b><br/> 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><b><u>New International Application Filed with the USPTO as a Receiving Office</u></b><br/> 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> |                             |                                                |                                          |                  |                  |

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

|                  |                                          |             |                       |
|------------------|------------------------------------------|-------------|-----------------------|
| First Inventor:  | Liao                                     | Docket No.: | TSMP20160591US00      |
| Application No.: | 15/436,568                               | Conf. No.:  | 1892                  |
| Art Unit:        | 2823                                     | Examiner:   | George R. Fourson III |
| Filed:           | 2/17/2017                                |             |                       |
| Title:           | FinFET Device and Method of Forming Same |             |                       |

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

**COMMENTS ON STATEMENT OF REASONS FOR ALLOWANCE**

Dear Sir:

In response to Examiner's Statement of Reasons for Allowance, Applicant agrees that the claims as allowed are patentably distinct over the cited art. Applicant further respectfully submits that it is the combination of all claim elements that comprehensively distinguish the claimed invention over the prior art.

Respectfully submitted,

2017-09-08  
Date

/John D. Koetter/  
John D. Koetter  
Attorney for Applicant  
Reg. No. 63416

SLATER MATSIL, LLP  
17950 Preston Rd., Ste. 1000  
Dallas, Texas 75252  
Tel.: 972-732-1001  
Fax: 972-732-9218  
docketing@slatermatsil.com

## Electronic Acknowledgement Receipt

|                                             |                                          |
|---------------------------------------------|------------------------------------------|
| <b>EFS ID:</b>                              | 30310005                                 |
| <b>Application Number:</b>                  | 15436568                                 |
| <b>International Application Number:</b>    |                                          |
| <b>Confirmation Number:</b>                 | 1892                                     |
| <b>Title of Invention:</b>                  | FinFET Device and Method of Forming Same |
| <b>First Named Inventor/Applicant Name:</b> | Chih-Teng Liao                           |
| <b>Customer Number:</b>                     | 43859                                    |
| <b>Filer:</b>                               | John David Koetter/Dana Brown            |
| <b>Filer Authorized By:</b>                 | John David Koetter                       |
| <b>Attorney Docket Number:</b>              | TSMP20160591US00                         |
| <b>Receipt Date:</b>                        | 08-SEP-2017                              |
| <b>Filing Date:</b>                         | 17-FEB-2017                              |
| <b>Time Stamp:</b>                          | 14:38:31                                 |
| <b>Application Type:</b>                    | Utility under 35 USC 111(a)              |

### Payment information:

|                        |    |
|------------------------|----|
| Submitted with Payment | no |
|------------------------|----|

### File Listing:

| Document Number | Document Description                    | File Name                                    | File Size(Bytes)/<br>Message Digest               | Multi Part /.zip | Pages (if appl.) |
|-----------------|-----------------------------------------|----------------------------------------------|---------------------------------------------------|------------------|------------------|
| 1               | Post Allowance Communication - Incoming | TSMP20160591US00_Comments_On_Stmt_of_ROA.pdf | 37512<br>c90841f3a5307b59560847274f72e57abaf31cd9 | no               | 1                |

### Warnings:

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| <b>Information:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |       |
| <b>Total Files Size (in bytes):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 37512 |
| <p><b>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.</b></p> <p><b><u>New Applications Under 35 U.S.C. 111</u></b><br/>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><b><u>National Stage of an International Application under 35 U.S.C. 371</u></b><br/>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><b><u>New International Application Filed with the USPTO as a Receiving Office</u></b><br/>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> |       |



# 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

## NOTICE OF ALLOWANCE AND FEE(S) DUE

43859 7590 07/05/2017  
SLATER MATSIL, LLP/TSMC  
17950 PRESTON ROAD, SUITE 1000  
DALLAS, TX 75252

EXAMINER

FOURSON III, GEORGE R

ART UNIT

PAPER NUMBER

2823

DATE MAILED: 07/05/2017

| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|-----------------|-------------|----------------------|---------------------|------------------|
|-----------------|-------------|----------------------|---------------------|------------------|

15/436,568

02/17/2017

Chih-Teng Liao

TSMP20160591US00

1892

TITLE OF INVENTION: FinFET Device and Method of Forming Same

| APPLN. TYPE    | ENTITY STATUS | ISSUE FEE DUE | PUBLICATION FEE DUE | PREV. PAID ISSUE FEE | TOTAL FEE(S) DUE | DATE DUE   |
|----------------|---------------|---------------|---------------------|----------------------|------------------|------------|
| nonprovisional | UNDISCOUNTED  | \$960         | \$0                 | \$0                  | \$960            | 10/05/2017 |

**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 ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

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)

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.

43859 7590 07/05/2017  
**SLATER MATSIL, LLP/TSMC**  
**17950 PRESTON ROAD, SUITE 1000**  
**DALLAS, TX 75252**

## 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. |
|-----------------|-------------|----------------------|---------------------|------------------|
| 15/436,568      | 02/17/2017  | Chih-Teng Liao       | TSMP20160591US00    | 1892             |

TITLE OF INVENTION: FinFET Device and Method of Forming Same

| APPLN. TYPE    | ENTITY STATUS | ISSUE FEE DUE | PUBLICATION FEE DUE | PREV. PAID ISSUE FEE | TOTAL FEE(S) DUE | DATE DUE   |
|----------------|---------------|---------------|---------------------|----------------------|------------------|------------|
| nonprovisional | UNDISCOUNTED  | \$960         | \$0                 | \$0                  | \$960            | 10/05/2017 |

| EXAMINER              | ART UNIT | CLASS-SUBCLASS |
|-----------------------|----------|----------------|
| FOURSON III, GEORGE R | 2823     | 257-401000     |

|                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                           |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).</b><br><input type="checkbox"/> Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.<br><input type="checkbox"/> "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. <b>Use of a Customer Number is required.</b> | <b>2. For printing on the patent front page, list</b><br>(1) The names of up to 3 registered patent attorneys or agents OR, alternatively, 1 _____<br>(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 _____<br>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 3.11. 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

|                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>4a. The following fee(s) are submitted:</b><br><input type="checkbox"/> Issue Fee<br><input type="checkbox"/> Publication Fee (No small entity discount permitted)<br><input type="checkbox"/> Advance Order - # of Copies _____ | <b>4b. Payment of Fee(s): (Please first reapply any previously paid issue fee shown above)</b><br><input type="checkbox"/> A check is enclosed.<br><input type="checkbox"/> Payment by credit card. Form PTO-2038 is attached.<br><input type="checkbox"/> The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form). |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

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

☐ Applicant certifying micro entity status. See 37 CFR 1.29

☐ Applicant asserting small entity status. See 37 CFR 1.27

☐ Applicant changing to regular undiscounted fee status.

**NOTE:** Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

**NOTE:** If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

**NOTE:** Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature \_\_\_\_\_ Date \_\_\_\_\_

Typed or printed name \_\_\_\_\_ Registration No. \_\_\_\_\_



# 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. |
|-----------------|-------------|----------------------|---------------------|------------------|
| 15/436,568      | 02/17/2017  | Chih-Teng Liao       | TSMP20160591US00    | 1892             |

|                                |      |            |
|--------------------------------|------|------------|
| 43859                          | 7590 | 07/05/2017 |
| SLATER MATSIL, LLP/TSMC        |      |            |
| 17950 PRESTON ROAD, SUITE 1000 |      |            |
| DALLAS, TX 75252               |      |            |

|                       |  |
|-----------------------|--|
| EXAMINER              |  |
| FOURSON III, GEORGE R |  |

|          |              |
|----------|--------------|
| ART UNIT | PAPER NUMBER |
| 2823     |              |

DATE MAILED: 07/05/2017

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

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

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.

## OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B 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.

### 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.

|                               |                                      |                                    |                                                   |
|-------------------------------|--------------------------------------|------------------------------------|---------------------------------------------------|
| <b>Notice of Allowability</b> | <b>Application No.</b><br>15/436,568 | <b>Applicant(s)</b><br>LIAO ET AL. |                                                   |
|                               | <b>Examiner</b><br>George Fourson    | <b>Art Unit</b><br>2823            | <b>AIA (First Inventor to File) Status</b><br>Yes |

**-- 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 \_\_\_\_\_.  
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on \_\_\_\_\_.

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 1-20. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see [http://www.uspto.gov/patents/init\\_events/pph/index.jsp](http://www.uspto.gov/patents/init_events/pph/index.jsp) or send an inquiry to PPHfeedback@uspto.gov.

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).  
**Certified copies:**  
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. ☐ CORRECTED DRAWINGS ( as "replacement sheets") must be submitted.  
☐ 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).**

6. ☐ 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. <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)                                                 | 5. <input type="checkbox"/> Examiner's Amendment/Comment                             |
| 2. <input checked="" type="checkbox"/> Information Disclosure Statements (PTO/SB/08),<br>Paper No./Mail Date <u>2/17/17</u> | 6. <input checked="" type="checkbox"/> Examiner's Statement of Reasons for Allowance |
| 3. <input type="checkbox"/> Examiner's Comment Regarding Requirement for Deposit of Biological Material                     | 7. <input type="checkbox"/> Other _____.                                             |
| 4. <input type="checkbox"/> Interview Summary (PTO-413),<br>Paper No./Mail Date _____.                                      |                                                                                      |

|                                                     |  |
|-----------------------------------------------------|--|
| /George Fourson/<br>Primary Examiner, Art Unit 2823 |  |
|-----------------------------------------------------|--|

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

The following is an examiner's statement of reasons for allowance: The prior art taken alone or in combination does not disclose or make obvious the recited processes or devices primarily due to recitation of wherein a portion of the reshaped first recess comprises one or more steps or recitation of comprising a V-shaped bottom surface having a stair-like pattern.

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."

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to George Fourson whose telephone number is (571) 272-1860. The examiner can normally be reached on Monday through Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri, can be reached on (571)272-9820. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Art Unit: 2823

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).

/George Fourson/  
Primary Examiner, Art Unit 2823

GFourson  
June 30, 2017

|                                   |                                       |  |                                                           |             |
|-----------------------------------|---------------------------------------|--|-----------------------------------------------------------|-------------|
| <b>Notice of References Cited</b> | Application/Control No.<br>15/436,568 |  | Applicant(s)/Patent Under<br>Reexamination<br>LIAO ET AL. |             |
|                                   | Examiner<br>George Fourson            |  | Art Unit<br>2823                                          | Page 1 of 2 |

**U.S. PATENT DOCUMENTS**

| * |   | Document Number<br>Country Code-Number-Kind Code | Date<br>MM-YYYY | Name              | CPC Classification | US Classification |
|---|---|--------------------------------------------------|-----------------|-------------------|--------------------|-------------------|
| * | A | US-2011/0073952 A1                               | 03-2011         | Kwok; Tsz-Mei     | H01L29/045         | 257/368           |
| * | B | US-2014/0131776 A1                               | 05-2014         | Ching; Kuo-Cheng  | H01L29/66545       | 257/288           |
| * | C | US-2014/0264348 A1                               | 09-2014         | Tsai; Chun Hsiung | C30B25/165         | 257/57            |
| * | D | US-2014/0361373 A1                               | 12-2014         | Hung; Yu-Hsiang   | H01L29/7848        | 257/365           |
| * | E | US-2015/0364593 A1                               | 12-2015         | JANGJIAN; Shiu-Ko | H01L29/785         | 257/401           |
| * | F | US-2016/0087104 A1                               | 03-2016         | LEE; BYEONGCHAN   | H01L29/7851        | 257/192           |
| * | G | US-2016/0172439 A1                               | 06-2016         | LIN; Chih-Han     | H01L29/0642        | 257/401           |
| * | H | US-2016/0163820 A1                               | 06-2016         | LEE; Wei-Yang     | H01L29/7851        | 438/283           |
| * | I | US-2016/0268312 A1                               | 09-2016         | Wang; Chih-Hao    | H01L21/02532       | 1/1               |
| * | J | US-9,450,047 B1                                  | 09-2016         | Liao; Chin-I      | H01L29/0847        | 1/1               |
| * | K | US-2016/0308048 A1                               | 10-2016         | CHING; Kuo-Cheng  | H01L29/7848        | 1/1               |
| * | L | US-2017/0077302 A1                               | 03-2017         | Cheng; Tung-Wen   | H01L29/7848        | 1/1               |
| * | M | US-2017/0141189 A1                               | 05-2017         | Chang; Che-Cheng  | H01L29/1083        | 1/1               |

**FOREIGN PATENT DOCUMENTS**

| * |   | Document Number<br>Country Code-Number-Kind Code | Date<br>MM-YYYY | Country | Name | CPC 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 |                                                                                           |

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|                                   |                                       |  |                                                           |             |
|-----------------------------------|---------------------------------------|--|-----------------------------------------------------------|-------------|
| <b>Notice of References Cited</b> | Application/Control No.<br>15/436,568 |  | Applicant(s)/Patent Under<br>Reexamination<br>LIAO ET AL. |             |
|                                   | Examiner<br>George Fourson            |  | Art Unit<br>2823                                          | Page 2 of 2 |

#### U.S. PATENT DOCUMENTS

| * |   | Document Number<br>Country Code-Number-Kind Code | Date<br>MM-YYYY | Name                               | CPC Classification | US Classification |
|---|---|--------------------------------------------------|-----------------|------------------------------------|--------------------|-------------------|
| * | A | US-2017/0154958 A1                               | 06-2017         | FUNG; Ka-Hing                      | H01L29/0673        | 1/1               |
| * | B | US-2017/0154967 A1                               | 06-2017         | HUANG; Yi-Jyun                     | H01L29/41791       | 1/1               |
| * | C | US-2017/0154991 A1                               | 06-2017         | Ko; Yongsun                        | H01L29/785         | 1/1               |
| * | D | US-2017/0162451 A1                               | 06-2017         | Pranatharthiharan; Balasubramanian | H01L21/823878      | 1/1               |
| * | E | US-2017/0162580 A1                               | 06-2017         | LIAW; Jhon Jhy                     | H01L21/0274        | 1/1               |
| * | F | US-2017/0170319 A1                               | 06-2017         | Li; Kun-Mu                         | H01L29/7848        | 1/1               |
| * | G | US-2017/0162584 A1                               | 06-2017         | Pranatharthiharan; Balasubramanian | H01L27/1104        | 1/1               |
|   | H | US-                                              |                 |                                    |                    |                   |
|   | I | US-                                              |                 |                                    |                    |                   |
|   | J | US-                                              |                 |                                    |                    |                   |
|   | K | US-                                              |                 |                                    |                    |                   |
|   | L | US-                                              |                 |                                    |                    |                   |
|   | M | US-                                              |                 |                                    |                    |                   |

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

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|---|---|-------------------------------------------------------------------------------------------|
|   | 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.

|                                                                                                              |                                                |                                                                   |
|--------------------------------------------------------------------------------------------------------------|------------------------------------------------|-------------------------------------------------------------------|
| <b>Search Notes</b><br><br> | <b>Application/Control No.</b><br><br>15436568 | <b>Applicant(s)/Patent Under Reexamination</b><br><br>LIAO ET AL. |
|                                                                                                              | <b>Examiner</b><br><br>GEORGE FOURSON III      | <b>Art Unit</b><br><br>2823                                       |

| CPC- SEARCHED                                                                       |           |          |
|-------------------------------------------------------------------------------------|-----------|----------|
| Symbol                                                                              | Date      | Examiner |
| H01L21/823821, H01L21/823418, H01L27/0886, H01L29/41791, H01L29/41783, H01L29/66545 | 6/29/2017 | gf       |

| CPC COMBINATION SETS - SEARCHED |      |          |
|---------------------------------|------|----------|
| Symbol                          | Date | Examiner |
|                                 |      |          |

| US CLASSIFICATION SEARCHED |          |           |          |
|----------------------------|----------|-----------|----------|
| Class                      | Subclass | Date      | Examiner |
| 257                        | 331      | 6/29/2017 | gf       |
| 438                        | 284      | 6/29/2017 | gf       |

| SEARCH NOTES         |           |          |
|----------------------|-----------|----------|
| Search Notes         | Date      | Examiner |
| EAST search attached | 6/29/2017 | gf       |

| INTERFERENCE SEARCH     |                         |           |          |
|-------------------------|-------------------------|-----------|----------|
| US Class/<br>CPC Symbol | US Subclass / CPC Group | Date      | Examiner |
| 257                     | 331                     | 6/29/2017 | gf       |
| 438                     | 284                     | 6/29/2017 | gf       |

|  |                                                        |
|--|--------------------------------------------------------|
|  | /GEORGE FOURSON III/<br>Primary Examiner.Art Unit 2823 |
|--|--------------------------------------------------------|

Doc code: IDS

PTO/SB/08a (01-10)

Doc description: Information Disclosure Statement (IDS) Filed

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| <b>INFORMATION DISCLOSURE<br/>STATEMENT BY APPLICANT</b><br>( Not for submission under 37 CFR 1.99) | Application Number     |                  |         |
|                                                                                                     | Filing Date            |                  | 2/17/17 |
|                                                                                                     | First Named Inventor   | Chih-Teng Liao   |         |
|                                                                                                     | Art Unit               |                  |         |
|                                                                                                     | Examiner Name          |                  |         |
|                                                                                                     | Attorney Docket Number | TSMP20160591US00 |         |

| U.S.PATENTS       |         |               |                        |            |                                                 | Remove                                                                 |
|-------------------|---------|---------------|------------------------|------------|-------------------------------------------------|------------------------------------------------------------------------|
| Examiner Initial* | Cite No | Patent Number | Kind Code <sup>1</sup> | Issue Date | Name of Patentee or Applicant of cited Document | Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear |
|                   | 1       | 7667271       |                        | 2010-02-23 | Yu et al.                                       |                                                                        |
|                   | 2       | 8362575       |                        | 2013-01-29 | Kwok et al.                                     |                                                                        |
|                   | 3       | 8367498       |                        | 2013-02-05 | Chang et al.                                    |                                                                        |
|                   | 4       | 8440517       |                        | 2013-05-14 | Lin et al.                                      |                                                                        |
|                   | 5       | 8497528       |                        | 2013-07-30 | Lee et al.                                      |                                                                        |
|                   | 6       | 8610240       |                        | 2013-12-17 | Lee et al.                                      |                                                                        |
|                   | 7       | 8680576       |                        | 2014-03-25 | Ching et al.                                    |                                                                        |
|                   | 8       | 8723272       |                        | 2014-05-13 | Liu et al.                                      |                                                                        |

**INFORMATION DISCLOSURE  
STATEMENT BY APPLICANT**  
( Not for submission under 37 CFR 1.99)

|                        |                  |  |
|------------------------|------------------|--|
| Application Number     |                  |  |
| Filing Date            |                  |  |
| First Named Inventor   | Chih-Teng Liao   |  |
| Art Unit               |                  |  |
| Examiner Name          |                  |  |
| Attorney Docket Number | TSMP20160591US00 |  |

|    |         |  |            |              |  |
|----|---------|--|------------|--------------|--|
| 9  | 8729627 |  | 2014-05-20 | Cheng et al. |  |
| 10 | 8729634 |  | 2014-05-20 | Shen et al.  |  |
| 11 | 8785285 |  | 2014-07-22 | Tsai et al.  |  |
| 12 | 8796759 |  | 2014-08-05 | Perng et al. |  |
| 13 | 8809139 |  | 2014-08-19 | Huang et al. |  |
| 14 | 8828823 |  | 2014-09-09 | Liu et al.   |  |
| 15 | 8836016 |  | 2014-09-16 | Wu et al.    |  |
| 16 | 8841701 |  | 2014-09-23 | Lin et al.   |  |
| 17 | 8847293 |  | 2014-09-30 | Lee et al.   |  |
| 18 | 8853025 |  | 2014-10-07 | Zhang et al. |  |

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| Application Number     |                  |  |
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| First Named Inventor   | Chih-Teng Liao   |  |
| Art Unit               |                  |  |
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|-------------------|---------|--------------------|------------------------|------------------|-------------------------------------------------|--------------------------------------------------------------------------|
|                   | 1       | 20110068407        |                        | 2011-03-24       | Yeh et al.                                      |                                                                          |
|                   | 2       | 20130011983        |                        | 2013-01-10       | Tsai et al.                                     |                                                                          |
|                   | 3       | 20140252412        |                        | 2014-09-11       | Tsai et al.                                     |                                                                          |

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|-------------------|---------|--------------------------------------|-----------------------------|------------------------|------------------|-------------------------------------------------|--------------------------------------------------------------------------|----------------|
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|                    |                        |                 |            |
|--------------------|------------------------|-----------------|------------|
| Examiner Signature | /George R Fourson III/ | Date Considered | 06/29/2017 |
|--------------------|------------------------|-----------------|------------|

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

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| Application Number     |                  |
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| First Named Inventor   | Chih-Teng Liao   |
| Art Unit               |                  |
| Examiner Name          |                  |
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| Application Number     |                  |  |
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| First Named Inventor   | Chih-Teng Liao   |  |
| Art Unit               |                  |  |
| Examiner Name          |                  |  |
| Attorney Docket Number | TSMP20160591US00 |  |

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☒ A certification statement is not submitted herewith.

**SIGNATURE**

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

|            |                  |                     |            |
|------------|------------------|---------------------|------------|
| Signature  | /Roger C. Knapp/ | Date (YYYY-MM-DD)   | 2017-02-17 |
| Name/Print | Roger C. Knapp   | Registration Number | 46836      |

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## EAST Search History

## EAST Search History (Prior Art)

| Ref # | Hits    | Search Query                                                                          | DBs                                         | Default Operator | Plurals | Time Stamp          |
|-------|---------|---------------------------------------------------------------------------------------|---------------------------------------------|------------------|---------|---------------------|
| S1    | 218628  | "438"/\$.ccls.                                                                        | US-PGPUB;<br>USPAT;<br>EPO; JPO;<br>DERWENT | OR               | OFF     | 2008/09/26<br>16:43 |
| S2    | 423975  | "257"/\$.ccls.                                                                        | US-PGPUB;<br>USPAT;<br>EPO; JPO;<br>DERWENT | OR               | OFF     | 2008/09/26<br>16:44 |
| S3    | 2648054 | semiconductor or ic or "integrated circuit" or microelectronic                        | US-PGPUB;<br>USPAT;<br>EPO; JPO;<br>DERWENT | OR               | OFF     | 2008/09/26<br>16:44 |
| S4    | 495960  | S1 or S2                                                                              | US-PGPUB;<br>USPAT;<br>EPO; JPO;<br>DERWENT | OR               | OFF     | 2008/09/26<br>16:44 |
| S5    | 2741463 | S1 or S2 or S3                                                                        | US-PGPUB;<br>USPAT;<br>EPO; JPO;<br>DERWENT | OR               | OFF     | 2008/09/26<br>16:45 |
| S6    | 855     | ("438/for.227").CCLS.                                                                 | EPO; JPO;<br>DERWENT                        | OR               | OFF     | 2008/09/26<br>16:45 |
| S7    | 24792   | "fin-fet" "finfet" "tri-gate" trigate ((fin pillar) with ("field effect transistor")) | US-PGPUB;<br>USPAT;<br>EPO; JPO;<br>DERWENT | OR               | OFF     | 2017/06/26<br>12:18 |
| S8    | 39292   | (epitaxial epitaxially) with (source drain "source/drain")                            | US-PGPUB;<br>USPAT;<br>EPO; JPO;<br>DERWENT | OR               | OFF     | 2017/06/26<br>12:18 |
| S9    | 5949    | S7 and S8                                                                             | US-PGPUB;<br>USPAT;<br>EPO; JPO;<br>DERWENT | OR               | OFF     | 2017/06/26<br>12:18 |
| S10   | 13295   | (recess recessed) with (fin pillar)                                                   | US-PGPUB;<br>USPAT;<br>EPO; JPO;<br>DERWENT | OR               | OFF     | 2017/06/26<br>12:19 |
| S11   | 1589    | S9 and S10                                                                            | US-PGPUB;                                   | OR               | OFF     | 2017/06/26<br>12:19 |

|     |        |                                                                                             |                                                 |    |     |                     |
|-----|--------|---------------------------------------------------------------------------------------------|-------------------------------------------------|----|-----|---------------------|
|     |        |                                                                                             | USPAT;<br>EPO; JPO;<br>DERWENT                  |    |     |                     |
| S12 | 159690 | @ad> "20161128" @rlad> "20161128"                                                           | US-<br>PGPUB;<br>USPAT;<br>EPO; JPO;<br>DERWENT | OR | OFF | 2017/06/26<br>12:20 |
| S13 | 1546   | S11 not S12                                                                                 | US-<br>PGPUB;<br>USPAT;<br>EPO; JPO;<br>DERWENT | OR | OFF | 2017/06/26<br>12:20 |
| S14 | 19327  | "dummy gate" "replacement gate"<br>"gate-last"                                              | US-<br>PGPUB;<br>USPAT;<br>EPO; JPO;<br>DERWENT | OR | OFF | 2017/06/26<br>14:30 |
| S15 | 11885  | (H01L21/823821 H01L21/823418<br>H01L27/0886 H01L29/41791<br>H01L29/41783).cpc.              | US-<br>PGPUB;<br>USPAT;<br>EPO; JPO;<br>DERWENT | OR | OFF | 2017/06/26<br>14:39 |
| S16 | 22434  | (H01L21/823821 H01L21/823418<br>H01L27/0886 H01L29/41791<br>H01L29/41783 H01L29/66545).cpc. | US-<br>PGPUB;<br>USPAT;<br>EPO; JPO;<br>DERWENT | OR | OFF | 2017/06/26<br>14:42 |
| S17 | 52660  | (recess recessed recesses) with (source<br>drain "source/drain")                            | US-<br>PGPUB;<br>USPAT;<br>EPO; JPO;<br>DERWENT | OR | OFF | 2017/06/26<br>16:06 |
| S18 | 24792  | "fin-fet" "finfet" "tri-gate" trigate ((fin<br>pillar) with ("field effect transistor"))    | US-<br>PGPUB;<br>USPAT;<br>EPO; JPO;<br>DERWENT | OR | OFF | 2017/06/26<br>16:06 |
| S19 | 39292  | (epitaxial epitaxially) with (source drain<br>"source/drain")                               | US-<br>PGPUB;<br>USPAT;<br>EPO; JPO;<br>DERWENT | OR | OFF | 2017/06/26<br>16:06 |
| S20 | 1747   | S17 and S19 and S18                                                                         | US-<br>PGPUB;<br>USPAT;<br>EPO; JPO;<br>DERWENT | OR | OFF | 2017/06/26<br>16:06 |
| S21 | 22434  | (H01L21/823821 H01L21/823418<br>H01L27/0886 H01L29/41791<br>H01L29/41783 H01L29/66545).cpc. | US-<br>PGPUB;<br>USPAT;<br>EPO; JPO;<br>DERWENT | OR | OFF | 2017/06/26<br>16:07 |
| S22 | 1063   | S20 and S21                                                                                 | US-<br>PGPUB;<br>USPAT;<br>EPO; JPO;<br>DERWENT | OR | OFF | 2017/06/26<br>16:07 |
| S23 | 53816  | (recess recessed recesses) with (steps<br>stepped staircase)                                | US-<br>PGPUB;                                   | OR | OFF | 2017/06/26<br>16:08 |

|     |      |                                                                                                                                                                                                                                                                                                  |                                                 |    |     |                     |
|-----|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|----|-----|---------------------|
|     |      |                                                                                                                                                                                                                                                                                                  | USPAT;<br>EPO; JPO;<br>DERWENT                  |    |     |                     |
| S24 | 82   | S23 and S22                                                                                                                                                                                                                                                                                      | US-<br>PGPUB;<br>USPAT;<br>EPO; JPO;<br>DERWENT | OR | OFF | 2017/06/26<br>16:08 |
| S25 | 1811 | (recess recessed recesses) with<br>(faceted facets)                                                                                                                                                                                                                                              | US-<br>PGPUB;<br>USPAT;<br>EPO; JPO;<br>DERWENT | OR | OFF | 2017/06/26<br>17:10 |
| S26 | 122  | S21 and S25                                                                                                                                                                                                                                                                                      | US-<br>PGPUB;<br>USPAT;<br>EPO; JPO;<br>DERWENT | OR | OFF | 2017/06/26<br>17:10 |
| S27 | 1937 | ((257/331) or (438/284)).OCLS.                                                                                                                                                                                                                                                                   | US-<br>PGPUB;<br>USPAT                          | OR | OFF | 2017/06/27<br>10:39 |
| S29 | 21   | ("7667271"   "8362575"   "8367498"  <br>"8440517"   "8497528"   "8610240"  <br>"8680576"   "8723272"   "8729627"  <br>"8729634"   "8785285"   "8796759"  <br>"8809139"   "8828823"   "8836016"  <br>"8841701"   "8847293"   "8853025"  <br>"20110068407"   "20130011983"  <br>"20140252412").PN. | US-<br>PGPUB;<br>USPAT                          | OR | OFF | 2017/06/29<br>08:58 |

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|                                                                                                                 |                                            |                                                               |  |
|-----------------------------------------------------------------------------------------------------------------|--------------------------------------------|---------------------------------------------------------------|--|
| <b>Issue Classification</b><br> | <b>Application/Control No.</b><br>15436568 | <b>Applicant(s)/Patent Under Reexamination</b><br>LIAO ET AL. |  |
|                                                                                                                 | <b>Examiner</b><br>GEORGE FOURSON III      | <b>Art Unit</b><br>2823                                       |  |

| CPC    |                                                                                     |    |                                                                                     |        |      |            |
|--------|-------------------------------------------------------------------------------------|----|-------------------------------------------------------------------------------------|--------|------|------------|
| Symbol |                                                                                     |    |                                                                                     |        | Type | Version    |
| H01L   |    | 21 |    | 823418 | F    | 2013-01-01 |
| H01L   |    | 21 |    | 823431 | I    | 2013-01-01 |
| H01L   |    | 21 |    | 823481 | I    | 2013-01-01 |
| H01L   |    | 29 |    | 66545  | I    | 2013-01-01 |
| H01L   |    | 29 |    | 7851   | I    | 2013-01-01 |
| H01L   |    | 29 |    | 0649   | I    | 2013-01-01 |
| H01L   |    | 29 |    | 41783  | A    | 2013-01-01 |
| H01L   |    | 29 |    | 41791  | A    | 2013-01-01 |
| H01L   |    | 27 |    | 0886   | A    | 2013-01-01 |
|        |    |    |    |        |      |            |
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| CPC Combination Sets                                                                |                                                                                     |      |     |         |         |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------|-----|---------|---------|
| Symbol                                                                              |                                                                                     | Type | Set | Ranking | Version |
|  |  |      |     |         |         |
|  |  |      |     |         |         |

|                                                        |            |                              |                   |
|--------------------------------------------------------|------------|------------------------------|-------------------|
| NONE                                                   |            | <b>Total Claims Allowed:</b> |                   |
|                                                        |            | 20                           |                   |
| (Assistant Examiner)                                   | (Date)     |                              |                   |
| /GEORGE FOURSON III/<br>Primary Examiner.Art Unit 2823 | 06/29/2017 | O.G. Print Claim(s)          | O.G. Print Figure |
| (Primary Examiner)                                     | (Date)     | 1,17                         | 12D               |



|                                                                                                                 |                                            |                                                               |
|-----------------------------------------------------------------------------------------------------------------|--------------------------------------------|---------------------------------------------------------------|
| <b>Issue Classification</b><br> | <b>Application/Control No.</b><br>15436568 | <b>Applicant(s)/Patent Under Reexamination</b><br>LIAO ET AL. |
|                                                                                                                 | <b>Examiner</b><br>GEORGE FOURSON III      | <b>Art Unit</b><br>2823                                       |

| <input checked="" type="checkbox"/> <b>Claims renumbered in the same order as presented by applicant</b> <input type="checkbox"/> <b>CPA</b> <input type="checkbox"/> <b>T.D.</b> <input type="checkbox"/> <b>R.1.47</b> |          |       |          |       |          |       |          |       |          |       |          |       |          |       |          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------|----------|-------|----------|-------|----------|-------|----------|-------|----------|-------|----------|-------|----------|
| Final                                                                                                                                                                                                                    | Original | Final | Original | Final | Original | Final | Original | Final | Original | Final | Original | Final | Original | Final | Original |
|                                                                                                                                                                                                                          | 1        |       | 17       |       |          |       |          |       |          |       |          |       |          |       |          |
|                                                                                                                                                                                                                          | 2        |       | 18       |       |          |       |          |       |          |       |          |       |          |       |          |
|                                                                                                                                                                                                                          | 3        |       | 19       |       |          |       |          |       |          |       |          |       |          |       |          |
|                                                                                                                                                                                                                          | 4        |       | 20       |       |          |       |          |       |          |       |          |       |          |       |          |
|                                                                                                                                                                                                                          | 5        |       |          |       |          |       |          |       |          |       |          |       |          |       |          |
|                                                                                                                                                                                                                          | 6        |       |          |       |          |       |          |       |          |       |          |       |          |       |          |
|                                                                                                                                                                                                                          | 7        |       |          |       |          |       |          |       |          |       |          |       |          |       |          |
|                                                                                                                                                                                                                          | 8        |       |          |       |          |       |          |       |          |       |          |       |          |       |          |
|                                                                                                                                                                                                                          | 9        |       |          |       |          |       |          |       |          |       |          |       |          |       |          |
|                                                                                                                                                                                                                          | 10       |       |          |       |          |       |          |       |          |       |          |       |          |       |          |
|                                                                                                                                                                                                                          | 11       |       |          |       |          |       |          |       |          |       |          |       |          |       |          |
|                                                                                                                                                                                                                          | 12       |       |          |       |          |       |          |       |          |       |          |       |          |       |          |
|                                                                                                                                                                                                                          | 13       |       |          |       |          |       |          |       |          |       |          |       |          |       |          |
|                                                                                                                                                                                                                          | 14       |       |          |       |          |       |          |       |          |       |          |       |          |       |          |
|                                                                                                                                                                                                                          | 15       |       |          |       |          |       |          |       |          |       |          |       |          |       |          |
|                                                                                                                                                                                                                          | 16       |       |          |       |          |       |          |       |          |       |          |       |          |       |          |

|                                                        |                                    |                             |
|--------------------------------------------------------|------------------------------------|-----------------------------|
| NONE                                                   | <b>Total Claims Allowed:</b><br>20 |                             |
| (Assistant Examiner)                                   | (Date)                             |                             |
| /GEORGE FOURSON III/<br>Primary Examiner.Art Unit 2823 | 06/29/2017                         | O.G. Print Claim(s)<br>1,17 |
| (Primary Examiner)                                     | (Date)                             | O.G. Print Figure<br>12D    |

| <b>PATENT APPLICATION FEE DETERMINATION RECORD</b><br>Substitute for Form PTO-875                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                               |                                  |          |                                    |               | Application or Docket Number<br>15/436,568 |                    |                               |                 |                    |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|----------|------------------------------------|---------------|--------------------------------------------|--------------------|-------------------------------|-----------------|--------------------|
| <b>APPLICATION AS FILED - PART I</b>                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                               |                                  |          |                                    |               |                                            |                    |                               |                 |                    |
| (Column 1)                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                               | (Column 2)                       |          | SMALL ENTITY                       |               | OR<br>OTHER THAN SMALL ENTITY              |                    |                               |                 |                    |
| FOR                                                                                                                                                                                                                                                                                                                                                                                                        | NUMBER FILED                                                                                                                                                                                                                  | NUMBER EXTRA                     | RATE(\$) | FEE(\$)                            |               | RATE(\$)                                   | FEE(\$)            |                               |                 |                    |
| BASIC FEE<br><small>(37 CFR 1.16(a), (b), or (c))</small>                                                                                                                                                                                                                                                                                                                                                  | N/A                                                                                                                                                                                                                           | N/A                              | N/A      |                                    |               | N/A                                        | 280                |                               |                 |                    |
| SEARCH FEE<br><small>(37 CFR 1.16(k), (l), or (m))</small>                                                                                                                                                                                                                                                                                                                                                 | N/A                                                                                                                                                                                                                           | N/A                              | N/A      |                                    |               | N/A                                        | 600                |                               |                 |                    |
| EXAMINATION FEE<br><small>(37 CFR 1.16(o), (p), or (q))</small>                                                                                                                                                                                                                                                                                                                                            | N/A                                                                                                                                                                                                                           | N/A                              | N/A      |                                    |               | N/A                                        | 720                |                               |                 |                    |
| TOTAL CLAIMS<br><small>(37 CFR 1.16(j))</small>                                                                                                                                                                                                                                                                                                                                                            | 20                                                                                                                                                                                                                            | minus 20 = *                     |          |                                    | OR            | x 80 =                                     | 0.00               |                               |                 |                    |
| INDEPENDENT CLAIMS<br><small>(37 CFR 1.16(h))</small>                                                                                                                                                                                                                                                                                                                                                      | 3                                                                                                                                                                                                                             | minus 3 = *                      |          |                                    |               | x 420 =                                    | 0.00               |                               |                 |                    |
| APPLICATION SIZE FEE<br><small>(37 CFR 1.16(s))</small>                                                                                                                                                                                                                                                                                                                                                    | If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 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). |                                  |          |                                    |               |                                            | 0.00               |                               |                 |                    |
| MULTIPLE DEPENDENT CLAIM PRESENT <small>(37 CFR 1.16(j))</small>                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                               |                                  |          |                                    |               |                                            | 0.00               |                               |                 |                    |
| * If the difference in column 1 is less than zero, enter "0" in column 2.                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                               |                                  |          | TOTAL                              |               | TOTAL                                      | 1600               |                               |                 |                    |
| <b>APPLICATION AS AMENDED - PART II</b>                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                               |                                  |          |                                    |               |                                            |                    |                               |                 |                    |
| (Column 1)                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                               | (Column 2)                       |          | (Column 3)                         |               | SMALL ENTITY                               |                    | OR<br>OTHER THAN SMALL ENTITY |                 |                    |
| AMENDMENT A                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                               | CLAIMS REMAINING AFTER AMENDMENT |          | HIGHEST NUMBER PREVIOUSLY PAID FOR | PRESENT EXTRA | RATE(\$)                                   | ADDITIONAL FEE(\$) |                               | RATE(\$)        | ADDITIONAL FEE(\$) |
|                                                                                                                                                                                                                                                                                                                                                                                                            | Total<br><small>(37 CFR 1.16(i))</small>                                                                                                                                                                                      | *                                | Minus    | **                                 | =             | x                                          | =                  | OR                            | x               | =                  |
|                                                                                                                                                                                                                                                                                                                                                                                                            | Independent<br><small>(37 CFR 1.16(h))</small>                                                                                                                                                                                | *                                | Minus    | ***                                | =             | x                                          | =                  | OR                            | x               | =                  |
|                                                                                                                                                                                                                                                                                                                                                                                                            | Application Size Fee <small>(37 CFR 1.16(s))</small>                                                                                                                                                                          |                                  |          |                                    |               |                                            |                    | OR                            |                 |                    |
|                                                                                                                                                                                                                                                                                                                                                                                                            | FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM <small>(37 CFR 1.16(j))</small>                                                                                                                                                |                                  |          |                                    |               |                                            |                    | OR                            |                 |                    |
| TOTAL ADD'L FEE                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                               |                                  |          |                                    |               |                                            |                    | OR                            | TOTAL ADD'L FEE |                    |
| AMENDMENT B                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                               | CLAIMS REMAINING AFTER AMENDMENT |          | HIGHEST NUMBER PREVIOUSLY PAID FOR | PRESENT EXTRA | RATE(\$)                                   | ADDITIONAL FEE(\$) |                               | RATE(\$)        | ADDITIONAL FEE(\$) |
|                                                                                                                                                                                                                                                                                                                                                                                                            | Total<br><small>(37 CFR 1.16(i))</small>                                                                                                                                                                                      | *                                | Minus    | **                                 | =             | x                                          | =                  | OR                            | x               | =                  |
|                                                                                                                                                                                                                                                                                                                                                                                                            | Independent<br><small>(37 CFR 1.16(h))</small>                                                                                                                                                                                | *                                | Minus    | ***                                | =             | x                                          | =                  | OR                            | x               | =                  |
|                                                                                                                                                                                                                                                                                                                                                                                                            | Application Size Fee <small>(37 CFR 1.16(s))</small>                                                                                                                                                                          |                                  |          |                                    |               |                                            |                    | OR                            |                 |                    |
|                                                                                                                                                                                                                                                                                                                                                                                                            | FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM <small>(37 CFR 1.16(j))</small>                                                                                                                                                |                                  |          |                                    |               |                                            |                    | OR                            |                 |                    |
| 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.<br>** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".<br>*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".<br>The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1. |                                                                                                                                                                                                                               |                                  |          |                                    |               |                                            |                    |                               |                 |                    |



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| APPLICATION<br>NUMBER | FILING or<br>371(c) DATE | GRP ART<br>UNIT | FIL FEE REC'D | ATTY. DOCKET NO | TOT CLAIMS | IND CLAIMS |
|-----------------------|--------------------------|-----------------|---------------|-----------------|------------|------------|
| 15/436,568            | 02/17/2017               | 2812            | 1600          | TSM20160591US00 | 20         | 3          |

CONFIRMATION NO. 1892

FILING RECEIPT



0000000089499803

43859  
SLATER MATSIL, LLP  
17950 PRESTON ROAD, SUITE 1000  
DALLAS, TX 75252

Date Mailed: 03/01/2017

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**

Inventor(s)

Chih-Teng Liao, Hsin-Chu, TAIWAN;  
Chih-Shan Chen, New Taipei City, TAIWAN;  
Yi-Wei Chiu, Kaohsiung City, TAIWAN;  
Ying Ting Hsia, Kaohsiung City, TAIWAN;  
Tzu-Chan Weng, Kaohsiung City, TAIWAN;

Applicant(s)

Taiwan Semiconductor Manufacturing Company, Ltd., Hsin-Chu, TAIWAN;

**Power of Attorney:** The patent practitioners associated with Customer Number 43859

**Domestic Priority data as claimed by applicant**

This appln claims benefit of 62/427,571 11/29/2016

**Foreign Applications** for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see <http://www.uspto.gov> for more information.) - None.

*Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.*

**Permission to Access Application via Priority Document Exchange:** Yes

**Permission to Access Search Results:** Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

**If Required, Foreign Filing License Granted:** 02/27/2017

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/436,568**

**Projected Publication Date:** 05/31/2018

**Non-Publication Request:** No

**Early Publication Request:** No  
**Title**

FinFET Device and Method of Forming Same

**Preliminary Class**

438

**Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications:** No

## **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.

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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 (1-866-999-4258).

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**Title 35, United States Code, Section 184**  
**Title 37, Code of Federal Regulations, 5.11 & 5.15**

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**NOT GRANTED**

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## POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(c).

I hereby appoint:



Practitioners associated with Customer Number:

43859

OR



Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

| Name | Registration Number |
|------|---------------------|
|      |                     |
|      |                     |
|      |                     |
|      |                     |
|      |                     |

| Name | Registration Number |
|------|---------------------|
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As attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignments documents attached to this form in accordance with 37 CFR 3.73(c).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(c) to:



The address associated with Customer Number:

43859

OR

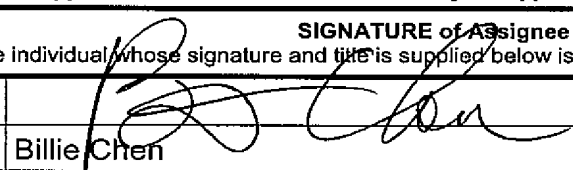
|                          |                         |       |     |  |
|--------------------------|-------------------------|-------|-----|--|
| <input type="checkbox"/> | Firm or Individual Name |       |     |  |
|                          | Address                 |       |     |  |
|                          | City                    | State | Zip |  |
|                          | Country                 |       |     |  |
|                          | Telephone               | Email |     |  |

Assignee Name and Address: Intellectual Property Division  
Taiwan Semiconductor Manufacturing Co., Ltd.  
No. 8, Li-Hsin Rd. 6, Science-Based Industrial Park  
Hsin-Chu, Taiwan 300-77

A copy of this form, together with a statement under 37 CFR 3.73(c) (Form PTO/AIA/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(c) may be completed by one of The practitioners appointed in this form, and must identify the application in which this Power of Attorney is to be filed.

### SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

|           |                                                                                     |           |               |
|-----------|-------------------------------------------------------------------------------------|-----------|---------------|
| Signature |  | Date      | July 28, 2014 |
| Name      | Billie Chen                                                                         | Telephone |               |
| Title     | Director, IP for Taiwan Semiconductor Manufacturing Co., Ltd.                       |           |               |

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. 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 1.11 and 1.14. This collection is estimated to take 3 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.

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.

**STATEMENT UNDER 37 CFR 3.73(c)**Applicant/Patent Owner: Taiwan Semiconductor Manufacturing Company, Ltd.

Application No./Patent No.: \_\_\_\_\_ Filed/Issue Date: \_\_\_\_\_

Titled: FinFET Device and Method of Forming SameTaiwan Semiconductor Manufacturing Company, Ltd., a Corporation

(Name of Assignee)

(Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☒ The assignee of the entire right, title, and interest.
2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):
- ☐ The extent (by percentage) of its ownership interest is \_\_\_\_\_%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.
- ☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (e.g., bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

- A. ☒ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel \_\_\_\_\_, Frame \_\_\_\_\_, or for which a copy thereof is attached.
- B. ☐ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:
1. From: \_\_\_\_\_ To: \_\_\_\_\_
- The document was recorded in the United States Patent and Trademark Office at
- Reel \_\_\_\_\_, Frame \_\_\_\_\_, or for which a copy thereof is attached.
2. From: \_\_\_\_\_ To: \_\_\_\_\_
- The document was recorded in the United States Patent and Trademark Office at
- Reel \_\_\_\_\_, Frame \_\_\_\_\_, or for which a copy thereof is attached.

[Page 1 of 2]

This collection of information is required by 37 CFR 3.73(b). 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 1.11 and 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.

**STATEMENT UNDER 37 CFR 3.73(c)**

3. From: \_\_\_\_\_ To: \_\_\_\_\_

The document was recorded in the United States Patent and Trademark Office at  
 Reel \_\_\_\_\_, Frame \_\_\_\_\_, or for which a copy thereof is attached.

4. From: \_\_\_\_\_ To: \_\_\_\_\_

The document was recorded in the United States Patent and Trademark Office at  
 Reel \_\_\_\_\_, Frame \_\_\_\_\_, or for which a copy thereof is attached.

5. From: \_\_\_\_\_ To: \_\_\_\_\_

The document was recorded in the United States Patent and Trademark Office at  
 Reel \_\_\_\_\_, Frame \_\_\_\_\_, or for which a copy thereof is attached.

6. From: \_\_\_\_\_ To: \_\_\_\_\_

The document was recorded in the United States Patent and Trademark Office at  
 Reel \_\_\_\_\_, Frame \_\_\_\_\_, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☒ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Roger C. Knapp/

2017-02-17

Signature

Date

Roger C. Knapp

46836

Printed or Typed Name

Title or Registration Number

## 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.

ATTORNEY DOCKET NO.  
TSMC20160591US00

### ASSIGNMENT

WHEREAS, I, the undersigned inventor (or one of the undersigned joint inventors), of residence as listed, having invented certain new and useful improvements as below entitled, for which application for United States Letters Patent is made; and

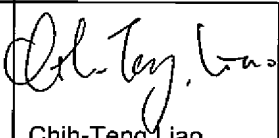
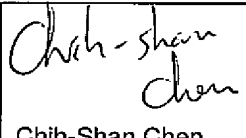
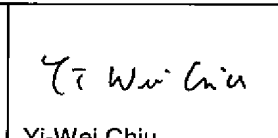
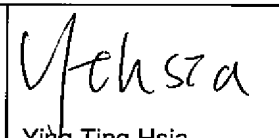
WHEREAS, Taiwan Semiconductor Manufacturing Company, Ltd. ("Assignee"), a corporation organized and existing under the laws of Taiwan, the Republic of China, with its principal office at No. 8, Li-Hsin Rd. 6 Science-Based Industrial Park, Hsin-Chu 300-77 Taiwan, R.O.C., is desirous of acquiring my entire right, title and interest in and to said invention, and to said application and any Letters Patent that may issue thereon in the United States and all other countries throughout the world;

NOW, THEREFORE, for good and valuable consideration, the receipt of which is hereby acknowledged, I hereby sell and assign to said Assignee, its successors and assigns, my entire right, title and interest in and to said invention and in and to said application and all patents which may be granted therefor, and all future non-provisional applications including divisions, reissues, substitutions, continuations, and extensions thereof; and I hereby authorize and request the Commissioner for Patents to issue all patents for said invention, or patent resulting therefrom, insofar as my interest is concerned, to said Assignee, as assignee of my entire right, title and interest. I declare that I have not executed and will not execute any agreement in conflict herewith.

I also hereby sell and assign to Assignee, its successors and assigns, my foreign rights to the invention disclosed in said application, in all countries of the world, including, but not limited to, the right to file applications and obtain patents under the terms of the International Convention for the Protection of Industrial Property, and of the European Patent Convention, and further agree to execute any and all patent applications, assignments, affidavits, and any other papers in connection therewith necessary to perfect such patent rights.

I hereby further agree that I will communicate to said Assignee, or to its successors, assigns, and legal representatives, any facts known to me respecting said invention or the file history thereof, and at the expense of said Assignee, its legal representatives, successors, or assigns, will testify in any legal proceedings, sign all lawful papers, execute all divisional, continuation, reissue and substitute applications, make all lawful oaths, and generally do everything possible to aid said Assignee, its legal representatives, successors, and assigns, to obtain and enforce proper patent protection for said invention in all countries.

IN WITNESS WHEREOF, I hereunto set my hand and seal this day and year;

| TITLE OF INVENTION             | FinFET Device and Method of Forming Same                                                              |                                                                                                       |                                                                                                     |                                                                                                         |
|--------------------------------|-------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| SIGNATURE OF INVENTOR AND NAME | <br>Chih-Teng Liao | <br>Chih-Shan Chen | <br>Yi-Wei Chiu | <br>Ying Ting Hsia |
| DATE                           | 2017.2.8                                                                                              | 2017.2.8                                                                                              | 2017.2.8                                                                                            | 2017.2.9                                                                                                |
| RESIDENCE                      | Hsin-Chu, Taiwan                                                                                      | New Taipei City, Taiwan                                                                               | Kaohsiung City, Taiwan                                                                              | Kaohsiung City, Taiwan                                                                                  |

ATTORNEY DOCKET NO.  
TSM20160591US00

### ASSIGNMENT

WHEREAS, I, the undersigned inventor (or one of the undersigned joint inventors), of residence as listed, having invented certain new and useful improvements as below entitled, for which application for United States Letters Patent is made; and

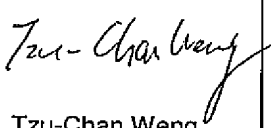
WHEREAS, Taiwan Semiconductor Manufacturing Company, Ltd. ("Assignee"), a corporation organized and existing under the laws of Taiwan, the Republic of China, with its principal office at No. 8, Li-Hsin Rd. 6 Science-Based Industrial Park, Hsin-Chu 300-77 Taiwan, R.O.C., is desirous of acquiring my entire right, title and interest in and to said invention, and to said application and any Letters Patent that may issue thereon in the United States and all other countries throughout the world;

NOW, THEREFORE, for good and valuable consideration, the receipt of which is hereby acknowledged, I hereby sell and assign to said Assignee, its successors and assigns, my entire right, title and interest in and to said invention and in and to said application and all patents which may be granted therefor, and all future non-provisional applications including divisions, reissues, substitutions, continuations, and extensions thereof; and I hereby authorize and request the Commissioner for Patents to issue all patents for said invention, or patent resulting therefrom, insofar as my interest is concerned, to said Assignee, as assignee of my entire right, title and interest. I declare that I have not executed and will not execute any agreement in conflict herewith.

I also hereby sell and assign to Assignee, its successors and assigns, my foreign rights to the invention disclosed in said application, in all countries of the world, including, but not limited to, the right to file applications and obtain patents under the terms of the International Convention for the Protection of Industrial Property, and of the European Patent Convention, and further agree to execute any and all patent applications, assignments, affidavits, and any other papers in connection therewith necessary to perfect such patent rights.

I hereby further agree that I will communicate to said Assignee, or to its successors, assigns, and legal representatives, any facts known to me respecting said invention or the file history thereof, and at the expense of said Assignee, its legal representatives, successors, or assigns, will testify in any legal proceedings, sign all lawful papers, execute all divisional, continuation, reissue and substitute applications, make all lawful oaths, and generally do everything possible to aid said Assignee, its legal representatives, successors, and assigns, to obtain and enforce proper patent protection for said invention in all countries.

IN WITNESS WHEREOF, I hereunto set my hand and seal this day and year;

| TITLE<br>OF<br>INVENTION                | FinFET Device and Method of Forming Same                                                             |  |  |  |
|-----------------------------------------|------------------------------------------------------------------------------------------------------|--|--|--|
| SIGNATURE<br>OF<br>INVENTOR<br>AND NAME | <br>Tzu-Chan Weng |  |  |  |
| DATE                                    | 2017. 2. 11                                                                                          |  |  |  |
| RESIDENCE                               | Kaohsiung City,<br>Taiwan                                                                            |  |  |  |

| Electronic Patent Application Fee Transmittal |          |                                          |        |                      |
|-----------------------------------------------|----------|------------------------------------------|--------|----------------------|
| Application Number:                           |          |                                          |        |                      |
| Filing Date:                                  |          |                                          |        |                      |
| Title of Invention:                           |          | FINFET DEVICE AND METHOD OF FORMING SAME |        |                      |
| First Named Inventor/Applicant Name:          |          | Chih-Teng Liao                           |        |                      |
| Filer:                                        |          | Roger Clark Knapp/Kasey Corcoran         |        |                      |
| Attorney Docket Number:                       |          | TSMP20160591US00                         |        |                      |
| Filed as Large Entity                         |          |                                          |        |                      |
| Filing Fees for   Utility under 35 USC 111(a) |          |                                          |        |                      |
| Description                                   | Fee Code | Quantity                                 | Amount | Sub-Total in USD(\$) |
| Basic Filing:                                 |          |                                          |        |                      |
| UTILITY APPLICATION FILING                    | 1011     | 1                                        | 280    | 280                  |
| UTILITY SEARCH FEE                            | 1111     | 1                                        | 600    | 600                  |
| UTILITY EXAMINATION FEE                       | 1311     | 1                                        | 720    | 720                  |
| Pages:                                        |          |                                          |        |                      |
| Claims:                                       |          |                                          |        |                      |
| Miscellaneous-Filing:                         |          |                                          |        |                      |
| Petition:                                     |          |                                          |        |                      |
| Patent-Appeals-and-Interference:              |          |                                          |        |                      |

| Description                       | Fee Code | Quantity | Amount | Sub-Total in USD(\$) |
|-----------------------------------|----------|----------|--------|----------------------|
| Post-Allowance-and-Post-Issuance: |          |          |        |                      |
| Extension-of-Time:                |          |          |        |                      |
| Miscellaneous:                    |          |          |        |                      |
| Total in USD (\$)                 |          |          |        | 1600                 |

## Electronic Acknowledgement Receipt

|                                             |                                          |
|---------------------------------------------|------------------------------------------|
| <b>EFS ID:</b>                              | 28398582                                 |
| <b>Application Number:</b>                  | 15436568                                 |
| <b>International Application Number:</b>    |                                          |
| <b>Confirmation Number:</b>                 | 1892                                     |
| <b>Title of Invention:</b>                  | FINFET DEVICE AND METHOD OF FORMING SAME |
| <b>First Named Inventor/Applicant Name:</b> | Chih-Teng Liao                           |
| <b>Customer Number:</b>                     | 43859                                    |
| <b>Filer:</b>                               | Roger Clark Knapp/Kasey Corcoran         |
| <b>Filer Authorized By:</b>                 | Roger Clark Knapp                        |
| <b>Attorney Docket Number:</b>              | TSMP20160591US00                         |
| <b>Receipt Date:</b>                        | 17-FEB-2017                              |
| <b>Filing Date:</b>                         |                                          |
| <b>Time Stamp:</b>                          | 19:02:10                                 |
| <b>Application Type:</b>                    | Utility under 35 USC 111(a)              |

### Payment information:

|                                          |                             |
|------------------------------------------|-----------------------------|
| Submitted with Payment                   | yes                         |
| Payment Type                             | DA                          |
| Payment was successfully received in RAM | \$ 1600                     |
| RAM confirmation Number                  | 022117INTEFSW00005985501065 |
| Deposit Account                          |                             |
| Authorized User                          |                             |

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

|                                 |                                                     |                                     |                                          |                  |                  |
|---------------------------------|-----------------------------------------------------|-------------------------------------|------------------------------------------|------------------|------------------|
|                                 |                                                     |                                     |                                          |                  |                  |
| File Listing:                   |                                                     |                                     |                                          |                  |                  |
| Document Number                 | Document Description                                | File Name                           | File Size(Bytes)/ Message Digest         | Multi Part /.zip | Pages (if appl.) |
| 1                               |                                                     | TSMP20160591US00_Spec.pdf           | 157869                                   | yes              | 30               |
|                                 |                                                     |                                     | bc8b39ee4c157db388aeb5299242196c86d54985 |                  |                  |
|                                 | Multipart Description/PDF files in .zip description |                                     |                                          |                  |                  |
|                                 | Document Description                                |                                     | Start                                    | End              |                  |
|                                 | Abstract                                            |                                     | 30                                       | 30               |                  |
|                                 | Claims                                              |                                     | 26                                       | 29               |                  |
|                                 | Specification                                       |                                     | 1                                        | 25               |                  |
| Warnings:                       |                                                     |                                     |                                          |                  |                  |
| Information:                    |                                                     |                                     |                                          |                  |                  |
| 2                               | Drawings-only black and white line drawings         | TSMP20160591US00_FormalDrawings.pdf | 1585581                                  | no               | 48               |
|                                 |                                                     |                                     | 5f8571ec24a57f54442e546e9c1fec134bec6899 |                  |                  |
| Warnings:                       |                                                     |                                     |                                          |                  |                  |
| Information:                    |                                                     |                                     |                                          |                  |                  |
| 3                               | Oath or Declaration filed                           | TSMP20160591US00_Declarations.pdf   | 100166                                   | no               | 5                |
|                                 |                                                     |                                     | 8231633780f7c19e324e84480007627e5e7cc446 |                  |                  |
| Warnings:                       |                                                     |                                     |                                          |                  |                  |
| Information:                    |                                                     |                                     |                                          |                  |                  |
| 4                               | Information Disclosure Statement (IDS) Form (SB08)  | TSMP20160591US00_IDS.pdf            | 690446                                   | no               | 6                |
|                                 |                                                     |                                     | 0aca39587f7664c145b792346d32a8a51b0df5cb |                  |                  |
| Warnings:                       |                                                     |                                     |                                          |                  |                  |
| Information:                    |                                                     |                                     |                                          |                  |                  |
| 5                               | Application Data Sheet                              | TSMP20160591US00_ADS.pdf            | 1875542                                  | no               | 9                |
|                                 |                                                     |                                     | b61beedecdc7860c1c118dd3a6c409a9014ff7e  |                  |                  |
| TSMC Exhibit 1129 Page 49 of 50 |                                                     |                                     |                                          |                  |                  |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                               |                           |                                          |    |   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|---------------------------|------------------------------------------|----|---|
| <b>Warnings:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                               |                           |                                          |    |   |
| <b>Information:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                               |                           |                                          |    |   |
| 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Power of Attorney                             | TSMP20160591US00_POA.pdf  | 45224                                    | no | 1 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                               |                           | 85c4c74c0a19a839b0ce41f1e808cb4cbab974a0 |    |   |
| <b>Warnings:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                               |                           |                                          |    |   |
| <b>Information:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                               |                           |                                          |    |   |
| 7                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Assignee showing of ownership per 37 CFR 3.73 | TSMP20160591US00_373c.pdf | 152676                                   | no | 5 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                               |                           | c195dd0aada668b01211a35a7f0311448603e5ef |    |   |
| <b>Warnings:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                               |                           |                                          |    |   |
| <b>Information:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                               |                           |                                          |    |   |
| 8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Fee Worksheet (SB06)                          | fee-info.pdf              | 35000                                    | no | 2 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                               |                           | b3200200c39320370eb896a58a203aa2c9321e70 |    |   |
| <b>Warnings:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                               |                           |                                          |    |   |
| <b>Information:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                               |                           |                                          |    |   |
| <b>Total Files Size (in bytes):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                               |                           | 4642504                                  |    |   |
| <p><b>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.</b></p> <p><b><u>New Applications Under 35 U.S.C. 111</u></b><br/> 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><b><u>National Stage of an International Application under 35 U.S.C. 371</u></b><br/> 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><b><u>New International Application Filed with the USPTO as a Receiving Office</u></b><br/> 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> |                                               |                           |                                          |    |   |

## **ABSTRACT**

A FinFET device and a method of forming the same are provided. A method includes forming a fin over a substrate. An isolation region is formed adjacent the fin. A dummy gate structure is formed over the fin. The fin adjacent the dummy gate structure is recessed to form a first recess. The first recess has a U-shaped bottom surface. The U-shaped bottom surface is below a top surface of the isolation region. The first recess is reshaped to form a reshaped first recess. The reshaped first recess has a V-shaped bottom surface. At least a portion of the V-shaped bottom surface comprises one or more steps. A source/drain region is epitaxially grown in the reshaped first recess.

WHAT IS CLAIMED IS:

1. A method comprising:  
forming a fin over a substrate;  
forming an isolation region adjacent the fin;  
forming a dummy gate structure over the fin;  
recessing the fin adjacent the dummy gate structure to form a first recess, the first recess having a U-shaped bottom surface, the U-shaped bottom surface being below a top surface of the isolation region;  
reshaping the first recess to form a reshaped first recess, the reshaped first recess having a V-shaped bottom surface, at least a portion of the V-shaped bottom surface comprising one or more steps; and  
epitaxially growing a source/drain region in the reshaped first recess.
2. The method of claim 1, wherein recessing the fin comprises performing a first etching process on the fin.
3. The method of claim 2, wherein the first etching process is an anisotropic dry etching process.
4. The method of claim 2, wherein the first etching process physically etches a material of the fin.
5. The method of claim 2, wherein reshaping the first recess comprises performing a second etching process on the fin, the second etching process being different from the first etching process.
6. The method of claim 5, wherein the second etching process is an isotropic dry etching process.

7. The method of claim 5, wherein the second etching process chemically etches a material of the fin.
8. The method of claim 1, wherein reshaping the first recess further comprises removing a damaged material along sidewalls and the U-shaped bottom surface of the first recess.
9. The method of claim 1, wherein epitaxially growing the source/drain region in the reshaped first recess comprises epitaxially growing a first semiconductor material in the reshaped first recess, the first semiconductor material being different from a second semiconductor material of the fin.
10. A method comprising:
  - patterning a substrate to form a strip, the strip comprising a first semiconductor material;
  - forming an isolation region along a sidewall of the strip, an upper portion of the strip extending above a top surface of the isolation region;
  - forming a dummy gate structure along sidewalls and a top surface of the upper portion of the strip;
  - performing an anisotropic etching process on an exposed portion of the upper portion of the strip to form a first recess, the exposed portion of the strip being not covered by the dummy gate structure;
  - performing an isotropic etching process on sidewalls and a bottom surface of the first recess to form a reshaped first recess, a bottom surface of the reshaped first recess having one or more steps; and
  - epitaxially growing a source/drain region in the reshaped first recess, the source/drain region comprising a second semiconductor material different from the first semiconductor material.

11. The method of claim 10, wherein performing the isotropic etching process further comprises removing a damaged material along the sidewalls and the bottom surface of the first recess.
12. The method of claim 10, wherein the anisotropic etching process physically etches the first semiconductor material.
13. The method of claim 10, wherein the anisotropic etching process etches the first semiconductor material by ion bombardment.
14. The method of claim 10, wherein the isotropic etching process chemically etches the first semiconductor material using radicals.
15. The method of claim 10, further comprising forming spacers on sidewalls of the dummy gate structure and on sidewalls of the exposed portion of the upper portion of the strip.
16. The method of claim 10, wherein the bottom surface of the reshaped first recess is below the top surface of the isolation region.
17. A device comprising:
  - a fin over a substrate;
  - an isolation region adjacent the fin;
  - a gate structure along sidewalls and over a top surface of a channel region of the fin; and
  - an epitaxial region over the fin adjacent the gate structure, the epitaxial region having a V-shaped bottom surface, at least a portion of the V-shaped bottom surface having a stair-like pattern.
18. The device of claim 17, wherein the stair-like pattern comprises one or more steps.

19. The device of claim 17, wherein the V-shaped bottom surface of the epitaxial region is below a top surface of the isolation region.

20. The device of claim 17, wherein the fin comprises a first semiconductor material and the epitaxial region comprises a second semiconductor material, the second semiconductor material being different from the first semiconductor material.

## **FINFET DEVICE AND METHOD OF FORMING SAME**

### **PRIORITY CLAIM AND CROSS-REFERENCE**

**[0001]** This application claims the benefit of U.S. Provisional Application Serial No. 62/427,571, filed on November 29, 2016, entitled “FinFET Device and Method of Forming Same,” which application is hereby incorporated herein by reference in its entirety.

### **BACKGROUND**

**[0002]** Semiconductor devices are used in a variety of electronic applications, such as, for example, personal computers, cell phones, digital cameras, and other electronic equipment. Semiconductor devices are typically fabricated by sequentially depositing insulating or dielectric layers, conductive layers, and semiconductor layers of material over a semiconductor substrate, and patterning the various material layers using lithography to form circuit components and elements thereon.

**[0003]** The semiconductor industry continues to improve the integration density of various electronic components (*e.g.*, transistors, diodes, resistors, capacitors, etc.) by continual reductions in minimum feature size, which allow more components to be integrated into a given area. However, as the minimum features sizes are reduced, additional problems arise that should be addressed.

### **BRIEF DESCRIPTION OF THE DRAWINGS**

**[0004]** Aspects of the present disclosure are best understood from the following detailed description when read with the accompanying figures. It is noted that, in accordance with the standard practice in the industry, various features are not drawn to scale. In fact, the dimensions of the various features may be arbitrarily increased or reduced for clarity of discussion.

**[0005]** Figure 1 is a perspective view of a fin field-effect transistor ("FinFET") device in accordance with some embodiments.

**[0006]** Figures 2A-5A are cross-sectional views of intermediate stages in the manufacture of a FinFET device in accordance with some embodiments.

**[0007]** Figures 6A and 6B are cross-sectional views of intermediate stages in the manufacture of a FinFET device in accordance with some embodiments.

**[0008]** Figures 7A, 7B and 7C are cross-sectional views of intermediate stages in the manufacture of a FinFET device in accordance with some embodiments.

**[0009]** Figures 8A, 8B and 8C are cross-sectional views of intermediate stages in the manufacture of a FinFET device in accordance with some embodiments.

**[0010]** Figures 9A, 9B and 9C are cross-sectional views of intermediate stages in the manufacture of a FinFET device in accordance with some embodiments.

**[0011]** Figures 10A, 10B, and 10C are cross-sectional views of intermediate stages in the manufacture of a FinFET device in accordance with some embodiments.

**[0012]** Figures 11A, 11B, and 11C are cross-sectional views of intermediate stages in the manufacture of a FinFET device in accordance with some embodiments.

**[0013]** Figures 12A, 12B, 12C, and 12D are cross-sectional views of intermediate stages in the manufacture of a FinFET device in accordance with some embodiments.

**[0014]** Figures 13A, 13B, and 13C are cross-sectional views of intermediate stages in the manufacture of a FinFET device in accordance with some embodiments.

**[0015]** Figures 14A, 14B, and 14C are cross-sectional views of intermediate stages in the manufacture of a FinFET device in accordance with some embodiments.

**[0016]** Figures 15A, 15B, and 15C are cross-sectional views of intermediate stages in the manufacture of a FinFET device in accordance with some embodiments.

**[0017]** Figures 16A, 16B, and 16C are cross-sectional views of intermediate stages in the manufacture of a FinFET device in accordance with some embodiments.

**[0018]** Figures 17A, 17B, and 17C are cross-sectional views of intermediate stages in the manufacture of a FinFET device in accordance with some embodiments.

**[0019]** Figures 18A, 18B, and 18C are cross-sectional views of intermediate stages in the manufacture of a FinFET device in accordance with some embodiments.

**[0020]** Figures 19A, 19B, and 19C are cross-sectional views of a FinFET device in accordance with some embodiments.

**[0021]** Figure 20 is a flow diagram illustrating a method of forming a FinFET device in accordance with some embodiments.

**DETAILED DESCRIPTION**

**[0022]** The following disclosure provides many different embodiments, or examples, for implementing different features of the invention. Specific examples of components and arrangements are described below to simplify the present disclosure. These are, of course, merely examples and are not intended to be limiting. For example, the formation of a first feature over or on a second feature in the description that follows may include embodiments in which the first and second features are formed in direct contact, and may also include embodiments in which additional features may be formed between the first and second features, such that the first and second features may not be in direct contact. In addition, the present disclosure may repeat reference numerals and/or letters in the various examples. This repetition is for the purpose of simplicity and clarity and does not in itself dictate a relationship between the various embodiments and/or configurations discussed.

**[0023]** Further, spatially relative terms, such as “beneath,” “below,” “lower,” “above,” “upper” and the like, may be used herein for ease of description to describe one element or feature’s relationship to another element(s) or feature(s) as illustrated in the figures. The spatially relative terms are intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. The apparatus may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein may likewise be interpreted accordingly.

**[0024]** Embodiments will be described with respect to a specific context, namely, a FinFET device and a method of forming the same. Various embodiments discussed herein allow for forming source/drain regions of a FinFET device, such that the number of misfit dislocations in source/drain regions are reduced, thereby preventing the relaxation of the source/drain regions through the formation of misfit dislocations. Various embodiments presented herein are discussed in the context of FinFETs formed using a gate-last process. In other embodiments, a gate-first process may be used. Also, some embodiments contemplate aspects used in planar devices, such as planar FETs.

**[0025]** Figure 1 illustrates an example of a fin field-effect transistor (FinFET) 30 in a three-dimensional view. The FinFET 30 comprises a fin 36 on a substrate 32. The substrate 32 includes isolation regions 34, and the fin 36 protrudes above and from between neighboring isolation regions 34. A gate dielectric 38 is along sidewalls and over a top surface of the fin 36, and a gate electrode 40 is over the gate dielectric 38. Source/drain regions 42 and 44 are disposed in opposite sides of the fin 36 with respect to the gate dielectric 38 and gate electrode 40. Figure 1 further illustrates reference cross-sections that are used in subsequent figures. Cross-section A-A is across a channel, gate dielectric 38, and gate electrode 40 of the FinFET 30. Cross-section C-C is in a plane that is parallel to cross section A-A and is across fin 36 outside of the channel. Cross-section B-B is perpendicular to cross-section A-A and is along a longitudinal axis of the fin 36 and in a direction of, for example, a current flow between the source/drain regions 42 and 44. Subsequent figures refer to these reference cross-sections for clarity.

**[0026]** Figures 2A through 18A-C are cross-sectional views of intermediate stages in the manufacturing of FinFETs in accordance with some embodiment. In Figures 2A through 18A-C, figures ending with an “A” designation are illustrated along the reference cross-section A-A illustrated in Figure 1, except for multiple FinFETs and multiple fins per FinFET; figures ending with a “B” designation are illustrated along the reference cross-section B-B illustrated in Figure 1; and figures ending with a “C” designation are illustrated along the cross-section C-C illustrated in Figure 1.

**[0027]** Figure 2A illustrates a substrate 50. The substrate 50 may be a semiconductor substrate, such as a bulk semiconductor, a semiconductor-on-insulator (SOI) substrate, or the like, which may be doped (e.g., with a p-type or an n-type dopant) or undoped. The substrate 50 may be a wafer, such as a silicon wafer. Generally, an SOI substrate comprises a layer of a semiconductor material formed on an insulator layer. The insulator layer may be, for example, a buried oxide (BOX) layer, a silicon oxide layer, or the like. The insulator layer is provided on a substrate, typically a silicon or glass substrate. Other substrates, such as a multi-layered or gradient substrate may also be used. In some embodiments, the semiconductor material of the substrate 50 may include silicon; germanium; a compound semiconductor including

silicon carbide, gallium arsenic, gallium phosphide, indium phosphide, indium arsenide, and/or indium antimonide; an alloy semiconductor including SiGe, GaAsP, AlInAs, AlGaAs, GaInAs, GaInP, and/or GaInAsP; or combinations thereof.

**[0028]** The substrate 50 may further include integrated circuit devices (not shown). As one of ordinary skill in the art will recognize, a wide variety of integrated circuit devices such as transistors, diodes, capacitors, resistors, the like, or combinations thereof may be formed in and/or on the substrate 50 to generate the structural and functional requirements of the design for the resulting FinFETs. The integrated circuit devices may be formed using any suitable methods.

**[0029]** In some embodiments, the substrate 50 may comprise a first region 100A and a second region 100B. The first region 100A can be for forming n-type devices, such as NMOS transistors, such as n-type FinFETs. The second region 100B can be for forming p-type devices, such as PMOS transistors, such as p-type FinFETs. Accordingly, the first region 100A may be also referred to as an NMOS region 100A, and the second region 100B may be also referred to as a PMOS region 100B.

**[0030]** Figure 2A further illustrates the formation of a mask 53 over the substrate 50. In some embodiments, the mask 53 may be used in a subsequent etching step to pattern the substrate 50 (See Figure 3A). As shown in Figure 2A, the mask 53 may include a first mask layer 53A and a second mask layer 53B. The first mask layer 53A may be a hard mask layer, may comprise silicon nitride, silicon oxynitride, silicon carbide, silicon carbonitride, a combination thereof, or the like, and may be formed using any suitable process, such as atomic layer deposition (ALD), physical vapor deposition (PVD), chemical vapor deposition (CVD), a combination thereof, or the like. The first mask layer 53A may be used to prevent or minimize etching of the substrate 50 underlying the first mask layer 53A in the subsequent etch step (See Figure 3A). The second mask layer 53B may comprise photoresist, and in some embodiments, may be used to pattern the first mask layer 53A for use in the subsequent etching step discussed above. The second mask layer 53B may be formed by using a spin-on technique and may be patterned using acceptable photolithography techniques. In some embodiments, the mask 53 may comprise three or more mask layers.

**[0031]** Figure 3A illustrates the formation of semiconductor strips 52 in the substrate 50. First, mask layers 53A and 53B may be patterned, where openings in mask layers 53A and 53B expose areas of the substrate 50 where trenches 55 will be formed. Next, an etching process may be performed, where the etching process creates the trenches 55 in the substrate 50 through the openings in the mask 53. The remaining portions of the substrate 50 underlying a patterned mask 53 form a plurality of semiconductor strips 52. The etching may be any acceptable etch process, such as a reactive ion etch (RIE), neutral beam etch (NBE), the like, or a combination thereof. The etch process may be anisotropic. In some embodiments, the semiconductor strips 52 may have a height  $H_1$  between about 50 nm and about 60 nm, and a width  $W_1$  between about 6 nm and about 8 nm.

**[0032]** Figure 4A illustrates the formation of an insulation material in the trenches 55 (see Figure 3A) between neighboring semiconductor strips 52 to form isolation regions 54. The insulation material may be an oxide, such as silicon oxide, a nitride, such as silicon nitride, the like, or a combination thereof, and may be formed by a high density plasma chemical vapor deposition (HDP-CVD), a flowable CVD (FCVD) (e.g., a CVD-based material deposition in a remote plasma system and post curing to make it convert to another material, such as an oxide), the like, or a combination thereof. Other insulation materials formed by any acceptable processes may be also used.

**[0033]** Furthermore, in some embodiments, the isolation regions 54 may include a conformal liner (not illustrated) formed on sidewalls and a bottom surface of the trenches 55 (see Figure 3A) prior to the filling of the trenches 55 with an insulation material of the isolation regions 54. In some embodiments, the liner may comprise a semiconductor (e.g., silicon) nitride, a semiconductor (e.g., silicon) oxide, a thermal semiconductor (e.g., silicon) oxide, a semiconductor (e.g., silicon) oxynitride, a polymer dielectric, combinations thereof, or the like. The formation of the liner may include any suitable method, such as ALD, CVD, HDP-CVD, PVD, a combination thereof, or the like. In such embodiments, the liner may prevent (or at least reduce) the diffusion of the semiconductor material from the semiconductor strips 52 (e.g., Si and/or Ge) into the surrounding isolation regions 54 during the subsequent annealing of the isolation regions 54. For example, after the insulation material of the isolation

regions 54 are deposited, an annealing process may be performed on the insulation material of the isolation regions 54.

**[0034]** Referring further to Figure 4A, a planarization process, such as a chemical mechanical polishing (CMP), may remove any excess insulation material of the isolation regions 54, such that top surfaces of the isolation regions 54 and top surfaces of the semiconductor strips 52 are coplanar. In some embodiments, the CMP may also remove the mask 53. In other embodiments, the mask 53 may be removed using a wet cleaning process separate from the CMP.

**[0035]** Figure 5A illustrates the recessing of the isolation regions 54 to form Shallow Trench Isolation (STI) regions 54. The isolation regions 54 are recessed such that fins 56 in the first region 100A and in the second region 100B protrude from between neighboring isolation regions 54. Further, the top surfaces of the isolation regions 54 may have a flat surface as illustrated, a convex surface, a concave surface (such as dishing), or a combination thereof. The top surfaces of the isolation regions 54 may be formed flat, convex, and/or concave by an appropriate etch. The isolation regions 54 may be recessed using an acceptable etching process, such as one that is selective to the material of the isolation regions 54. For example, a chemical oxide removal using a CERTAS® etch, an Applied Materials SICONI tool, or dilute hydrofluoric (dHF) acid may be used.

**[0036]** A person having ordinary skill in the art will readily understand that the process described with respect to Figures 2A through 5A is just one example of how the fins 56 may be formed. In other embodiments, a dielectric layer can be formed over a top surface of the substrate 50; trenches can be etched through the dielectric layer; homoepitaxial structures can be epitaxially grown in the trenches; and the dielectric layer can be recessed such that the homoepitaxial structures protrude from the dielectric layer to form fins. In yet other embodiments, heteroepitaxial structures can be used for the fins. For example, the semiconductor strips 52 in Figure 4A can be recessed, and a material different from the semiconductor strips 52 may be epitaxially grown in their place. In even further embodiments, a dielectric layer can be formed over a top surface of the substrate 50; trenches can be etched through the dielectric layer; heteroepitaxial

structures can be epitaxially grown in the trenches using a material different from the substrate 50; and the dielectric layer can be recessed such that the heteroepitaxial structures protrude from the dielectric layer to form fins 56. In some embodiments where homoepitaxial or heteroepitaxial structures are epitaxially grown, the grown materials may be in situ doped during growth. In other embodiments, homoepitaxial or heteroepitaxial structures may be doped using, for example, ion implantation after homoepitaxial or heteroepitaxial structures are epitaxially grown. Still further, it may be advantageous to epitaxially grow a material in the NMOS region 100A different from the material in the PMOS region 100B. In various embodiments, the fins 56 may comprise silicon germanium ( $\text{Si}_x\text{Ge}_{1-x}$ , where  $x$  can be between approximately 0 and 100), silicon carbide, pure or substantially pure germanium, a III-V compound semiconductor, a II-VI compound semiconductor, or the like. For example, the available materials for forming III-V compound semiconductor include, but are not limited to, InAs, AlAs, GaAs, InP, GaN, InGaAs, InAlAs, GaSb, AlSb, AlP, GaP, and the like.

**[0037]** In Figures 6A and 6B, a dummy dielectric layer 58 is formed on the fins 56. The dummy dielectric layer 58 may be, for example, silicon oxide, silicon nitride, a combination thereof, or the like, and may be deposited (using, for example, CVD, PVD, a combination thereof, or the like) or thermally grown (for example, using thermal oxidation, or the like) according to acceptable techniques. A dummy gate layer 60 is formed over the dummy dielectric layer 58, and a mask 62 is formed over the dummy gate layer 60. In some embodiments, the dummy gate layer 60 may be deposited over the dummy dielectric layer 58 and then planarized using, for example, a CMP process. The mask 62 may be deposited over the dummy gate layer 60. The dummy gate layer 60 may be made of, for example, polysilicon, although other materials that have a high etching selectivity with respect to the material of the isolation regions 54 may also be used. The mask 62 may include one or more layers of, for example, silicon nitride, silicon oxynitride, silicon carbide, silicon carbonitride, the like, or a combination thereof. In an embodiment, the mask 62 comprises a first mask layer 62A formed of silicon nitride and a second mask layer 62B formed of silicon oxide. In some embodiments, the first mask layer 62A may have a thickness between about 9 nm and

about 13 nm, and the second mask layer 62B may have a thickness between about 110 nm and about 130 nm.

**[0038]** Referring further to Figures 6A and 6B, in the illustrated embodiment, a single dummy dielectric layer 58, a single dummy gate layer 60, and a single mask 62 are formed across the first region 100A and the second region 100B. In other embodiments, separate dummy dielectric layers, separate dummy gate layers, and separate masks may be formed in the first region 100A and the second region 100B. In some embodiments, the dummy dielectric layer 58 may have a thickness between about 11 nm and about 15 nm, and the dummy gate layer 60 may have a thickness between about 155 nm and about 165 nm. In some embodiments, the dummy dielectric layer 58 may be omitted.

**[0039]** In Figures 7A, 7B, and 7C, the mask 62 (see Figures 6A and 6B) may be patterned using acceptable photolithography and etching techniques to form a mask 72 in the first region 100A and a mask 78 in the second region 100B. The pattern of the masks 72 and 78 then may be transferred to the dummy gate layer 60 by an acceptable etching technique to form dummy gates 70 in the first region 100A and dummy gates 76 in the second region 100B. Optionally, the pattern of the masks 72 and 78 may similarly be transferred to dummy dielectric layer 58. The pattern of the dummy gates 70 and 76 cover respective channel regions of the fins 56 while exposing source/drain regions of the fins 56. The dummy gates 70 and 76 may also have a lengthwise direction substantially perpendicular to the lengthwise direction of respective fins 56. A size of the dummy gates 70 and 76, and a pitch between dummy gates 70 and 76, may depend on a region of a die in which the dummy gates are formed. In some embodiments, dummy gates 70 and 76 may have a larger size and a larger pitch when located in an input/output region of a die (e.g., where input/output circuitry is disposed) than when located in a logic region of a die (e.g., where logic circuitry is disposed). In some embodiments, the dummy gates 70 may have a width between about 15 nm and about 27 nm, and the dummy gates 76 may have a width between about 15 nm and about 27 nm.

**[0040]** Referring further to Figures 7A, 7B and 7C, appropriate wells (not shown) may be formed in the fins 56, the semiconductor strips 52, and/or the substrate 50. For example, a P-well may be formed in the first region 100A, and an N-well may be formed in the second region 100B. The different implant steps for the different regions 100A and 100B may be achieved using a photoresist or other masks (not shown). For example, a photoresist is formed over the fins 56 and the isolation regions 54 in the first region 100A and the second region 100B. The photoresist is patterned to expose the second region 100B of the substrate 50, such as a PMOS region, while protecting the first region 100A, such as an NMOS region. The photoresist can be formed by using a spin-on technique and can be patterned using acceptable photolithography techniques. Once the photoresist is patterned, n-type impurities are implanted in the second region 100B, and the photoresist may act as a mask to substantially prevent n-type impurities from being implanted into the first region 100A. The n-type impurities may be phosphorus, arsenic, or the like, and may be implanted in the second region 100B to a concentration of equal to or less than  $10^{18} \text{ cm}^{-3}$ , such as in a range from about  $10^{17} \text{ cm}^{-3}$  to about  $10^{18} \text{ cm}^{-3}$ . After the implantation process, the photoresist is removed using, for example, an acceptable ashing process followed by a wet cleaning process.

**[0041]** Following the implanting of the second region 100B, a second photoresist (not shown) is formed over the fins 56 and the isolation regions 54 in the first region 100A and the second region 100B. The second photoresist is patterned to expose the first region 100A of the substrate 50, while protecting the second region 100B. The second photoresist can be formed by using a spin-on technique and can be patterned using acceptable photolithography techniques. Once the second photoresist is patterned, p-type impurities are implanted in the first region 100A, and the second photoresist may act as a mask to substantially prevent p-type impurities from being implanted into the second region 100B. The p-type impurities may be boron,  $\text{BF}_2$ , or the like, and may be implanted in the first region 100A to a concentration of equal to or less than  $10^{18} \text{ cm}^{-3}$ , such as in a range from about  $10^{17} \text{ cm}^{-3}$  to about  $10^{18} \text{ cm}^{-3}$ . After the implantation process, the second photoresist is removed using, for example, an acceptable ashing process followed by a wet cleaning process.

**[0042]** After implanting appropriate impurities in first region 100A and the second region 100B, an anneal may be performed to activate the p-type and n-type impurities that were implanted. The implantation process may form a P-well in the first region 100A, and an N-well in the second region 100B. In some embodiments where the fins are epitaxial grown, the grown materials of the fins 56 may be in situ doped during the growth process.

**[0043]** In Figures 8A, 8B, and 8C, a gate spacer layer 80 is formed on exposed surfaces of the dummy gates 70 and 76 (see Figures 8A and 8B) and/or the dummy dielectric layer 58 over the fins 56 (see Figure 8C). Any suitable methods of forming the gate spacer layer 80 may be used. In some embodiments, a deposition (such as CVD, ALD, or the like) may be used form the gate spacer layer 80. In some embodiments, the gate spacer layer 80 may include one or more layers of, for example, silicon nitride (SiN), silicon oxynitride, silicon carbonitride, silicon oxycarbonitride (SiOCN), a combination thereof, or the like. In some embodiments, the gate spacer layer 80 may comprise a first gate spacer layer 80A, a second gate spacer layer 80B over the first gate spacer layer 80A, and a third gate spacer layer 80C of the second gate spacer layer 80B. In an embodiment, the first gate spacer layer 80A comprises SiOCN, the second gate spacer layer 80B comprises SiOCN, and the third gate spacer layer 80C comprises SiN. In some embodiment, the first gate spacer layer 80A has a thickness between about 3 nm and about 5 nm, the second gate spacer layer 80B has a thickness between about 3 nm and about 5 nm, and the third gate spacer layer 80C has a thickness between about 4 nm and about 6 nm.

**[0044]** Referring further to Figures 8A, 8B, and 8C, after forming the first spacer layer 80A, lightly doped source/drain (LDD) regions 75 and 79 may be formed in the substrate 50 in the first region 100A and the second region 100B, respectively. Similar to the implantation process discussed above with reference to Figures 7A, 7B and 7C, a mask (not shown), such as a photoresist, may be formed over the first region 100A, e.g., the NMOS region, while exposing the second region 100B, e.g., the PMOS region, and p-type impurities may be implanted into the exposed fins 56 in the second region 100B to create LDD regions 79. During the implantation of the LDD regions 79, the dummy gate 76 may act as a mask to prevent (or at least reduce) dopants from implanting into a

channel region of the exposed fins 56. Thus, the LDD regions 79 may be formed substantially in source/drain regions of the exposed fins 56. The mask may then be removed. Subsequently, a second mask (not shown), such as a photoresist, may be formed over the second region 100B, while exposing the first region 100A, and n-type impurities may be implanted into the exposed fins 56 in the first region 100A to create LDD regions 75. During the implantation of the LDD regions 75, the dummy gate 70 may act as a mask to prevent (or at least reduce) dopants from implanting into a channel region of the exposed fins 56. Thus, the LDD regions 75 may be formed substantially in source/drain regions of the exposed fins 56. The second mask may then be removed. The n-type impurities may be any of the n-type impurities previously discussed, and the p-type impurities may be any of the p-type impurities previously discussed. The LDD regions 75 and 79 may each have a concentration of impurities from about  $10^{15} \text{ cm}^{-3}$  to about  $10^{16} \text{ cm}^{-3}$ . An annealing process may be performed to activate the implanted impurities.

**[0045]** Referring further to Figures 8A, 8B, and 8C, after forming the LDD regions 75 and 79, the first spacer layer 80A may be carbon doped using a suitable doping process. In the illustrated embodiments, carbon doping of the first spacer layer 80A is performed after the LDD regions 75 and 79 are formed. In other embodiments, carbon doping of the first spacer layer 80A may be performed after forming the first gate spacer layer 80A, but before forming the LDD regions 75 and 79. Subsequently, the second gate spacer layer 80B is formed over the first gate spacer layer 80A, and the third gate spacer layer 80C is formed over the second gate spacer layer 80B. In some embodiments, the second spacer layer 80B may also be carbon doped using a suitable doping process. In other embodiments, the second spacer layer 80B and the third spacer layer 80C may also be carbon doped using suitable doping processes.

**[0046]** Referring to Figures 9A, 9B, 9C, 10A, 10B, and 10C, a patterning process is performed to remove excess portions of the spacer layer 80 in the first region 100A. Any acceptable patterning process may be used. Referring first to Figures 9A, 9B, and 9C, in some embodiments, a tri-layer mask 120 is formed over the first region 100A and the second region 100B. The tri-layer mask 120 comprises a bottom layer 120A, a middle layer 120B over the bottom layer 120A, and a top layer 120C over the middle

layer 120B. In some embodiments, the bottom layer 120A may comprise an organic material, such as a spin-on carbon (SOC) material, or the like, and may be formed using spin-on coating, CVD, ALD, or the like. The middle layer 120B may comprise an inorganic material, which may be a nitride (such as SiN, TiN, TaN, or the like), an oxynitride (such as SiON), an oxide (such as silicon oxide), or the like, and may be formed using CVD, ALD, or the like. The top layer 120C may comprise an organic material, such as a photoresist material, and may be formed using a spin-on coating, or the like. In some embodiments, the top layer 120C of the tri-layer mask 120 is patterned to expose the first region 100A. The top layer 120C may be patterned using suitable photolithography techniques.

**[0047]** Referring to Figures 10A, 10B, and 10C, an etching process is performed using the patterned tri-layer mask 120 as a mask. The etching process may be anisotropic. After performing the etching process, lateral portions of the first spacer layer 80A, the second spacer layer 80B, and the third spacer layer 80C over the LDD regions 75 and over the isolation regions 54 may be removed to expose top surfaces of the fins 56 and the masks 72 for the dummy gate stacks 70. Portions of the first spacer layer 80A, the second spacer layer 80B, and the third spacer layer 80C along sidewalls of the dummy gates 70 and the fins 56 may remain and form spacers 122. In other embodiments, the spacer layer 80 may also be removed from the sidewalls of the fins 56. After patterning the spacer layer 80, the tri-layer mask 120 may be removed using any suitable removal process.

**[0048]** Figures 11A through 15C illustrate the formation of epitaxial source/drain regions 82 and 84 in the first region 100A and the second region 100B. In some embodiments, the epitaxial source/drain regions 82 (see Figures 15B and 15C) in the first region 100A may be formed before the epitaxial source/drain regions 84 (see Figures 15B and 15C) are formed in the second region 100B. In other embodiments, the epitaxial source/drain regions 84 in the second region 100B may be formed before forming the epitaxial source/drain regions 82 in first region 100A.

**[0049]** Figures 11A through 14C illustrate the formation of the epitaxial source/drain regions 82 in the first region 100A. During the formation of the epitaxial

source/drain regions 82 in first region 100A, e.g., the NMOS region, the second region 100B, e.g., the PMOS region may be masked (not shown). Referring first to Figures 11A, 11B, and 11C, a first patterning process is performed on the fins 56 to form recesses 124 in source/drain regions of the fins 56. The first patterning process may be performed in a manner that the recesses 124 are formed between neighboring dummy gates 70 (in interior regions of the fins 56), or between an isolation region 54 and adjacent dummy gate 70 (in end regions of the fins 56) as shown in the cross section illustrated in Figure 11B. In some embodiments, the first patterning process may include a suitable anisotropic dry etching process, while using the dummy gates 70, the spacers 122 and/or isolation regions 54 as a combined mask. The suitable anisotropic dry etching process may include a reactive ion etch (RIE), neutral beam etch (NBE), the like, or a combination thereof. In some embodiments where the RIE is used in the first patterning process, process parameters such as, for example, a process gas mixture, a voltage bias, and an RF power may be chosen such that etching is predominantly performed using physical etching, such as ion bombardment, rather than chemical etching, such as radical etching through chemical reactions. In some embodiments, a voltage bias may be increased to increase energy of ions used in the ion bombardment process and, thus, increase a rate of physical etching. Since, the physical etching is anisotropic in nature and the chemical etching is isotropic in nature, such an etching process has an etch rate in the vertical direction that is greater than an etch rate in the lateral direction. In some embodiments, the anisotropic etching process may be performed using a process gas mixture including  $\text{CH}_3\text{F}$ ,  $\text{CH}_4$ ,  $\text{HBr}$ ,  $\text{O}_2$ ,  $\text{Ar}$ , a combination thereof, or the like. In some embodiments, the first patterning process forms recesses 124 having U-shaped bottom surfaces. The recesses 124 may also be referred to as U-shaped recesses 124. In some embodiments, the V-shaped recesses 126 have a depth  $D_1$ , as measured from a top surface of the fins 56, between about 53 nm and about 59 nm. In some embodiments, the etching process for forming the U-shaped recesses 124 may also etch isolation regions, which is illustrated in Figure 11C by dashed lines.

**[0050]** Referring to Figures 12A, 12B, and 12C, a second patterning process is performed on the fins 56 to reshape the U-shaped recesses 124 and form recesses 126

having V-shaped bottom surfaces. The recesses 126 may also be referred to as V-shaped recesses 126. In some embodiments, the second patterning process may include a suitable isotropic dry etching process, while using the dummy gates 70, the spacers 122 and/or isolation regions 54 as a combined mask. The suitable isotropic dry etching process may include a dry etch process such that etching is predominantly performed using chemical etching, such as radical etching through chemical reactions, rather than physical etching, such as ion bombardment. In some embodiments, process parameters such as, for example, a process gas mixture may be chosen such that etching is predominantly performed using chemical etching rather than physical etching. In some embodiments, a voltage bias may be reduced to reduce energy of ions used in the ion bombardment process and, thus, reduce a rate of physical etching. Since, the physical etching is anisotropic in nature and the chemical etching is isotropic in nature, such an etching process has an etch rate in the vertical direction that is substantially same as an etch rate in the lateral direction. In some embodiments, radicals that are used for the isotropic etching process may be electrically neutral. In some embodiments, the isotropic etching process may be performed using a process gas mixture including HBr, CH<sub>3</sub>F, Cl<sub>2</sub>, NF<sub>3</sub>, H<sub>2</sub>, a combination thereof, or the like. In addition to reshaping the U-shaped recesses 124 into the V-shaped recesses 126, the isotropic etching process of the second patterning process may remove portions of the semiconductor strips 52 along sidewalls and a bottom of the U-shaped recesses 124 that are damaged by anisotropic etching process (ion bombardment) of the first patterning process. Furthermore, bottoms of the V-shaped recesses 126 may have stair-like patterns. In some embodiments, the etching process for forming the V-shaped recesses 126 may also etch isolation regions 54, which is illustrated in Figure 12C by dashed lines.

**[0051]** Figure 12D illustrates a magnified view of a portion 128 (including the V-shaped recess 126) of the structure illustrated in Figure 12B. In the illustrated embodiment, the V-shaped recesses 126 have bottoms with stair-like patterns that have three steps. In other embodiments, the stair-like patterns may have less or more than three steps. In some embodiments, the number of steps in the stair-like patterns depends on the process parameters of the second patterning process, such as, for example, ratios of amounts of various etchant gases in a process gas mixture and

duration of the second patterning process. In some embodiments, etch parameters of the second patterning process may be tuned to change the number of steps in the stair-like patterns. The V-shaped recesses 126 have a depth  $D_2$  as measured from the top surface of the fins 56 such that the depth  $D_2$  is greater than the depth  $D_1$  of the U-shaped recesses 124 (see Figure 11B). In some embodiments, the depth  $D_2$  may be between about 53 nm and about 59 nm. The V-shaped recesses 126 have a width  $W_a$  at a zero depth from the top surface of the fins 56, a width  $W_b$  at a depth  $D_4$  from the top surface of the fins 56, and a width  $W_c$  at a depth  $D_3$  from the top surface of the fins 56. In the illustrated embodiment, the depth  $D_4$  is about 0.5 times the depth  $D_2$ , and the depth  $D_3$  is about 0.9 times the depth  $D_2$ . In some embodiments, a ratio of the widths  $W_a:W_b:W_c$  is about 1: about 0.98 to about 1.01: about 0.97 to about 0.99. Accordingly, the V-shaped recesses 126 may have substantially vertical sidewalls up to the depth  $D_3$ . In some embodiments, the V-shaped recesses 126 may have an aspect ratio greater than about 5. In the illustrated embodiment, the bottoms of the V-shaped recesses 126 between the depth  $D_3$  and the depth  $D_2$  have stair-shape pattern with three steps. In the illustrated embodiment, the V-shaped recesses 126 have a width  $W_d$  at the first step of the stair-shaped pattern, a width  $W_e$  at a second step of the stair-shaped pattern, and a width  $W_f$  at a third step of the stair-shaped pattern, with the first step being nearest to the top surface of the fins 56, the third step being farthest from the top surface of the fins 56, and the second step being interposed between the first step and the second step. In some embodiments, a ratio of the widths  $W_d:W_e:W_f$  is about 1.5 to about 1.8 : about 1.3 to about 1.5: about 1.

**[0052]** Referring further to Figures 12A, 12B, 12C, and 12D, by removing damaged portions of the semiconductor strips 52 along sidewalls and the bottoms of the U-shaped recesses 124, and by reshaping the U-shaped recesses 124 into the V-shaped recesses 126, the number of misfit dislocations in subsequently formed source/drain regions is reduced or eliminated. Accordingly, relaxation of the source/drain regions through the formation of misfit dislocations may be avoided. Non-relaxed source/drain regions allow for a greater stress to be applied to the channel regions of the resulting FinFETs, which improves performance characteristics of the resulting FinFET device. Furthermore, by reducing the number of misfit dislocations in the source/drain regions,

the number of known bad devices in a wafer may be reduced to be less than about 30 %, which improves the yield of the known good devices.

**[0053]** Figures 13A, 13B, and 13C illustrate the formation of epitaxial source/drain regions 82 in the first region 100A. In some embodiments, the epitaxial source/drain regions 82 are epitaxially grown in the V-shaped recesses 126 (See Figures 12B, 12C, and 12D) using metal-organic CVD (MOCVD), molecular beam epitaxy (MBE), liquid phase epitaxy (LPE), vapor phase epitaxy (VPE), selective epitaxial growth (SEG), a combination thereof, or the like. The epitaxial source/drain regions 82 may include any acceptable material, such as any material that is appropriate for n-type FinFETs. For example, if the fin 56 is silicon, the epitaxial source/drain regions 82 may include silicon, SiC, SiCP, SiP, or the like. The epitaxial source/drain regions 82 may have surfaces raised from respective surfaces of the fins 56 and may have facets. The epitaxial source/drain regions 82 are formed in the fins 56 such that each dummy gate 70 is disposed between respective neighboring pairs of the epitaxial source/drain regions 82. In some embodiments the epitaxial source/drain regions 82 may extend past the fins 56 and into the semiconductor strips 52.

**[0054]** The material of the epitaxial source/drain regions 82 in the first region 100A may be implanted with dopants, similar to the process previously discussed for forming the LDD regions 75, followed by an anneal (see Figures 8A, 8B, and 8C). The epitaxial source/drain regions 82 may have an impurity concentration of in a range from about  $10^{19} \text{ cm}^{-3}$  to about  $10^{21} \text{ cm}^{-3}$ . The n-type impurities for source/drain regions in the first region 100A, e.g., the NMOS region, may be any of the n-type impurities previously discussed. In other embodiments, the material of the epitaxial source/drain regions 82 may be in situ doped during growth. In the illustrated embodiments, each of the source/drain regions 82 is physically separate from other source/drain regions 82. In other embodiments, two or more adjacent source/drain regions 82 may be merged. Such an embodiment is depicted in Figures 19A, 19B, and 19C, such that two adjacent source/drain regions 82 are merged to form a common source/drain region. In some embodiments, more than two adjacent source/drain regions 82 may be merged.

**[0055]** Referring to Figures 14A, 14B, and 14C, after forming the epitaxial source/drain regions 82 in the first region 100A, the epitaxial source/drain regions 84 are formed in the second region 100B. In some embodiments, the epitaxial source/drain regions 84 are formed in the second region 100B using similar methods as the epitaxial source/drain regions 82 described above with reference to Figures 9A through 14C, and the detailed description is not repeated for the sake of brevity. In some embodiments, during the formation of the epitaxial source/drain regions 84 in the second region 100B, e.g., the PMOS region, the first region 100A, e.g., the NMOS region may be masked (not shown). In some embodiments, the spacer layer 80 in the second region 100B is patterned to form spacers 130 along sidewalls of the dummy gates 76 and the fins 56. The spacer layer 80 in the second region 100B may be patterned using similar methods as the spacer layer 80 in the first region 100A, described above with reference to Figures 9A-10C, and the description is not repeated herein for the sake of brevity. Subsequently, the source/drain regions of the fins 56 in the second region 100B are etched to form recesses (shown as filled with the epitaxial source/drain regions 84 in Figures 14B and 14C) similar to the V-shaped recesses 126 (See Figures 12B, 12C, and 12D). The recesses in the second region 100B may be formed using similar method as the V-shaped recesses 126 in the first region, described above with reference to Figures 11A-12D, and the description is not repeated herein for the sake of brevity.

**[0056]** Next, the epitaxial source/drain regions 84 in the second region 100B are epitaxially grown in the recesses using MOCVD, MBE, LPE, VPE, SEG, a combination thereof, or the like. The epitaxial source/drain regions 84 may include any acceptable material, such as any material that is appropriate for p-type FinFETs. For example, if the fin 56 is silicon, the epitaxial source/drain regions 84 may comprise SiGe, SiGeB, Ge, GeSn, or the like. The epitaxial source/drain regions 84 may have surfaces raised from respective surfaces of the fins 56 and may have facets. In the second region 100B, epitaxial source/drain regions 84 are formed in the fins 56 such that each dummy gate 76 is disposed between respective neighboring pairs of the epitaxial source/drain regions 84. In some embodiments epitaxial source/drain regions 84 may extend past the fins 56 and into the semiconductor strips 52.

**[0057]** The material of the epitaxial source/drain regions 84 in the second region 100B may be implanted with dopants, similar to the process previously discussed for forming the LDD regions 79, followed by an anneal (see Figures 8A, 8B, and 8C). The source/drain regions 84 may have an impurity concentration in a range from about  $10^{19}$   $\text{cm}^{-3}$  to about  $10^{21}$   $\text{cm}^{-3}$ . The p-type impurities for the source/drain regions 84 in the second region 100B, e.g., the PMOS region, may be any of the p-type impurities previously discussed. In other embodiments, the epitaxial source/drain regions 84 may be in situ doped during growth. In the illustrated embodiments, each of the source/drain regions 84 is physically separate from other source/drain regions 84. In other embodiments, two or more adjacent source/drain regions 84 may be merged. Such an embodiment is depicted in Figures 19A, 19B, and 19C, such that two adjacent source/drain regions 84 are merged to form a common source/drain region. In some embodiments, more than two adjacent source/drain regions 84 may be merged.

**[0058]** Referring further to Figures 14A, 14B, and 14C, an etch stop layer 87 and an interlayer dielectric (ILD) 88 are deposited over the dummy gates 70 and 76, and over the source/drain regions 82 and 84. In an embodiment, the ILD 88 is a flowable film formed by a flowable CVD. In some embodiments, the ILD 88 is formed of a dielectric material such as Phospho-Silicate Glass (PSG), Boro-Silicate Glass (BSG), Boron-Doped Phospho-Silicate Glass (BPSG), undoped Silicate Glass (USG), or the like, and may be deposited by any suitable method, such as CVD, PECVD, a combination thereof, or the like. In some embodiments, the etch stop layer 87 is used as a stop layer while patterning the ILD 88 to form openings for subsequently formed contacts. Accordingly, a material for the etch stop layer 87 may be chosen such that the material of the etch stop layer 87 has a lower etch rate than the material of ILD 88.

**[0059]** Referring to Figures 15A, 15B, and 15C, a planarization process, such as a CMP, may be performed to level the top surface of ILD 88 with the top surfaces of the dummy gates 70 and 76. After the planarization process, top surfaces of the dummy gates 70 and 76 are exposed through the ILD 88. In some embodiments, the CMP may also remove the masks 72 and 78, or portions thereof, on the dummy gates 70 and 76.

**[0060]** Referring to Figures 16A, 16B, and 16C, remaining portions of masks 72 and 78 and the dummy gates 70 and 76 are removed in an etching step(s), so that recesses 90 are formed. Each of the recesses 90 exposes a channel region of a respective fin 56. Each channel region is disposed between neighboring pairs of the epitaxial source/drain regions 82 in the first region 100A or between neighboring pairs of the epitaxial source/drain regions 84 in the second region 100B. During the removal, the dummy dielectric layer 58 may be used as an etch stop layer when the dummy gates 70 and 76 are etched. The dummy dielectric layer 58 may then be removed after the removal of the dummy gates 70 and 76.

**[0061]** Referring to Figures 17A, 17B, and 17C, gate dielectric layers 92 and 96, and gate electrodes 94 and 98 are formed for replacement gates in the first region 100A and the second region 100B, respectively. The gate dielectric layers 92 and 96 are deposited conformally in the recesses 90, such as on the top surfaces and the sidewalls of the fins 56, on sidewalls of the gate spacers 122 and 130, respectively, and on a top surface of the ILD 88. In some embodiments, the gate dielectric layers 92 and 96 comprise silicon oxide, silicon nitride, or multilayers thereof. In other embodiments, the gate dielectric layers 92 and 96 include a high-k dielectric material, and in these embodiments, the gate dielectric layers 92 and 96 may have a k value greater than about 7.0, and may include a metal oxide or a silicate of Hf, Al, Zr, La, Mg, Ba, Ti, Pb, and combinations thereof. The formation methods of the gate dielectric layers 92 and 96 may include Molecular-Beam Deposition (MBD), ALD, PECVD, a combination thereof, or the like.

**[0062]** Next, the gate electrodes 94 and 98 are deposited over the gate dielectric layers 92 and 96, respectively, and fill the remaining portions of the recesses 90. The gate electrodes 94 and 98 may be made of a metal-containing material such as TiN, TaN, TaC, Co, Ru, Al, Ag, Au, W, Ni, Ti, Cu, combinations thereof, or multi-layers thereof. After the filling of the gate electrodes 94 and 98, a planarization process, such as a CMP, may be performed to remove the excess portions of the gate dielectric layers 92 and 96, and the gate electrodes 94 and 98, which excess portions are over the top surface of ILD 88. The resulting remaining portions of material of the gate electrodes

94 and 98, and the gate dielectric layers 92 and 96 thus form replacement gates of the resulting FinFETs.

**[0063]** In some embodiments, the formation of the gate dielectric layers 92 and 96 may occur simultaneously such that the gate dielectric layers 92 and 96 are made of the same materials, and the formation of the gate electrodes 94 and 98 may occur simultaneously such that the gate electrodes 94 and 98 are made of the same materials. However, in other embodiments, the gate dielectric layers 92 and 96 may be formed by distinct processes, such that the gate dielectric layers 92 and 96 may be made of different materials, and the gate electrodes 94 and 98 may be formed by distinct processes, such that the gate electrodes 94 and 98 may be made of different materials. Various masking steps may be used to mask and expose appropriate regions when using distinct processes.

**[0064]** Referring to Figures 18A, 18B, and 18C, an ILD 102 is deposited over the ILD 88, contacts 104 and 106 are formed through the ILD 102 and the ILD 88, and contacts 108 and 110 are formed through the ILD 102. In an embodiment, the ILD 102 is formed using similar materials and methods as ILD 88, described above with reference to Figures 14A, 14B, and 14C, and the description is not repeated herein for the sake of brevity. In some embodiments, the ILD 102 and the ILD 88 are formed of a same material. In other embodiments, the ILD 102 and the ILD 88 are formed of different materials.

**[0065]** Openings for the contacts 104 and 106 are formed through the ILDs 88 and 102, and the etch stop layer 87. Openings for the contacts 108 and 110 are formed through the ILD 102 and the etch stop layer 87. These openings may all be formed simultaneously in a same process, or in separate processes. The openings may be formed using acceptable photolithography and etching techniques. A liner, such as a diffusion barrier layer, an adhesion layer, or the like, and a conductive material are formed in the openings. The liner may include titanium, titanium nitride, tantalum, tantalum nitride, or the like. The conductive material may be copper, a copper alloy, silver, gold, tungsten, aluminum, nickel, or the like. A planarization process, such as a CMP, may be performed to remove excess materials from a top surface of the ILD 102.

The remaining liner and conductive material form contacts 104, 106, 108, and 110 in the openings. An anneal process may be performed to form a silicide (not shown) at the interface between the epitaxial source/drain regions 82 and 84 and the contacts 104 and 105, respectively. The contacts 104 are physically and electrically coupled to the epitaxial source/drain regions 82, the contacts 106 are physically and electrically coupled to the epitaxial source/drain regions 84, the contact 108 is physically and electrically coupled to the gate electrode 94, and the contact 110 is physically and electrically coupled to the gate electrode 98. While the contacts 104 and 106 are depicted in Figure 18B in a same cross-section as the contacts 108 and 110, this depiction is for purposes of illustration and in some embodiments the contacts 104 and 106 are disposed in different cross-sections from contacts 108 and 110.

**[0066]** Figures 19A, 19B, and 19C illustrated cross-sectional views of a FinFET device that is similar to the FinFET device illustrated in Figures 18A, 18B, and 18C, with like elements labeled with like numerical references. In some embodiments, the FinFET device of Figures 19A, 19B, and 19C may be formed using similar materials and methods and FinFET device of Figures 18A, 18B, and 18C, described above with reference to Figures 1-18C, and the description is not repeated herein for the sake of brevity. In the illustrated embodiment, two adjacent source/drain regions 82 and two adjacent source/drain regions 84 are merged to form respective common source/drain regions. In other embodiments, more than two adjacent source/drain regions 82 and more than two adjacent source/drain regions 84 may be merged.

**[0067]** Figure 20 is a flow diagram illustrating a method of forming a FinFET device in accordance with some embodiments. The method 2000 starts with step 2001, where a substrate (such as the substrate 50 illustrated in Figure 2A) is patterned to form strips (such as the semiconductor strips 52 illustrated in Figure 3A) as described above with reference to Figures 2A and 3A. In step 2003, isolation regions (such as the isolation regions 54 illustrated in Figure 5A) are formed between adjacent strips as described above with reference to Figures 4A and 5A. In step 2005, dummy gate stacks (such as the dummy gates 70 and 76 illustrated in Figures 7A and 7B) are formed over the strips as described above with reference to Figures 6A, 6B, and 7A-7C. In step 2007, a first patterning process is performed on the strips to form recesses (such as the

recesses 124 illustrated in Figures 11B and 11C) in the strips as described above with reference to Figures 8A-11C. In step 2009, a second patterning process is performed on the strips to form reshaped recesses (such as the recesses 126 illustrated in Figures 12B-12D) in the strips as described above with reference to Figures 12A-12D. In step 2011, source/drain regions (such as the epitaxial source/drain regions 82 illustrated in Figures 13B and 13C) are epitaxially grown in the reshaped recesses as described above with reference to Figures 13A-13D. In some embodiments, steps 2007, 2009, and 2011 are performed on strips disposed in a first region of the substrate where n-type devices are formed. In such embodiments, steps 2007, 2009, and 2011 may be repeated to be performed on strips disposed in a second region of the substrate where p-type devices are formed as described above with reference to Figures 14A-14C. In step 2013, replacement gate stacks (such as the gate dielectric layers 92/the gate electrodes 94 and the gate dielectric layers 96/the gate electrodes 98 illustrated in Figures 17A and 17B) are formed over the strips as described above with reference to Figures 15A-17C.

**[0068]** Various embodiments discussed herein allow for reducing the number of misfit dislocations in source/drain regions, and preventing the relaxation of the source/drain regions through the formation of misfit dislocations. By forming non-relaxed source/drain regions, stress characteristics of source/drain regions are improved, which improves performance characteristics of the resulting FinFET device. Furthermore, by reducing the number of misfit dislocations in the source/drain regions, the yield of the known good devices is improved.

**[0069]** According to an embodiment, a method includes forming a fin over a substrate. An isolation region is formed adjacent the fin. A dummy gate structure is formed over the fin. The fin adjacent the dummy gate structure is recessed to form a first recess. The first recess has a U-shaped bottom surface. The U-shaped bottom surface is below a top surface of the isolation region. The first recess is reshaped to form a reshaped first recess. The reshaped first recess has a V-shaped bottom surface. At least a portion of the V-shaped bottom surface includes one or more steps. A source/drain region is epitaxially grown in the reshaped first recess.

**[0070]** According to another embodiment, a method includes patterning a substrate to form a strip, the strip comprising a first semiconductor material. An isolation region is formed along a sidewall of the strip. An upper portion of the strip extends above a top surface of the isolation region. A dummy gate structure is formed along sidewalls and a top surface of the upper portion of the strip. An anisotropic etching process is performed on an exposed portion of the upper portion of the strip to form a first recess. The exposed portion of the strip is not covered by the dummy gate structure. An isotropic etching process is performed on sidewalls and a bottom surface of the first recess to form a reshaped first recess. A bottom surface of the reshaped first recess has one or more steps. A source/drain region is epitaxially grown in the reshaped first recess. The source/drain region includes a second semiconductor material different from the first semiconductor material.

**[0071]** According to yet another embodiment, a device includes a fin over a substrate, an isolation region adjacent the fin, a gate structure along sidewalls and over a top surface of a channel region of the fin, and an epitaxial region over the fin adjacent the gate structure. The epitaxial region has a V-shaped bottom surface. At least a portion of the V-shaped bottom surface has a stair-like pattern.

**[0072]** The foregoing outlines features of several embodiments so that those skilled in the art may better understand the aspects of the present disclosure. Those skilled in the art should appreciate that they may readily use the present disclosure as a basis for designing or modifying other processes and structures for carrying out the same purposes and/or achieving the same advantages of the embodiments introduced herein. Those skilled in the art should also realize that such equivalent constructions do not depart from the spirit and scope of the present disclosure, and that they may make various changes, substitutions, and alterations herein without departing from the spirit and scope of the present disclosure.

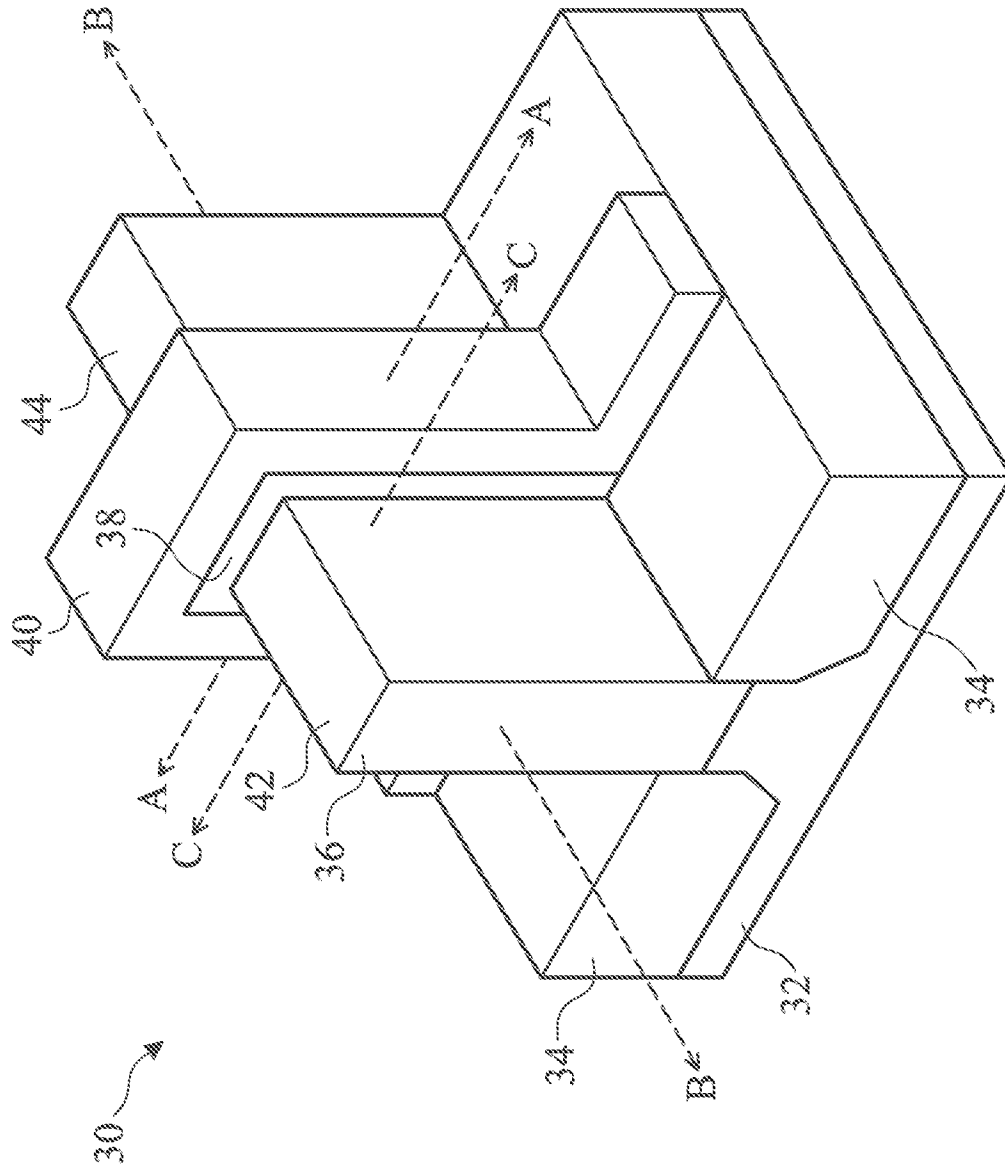


Figure 1

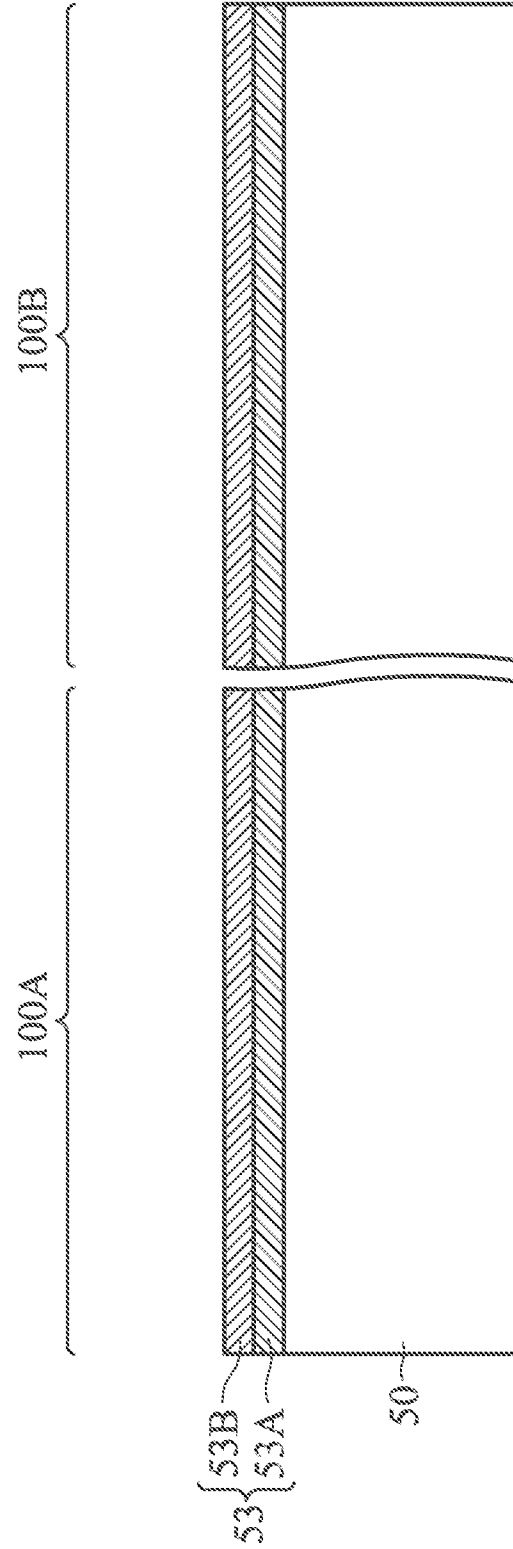


Figure 2A

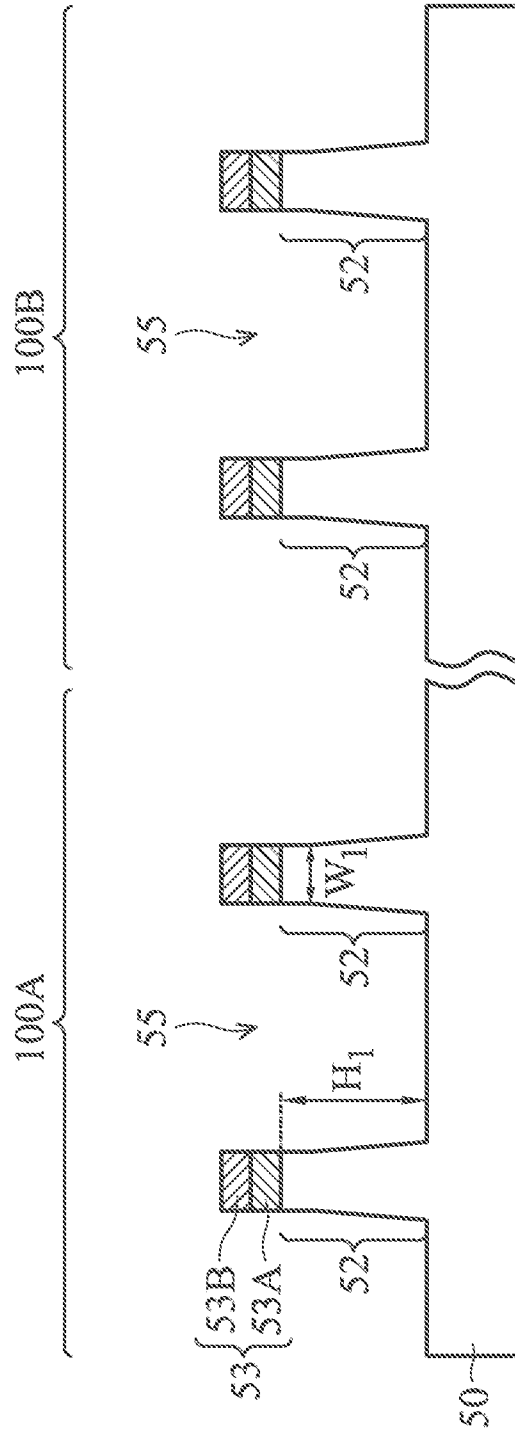


Figure 3A

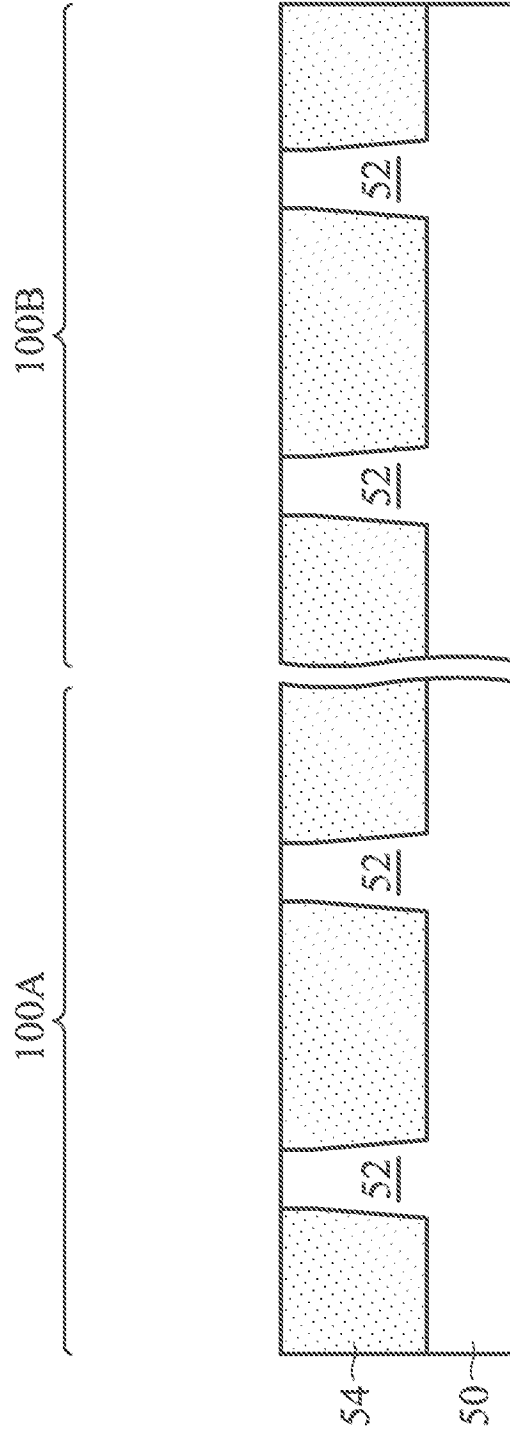


Figure 4A

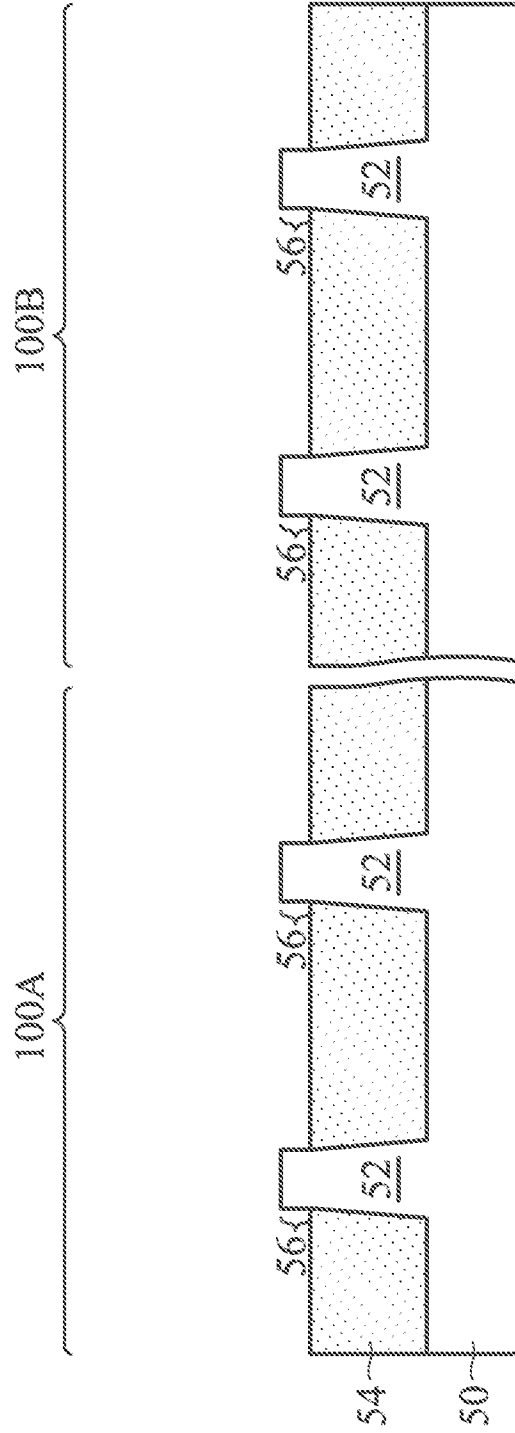


Figure 5A

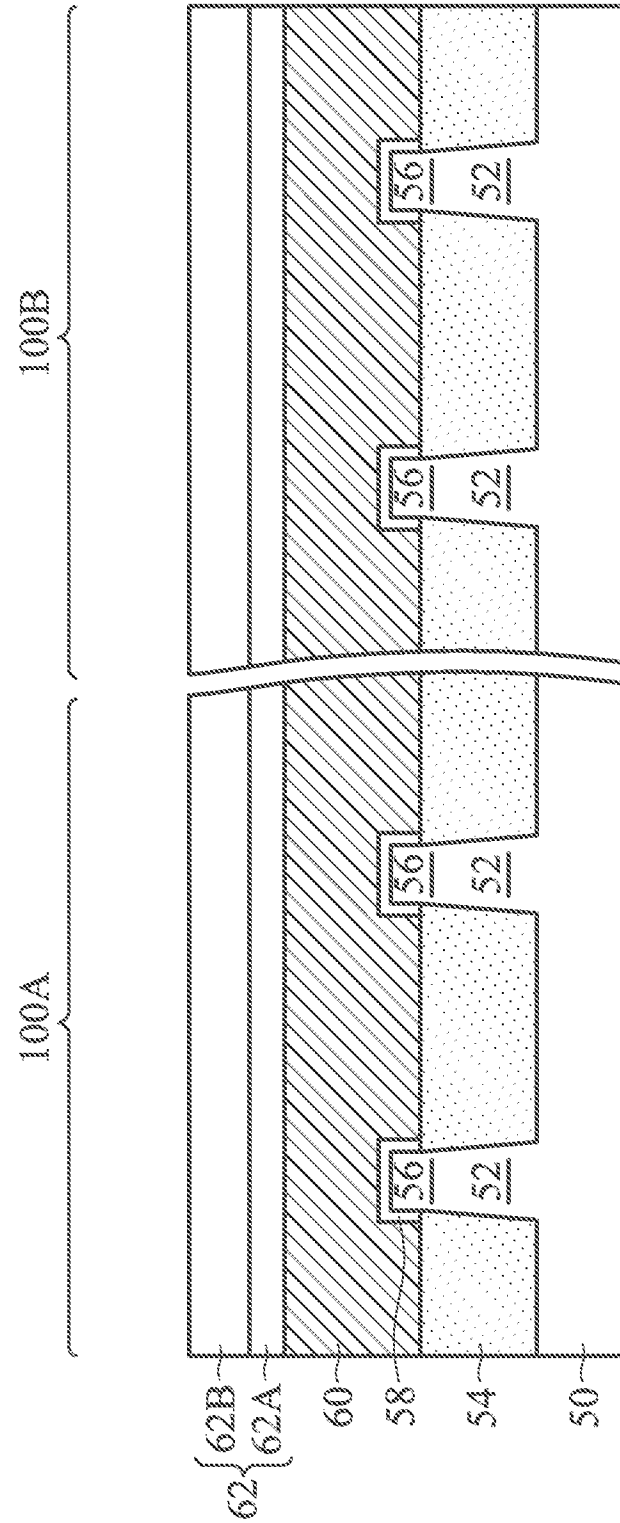


Figure 6A

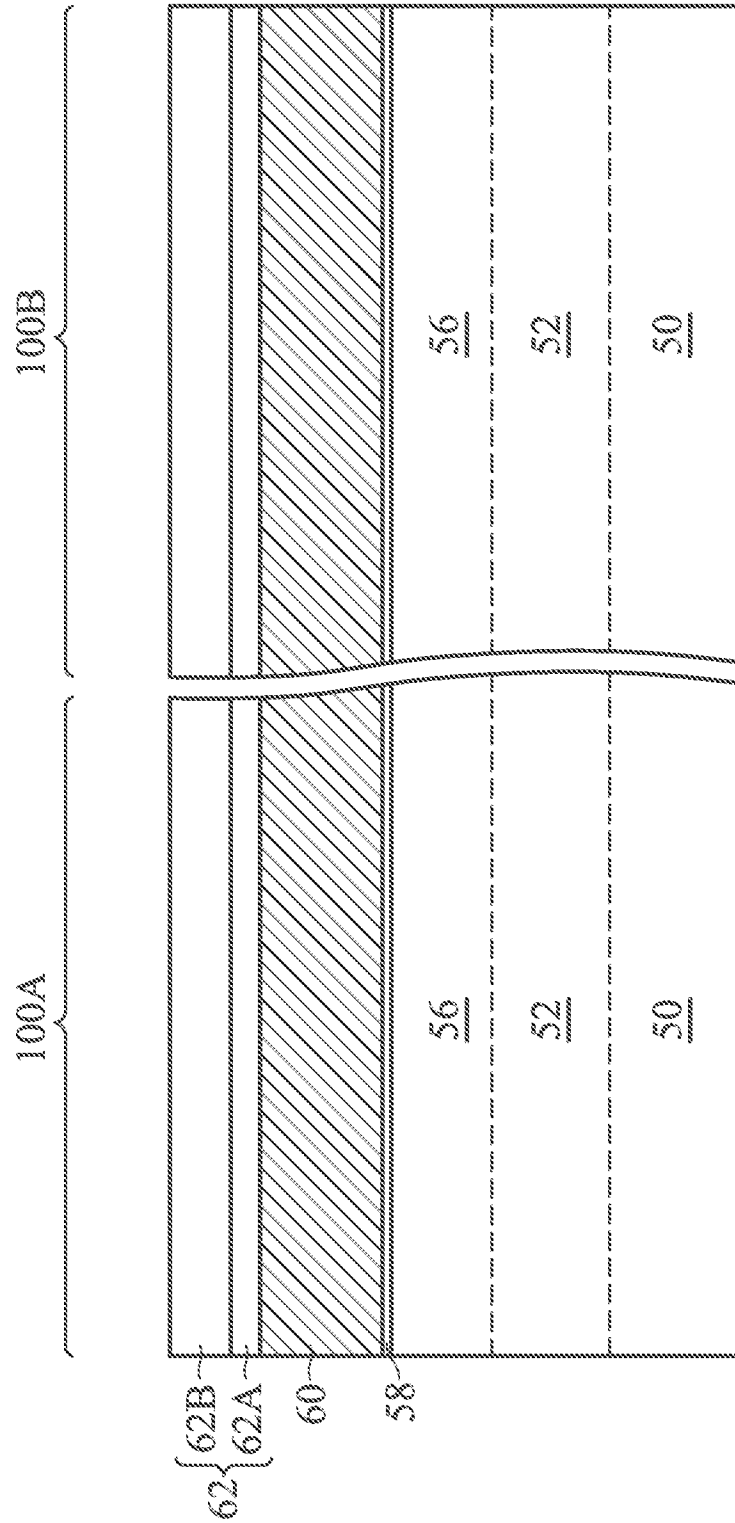


Figure 6B

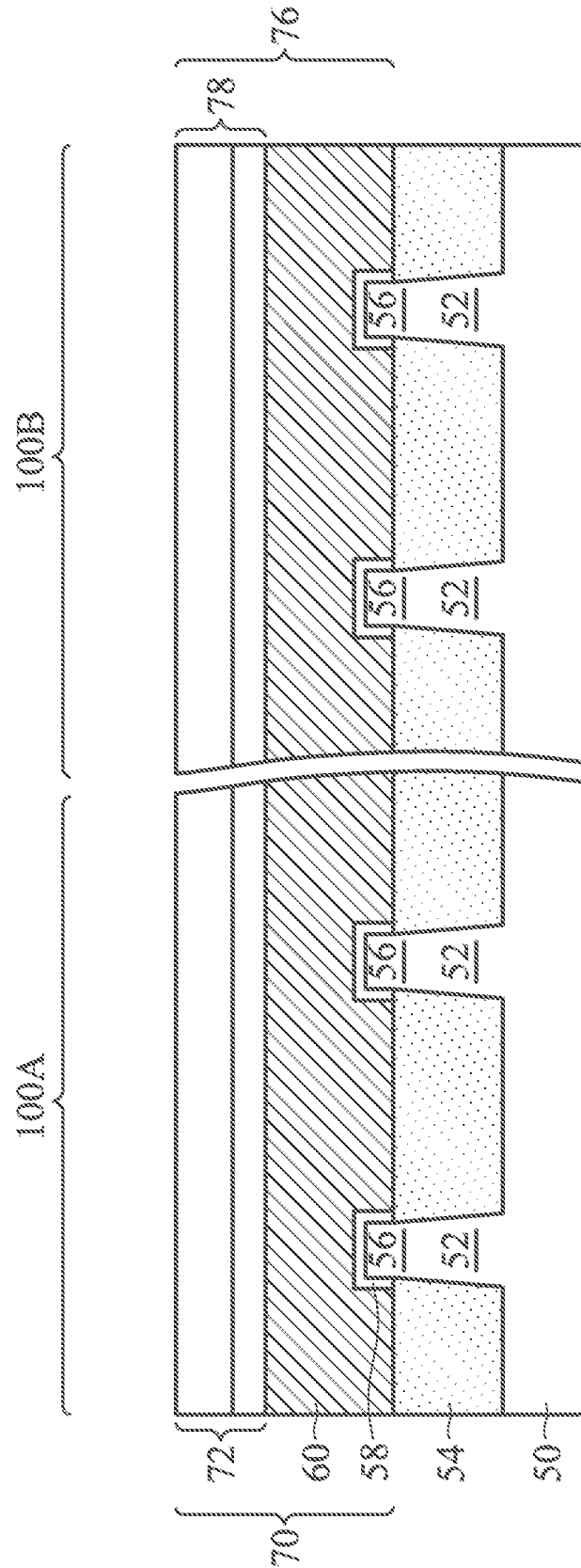


Figure 7A

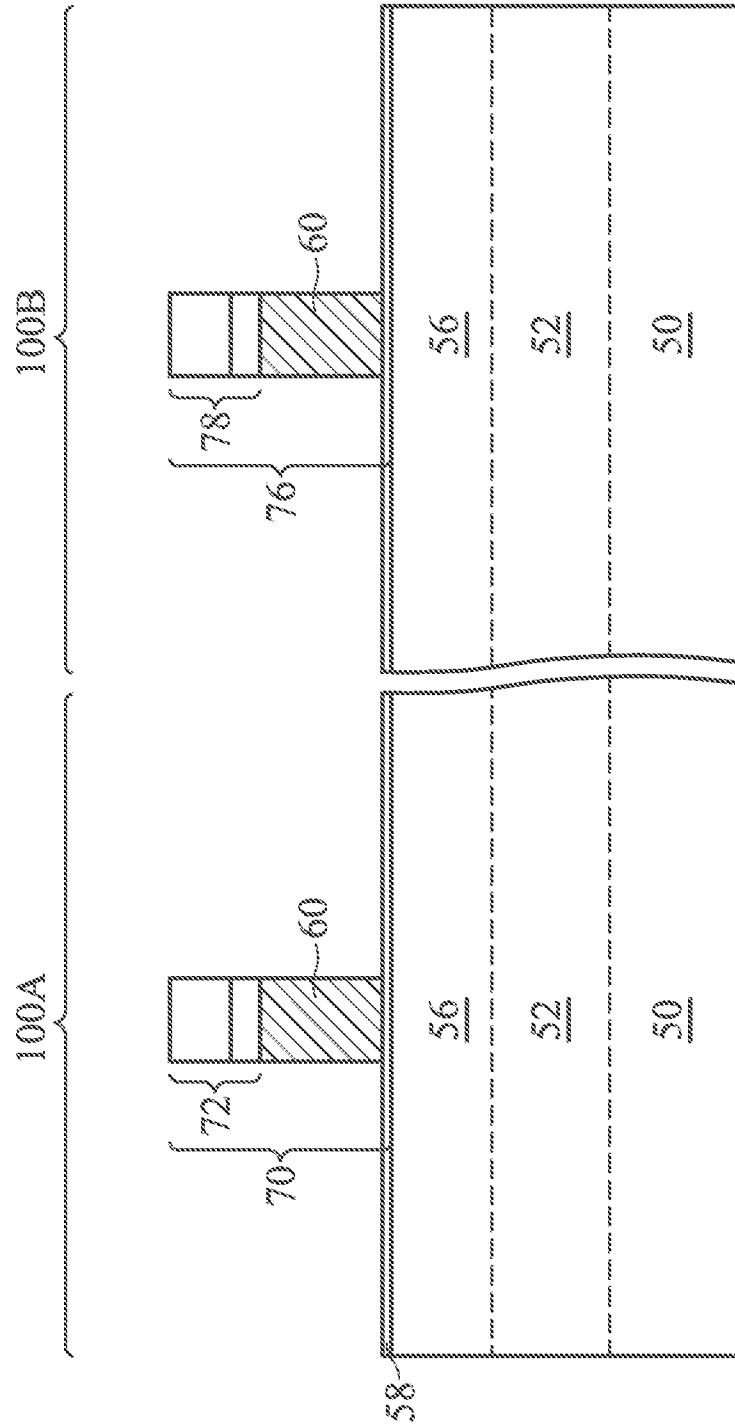


Figure 7B

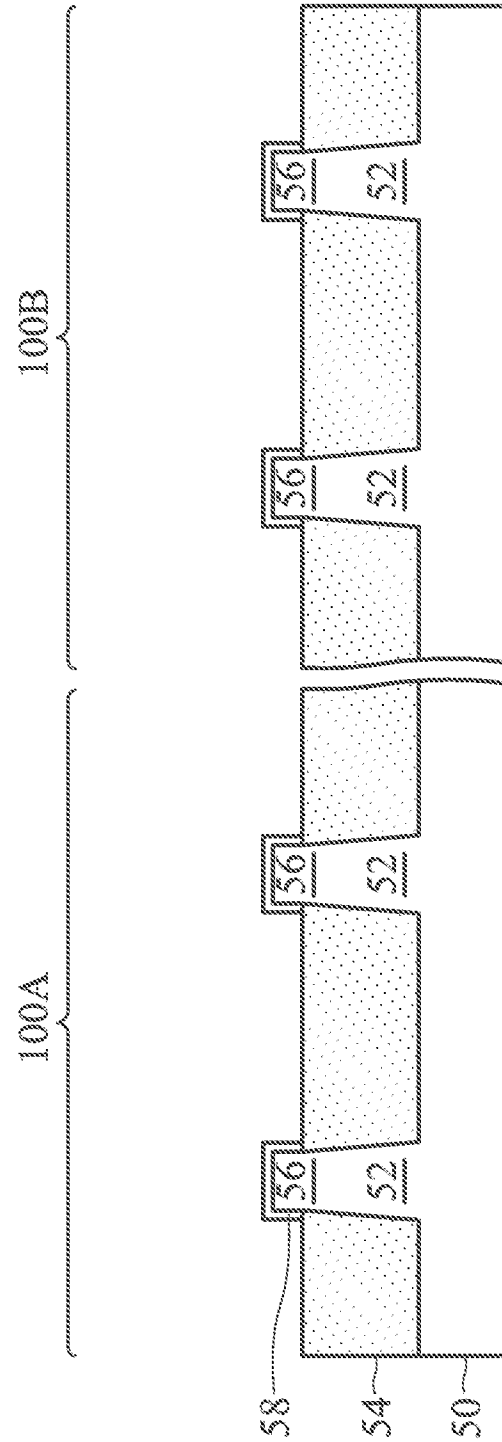


Figure 7C

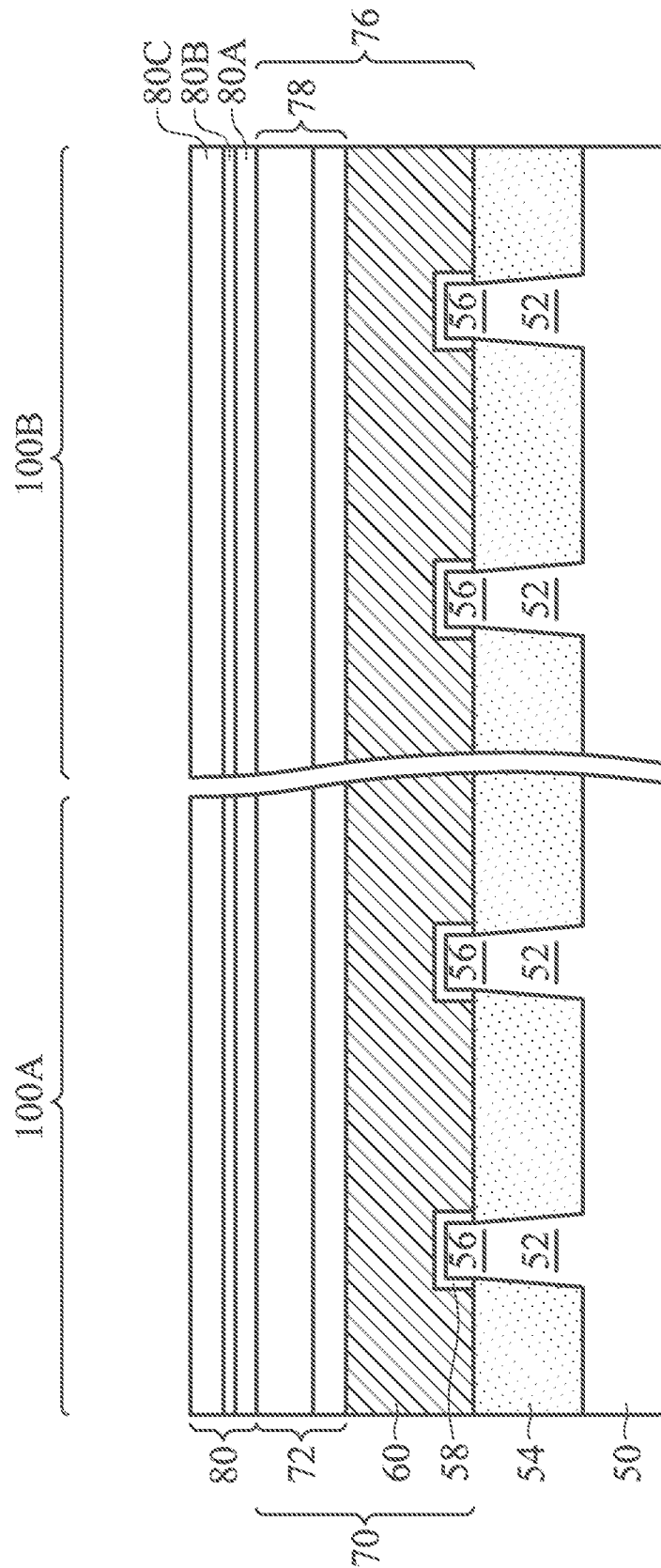


Figure 8A

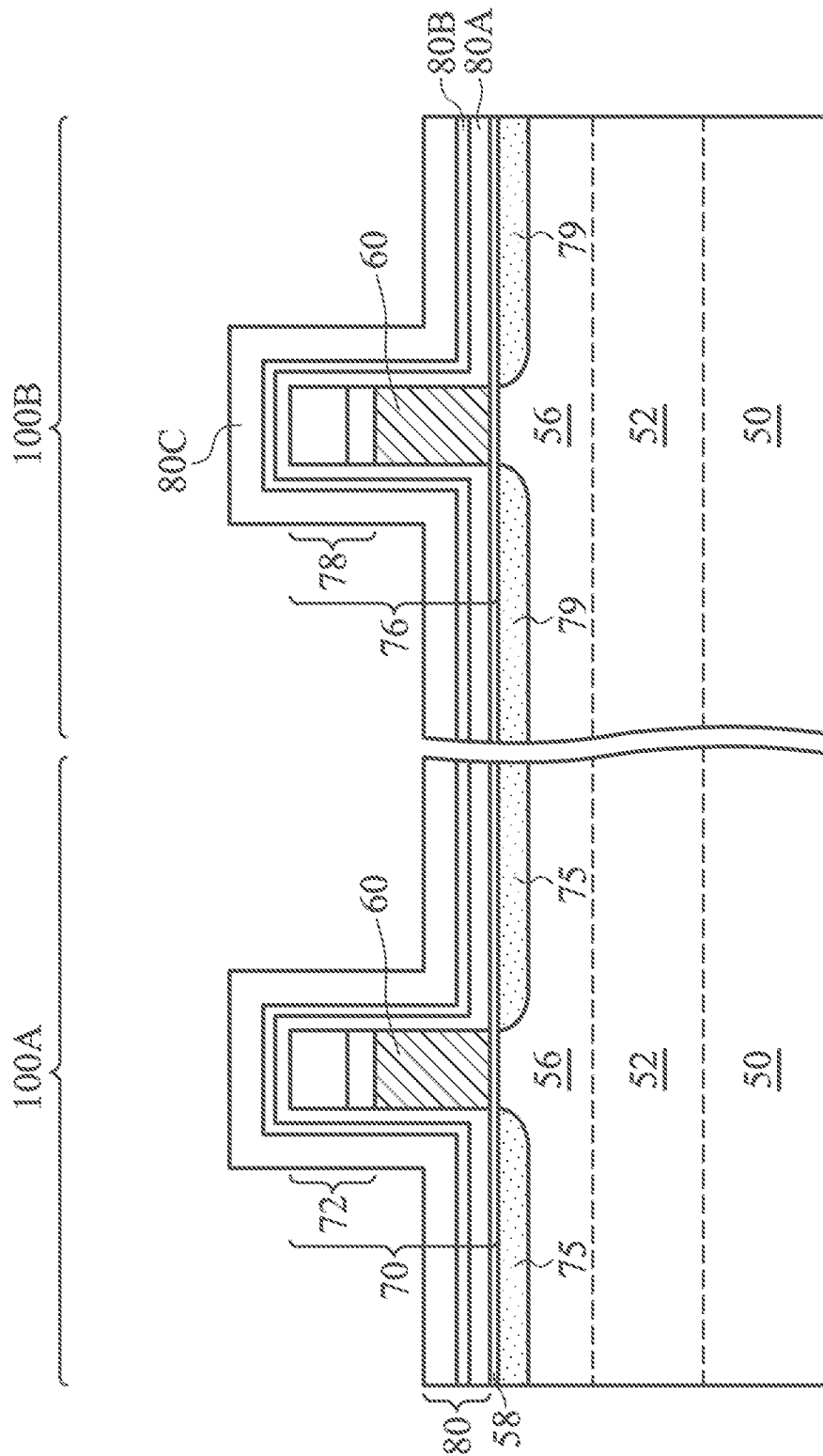


Figure 8B

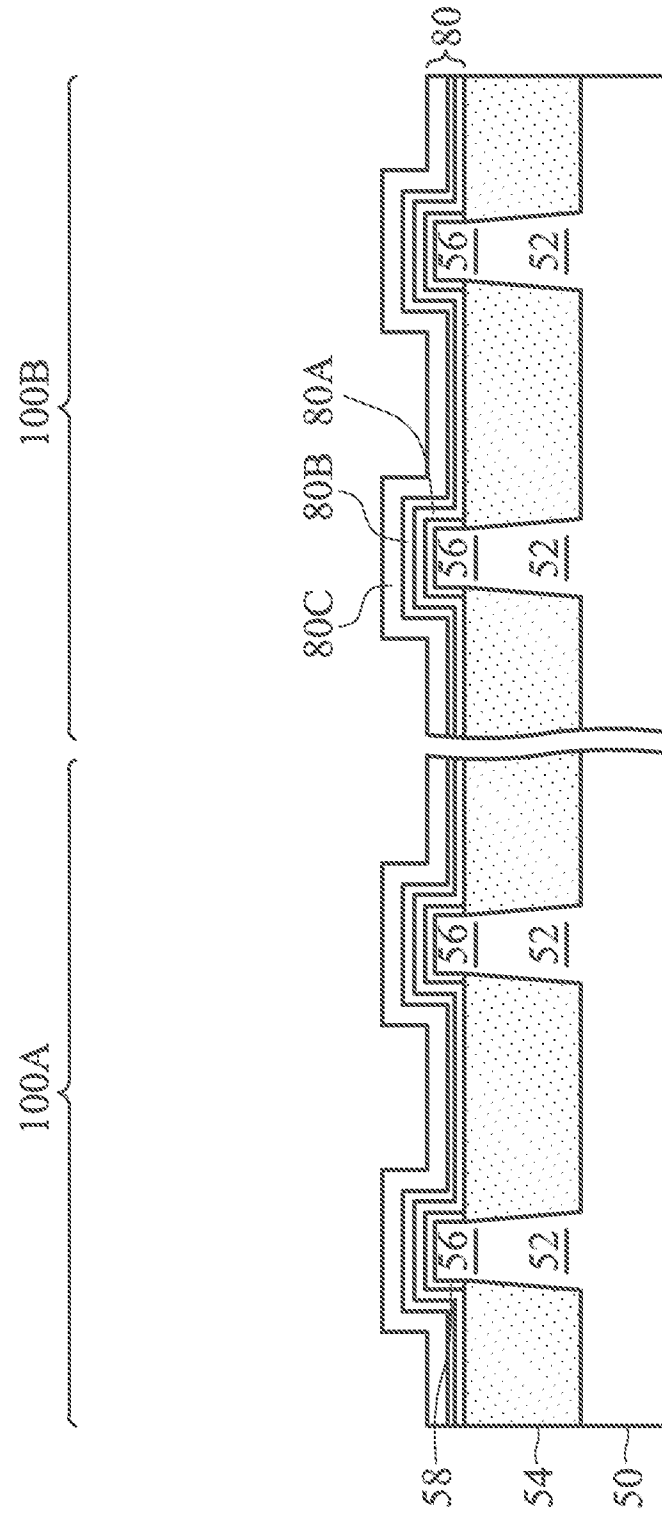


Figure 8C

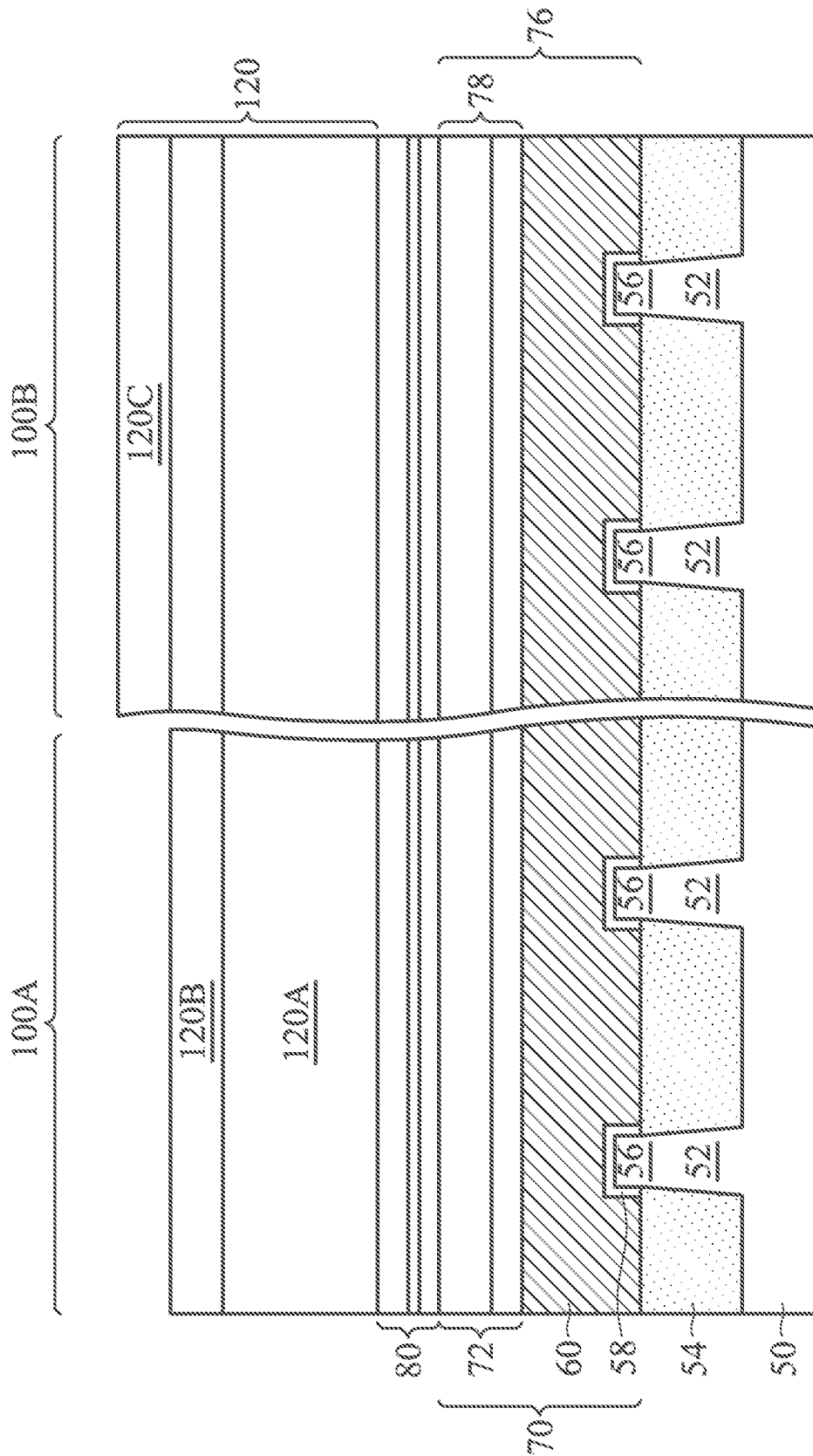


Figure 9A

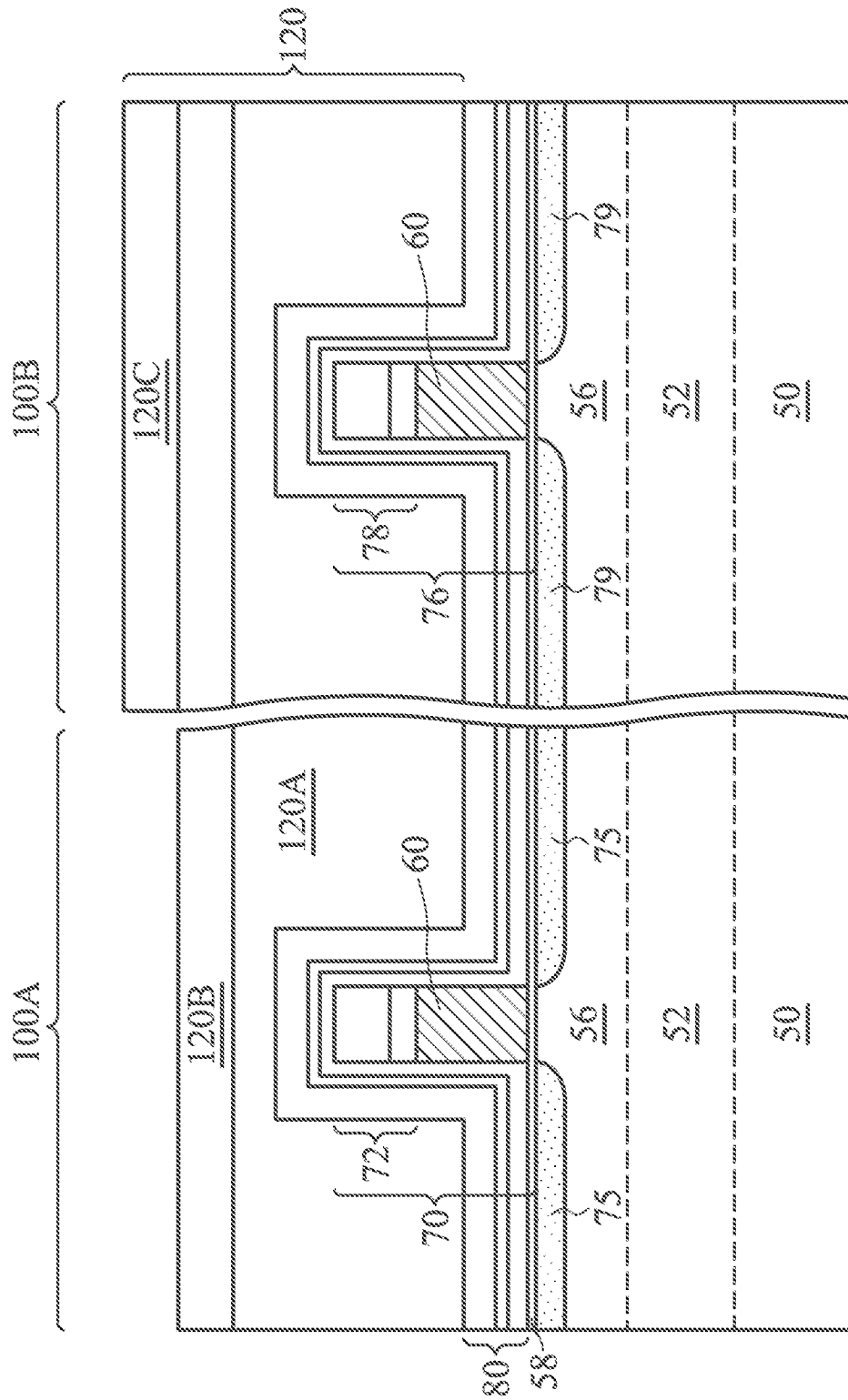


Figure 9B

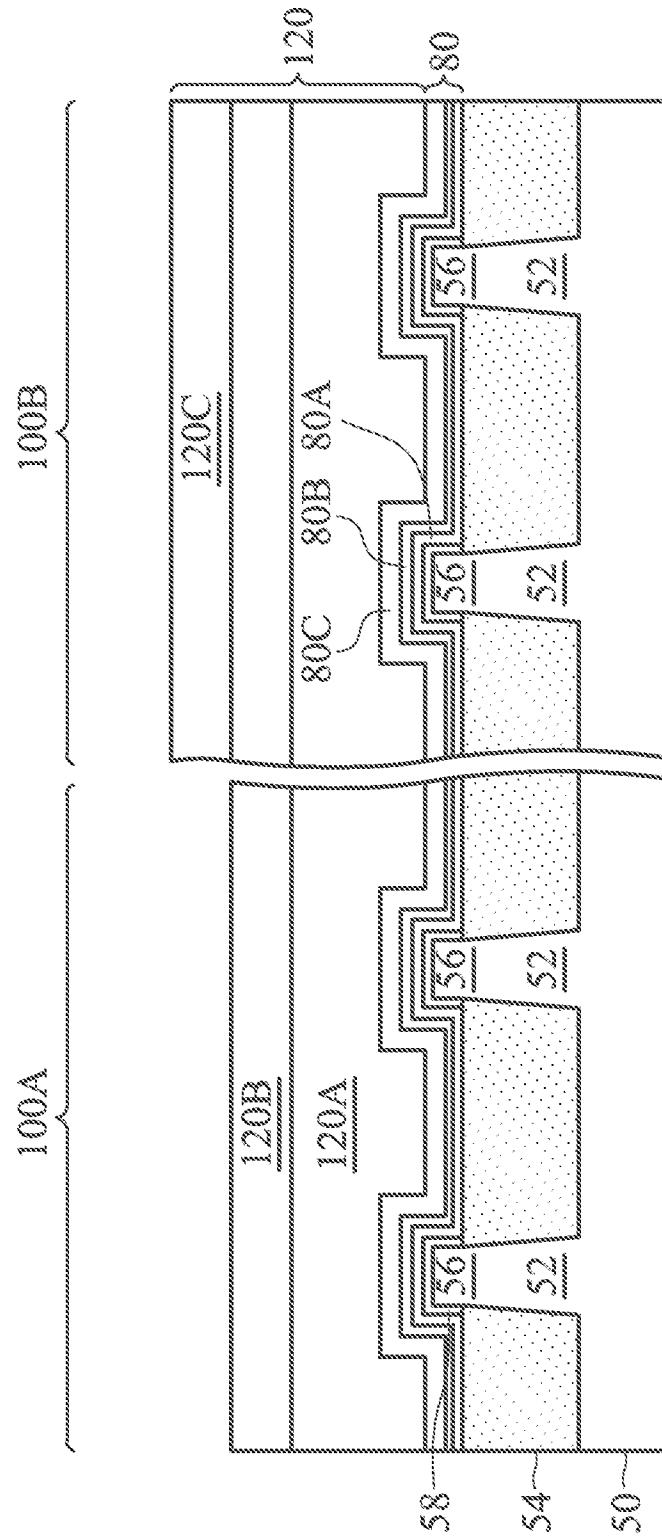


Figure 9C

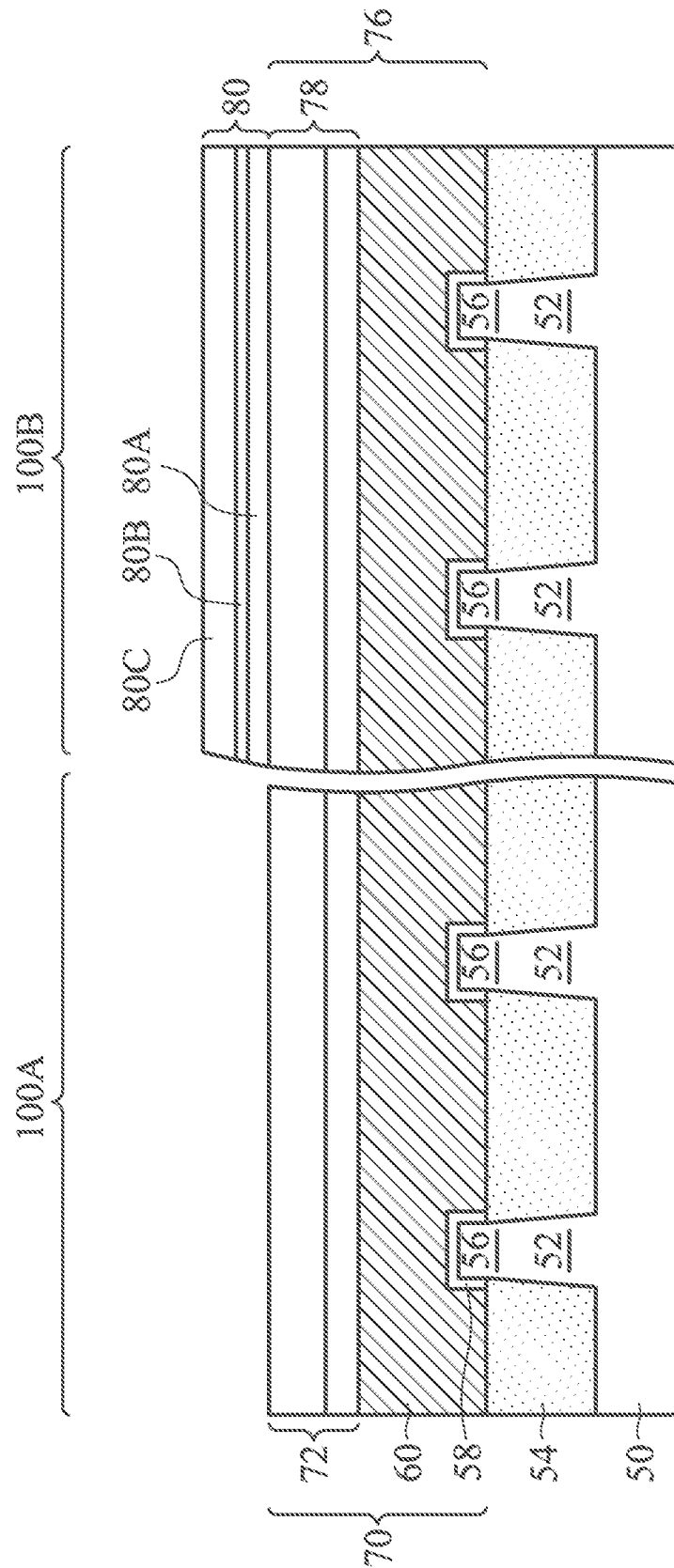


Figure 10A

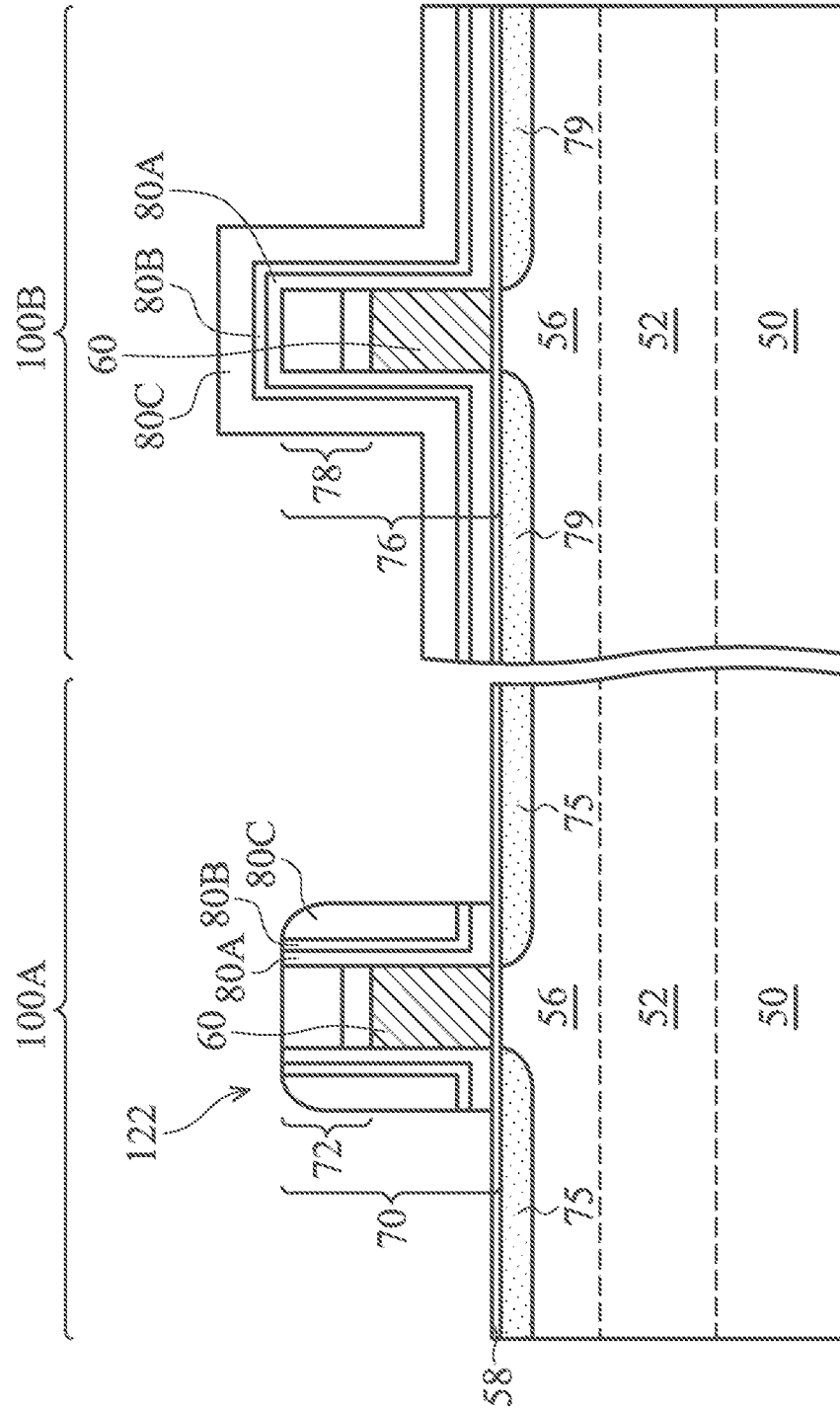


Figure 10B

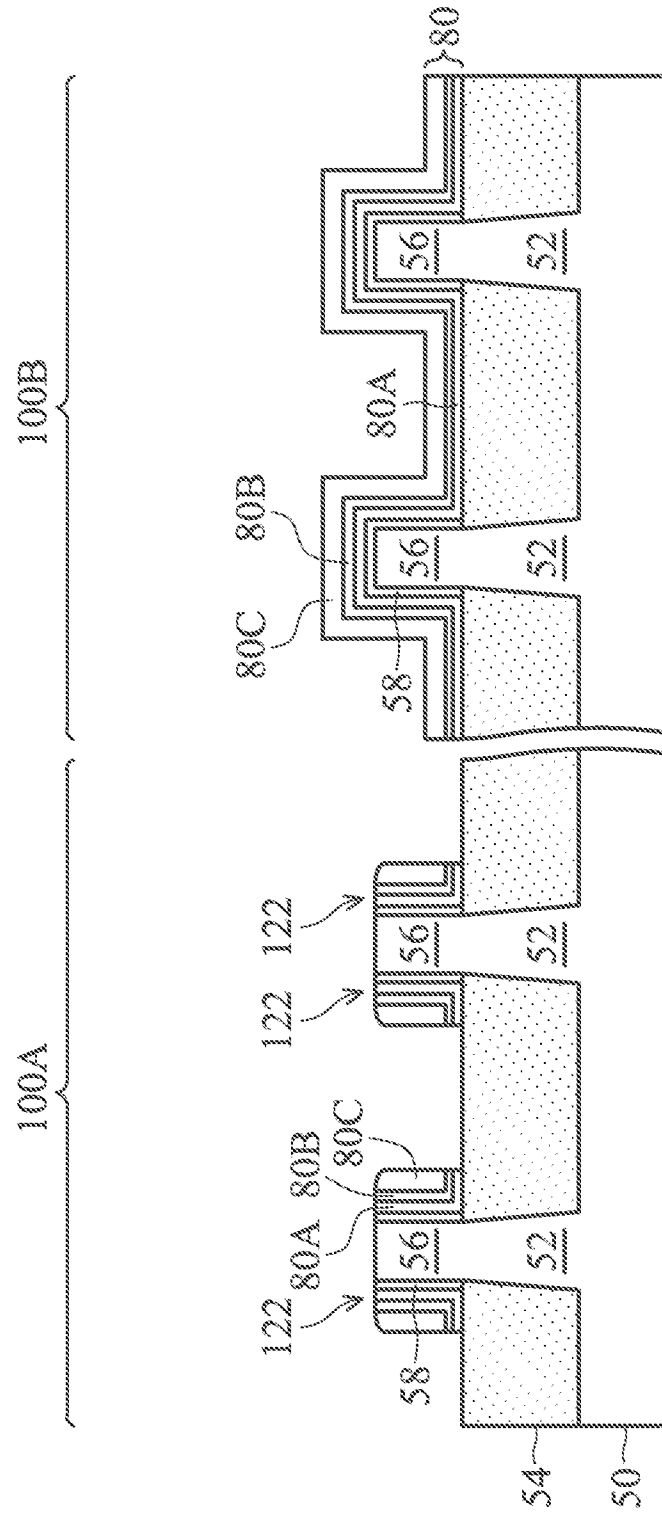


Figure 10C

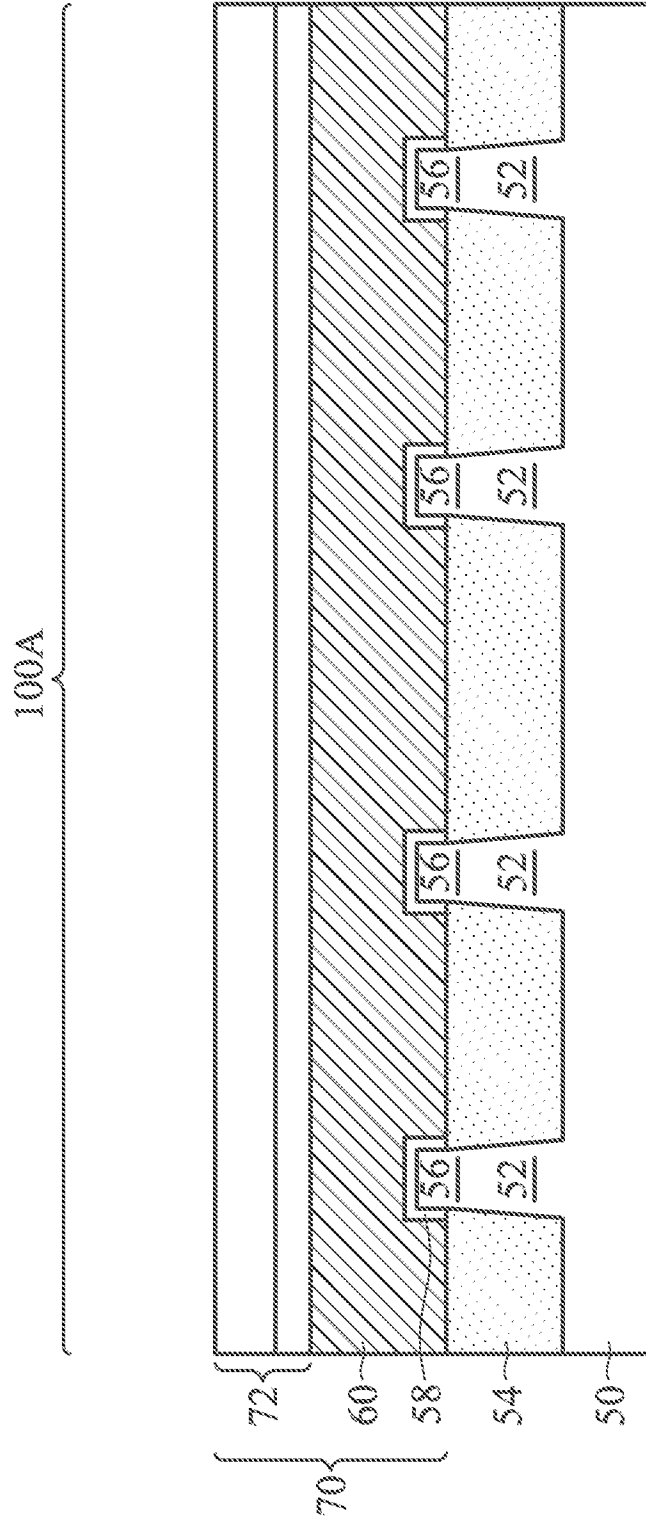


Figure 11A

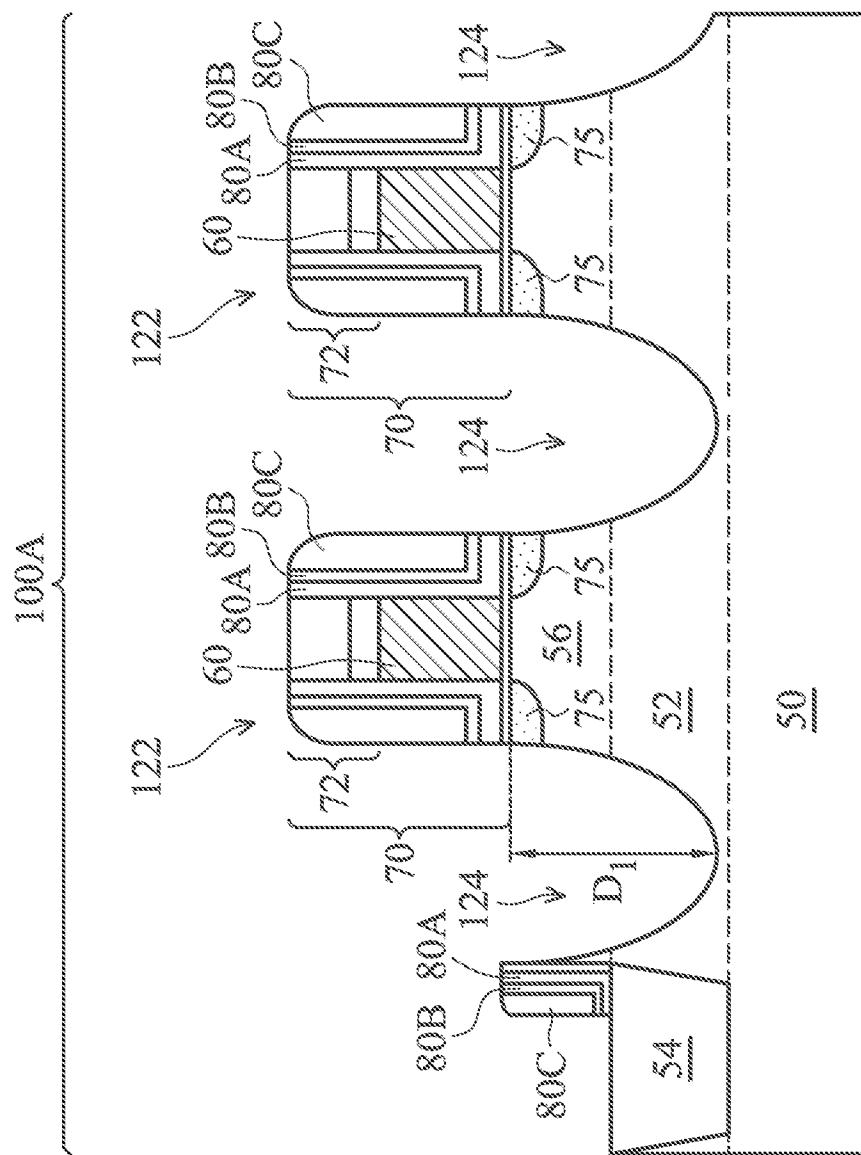


*Figure 1B*

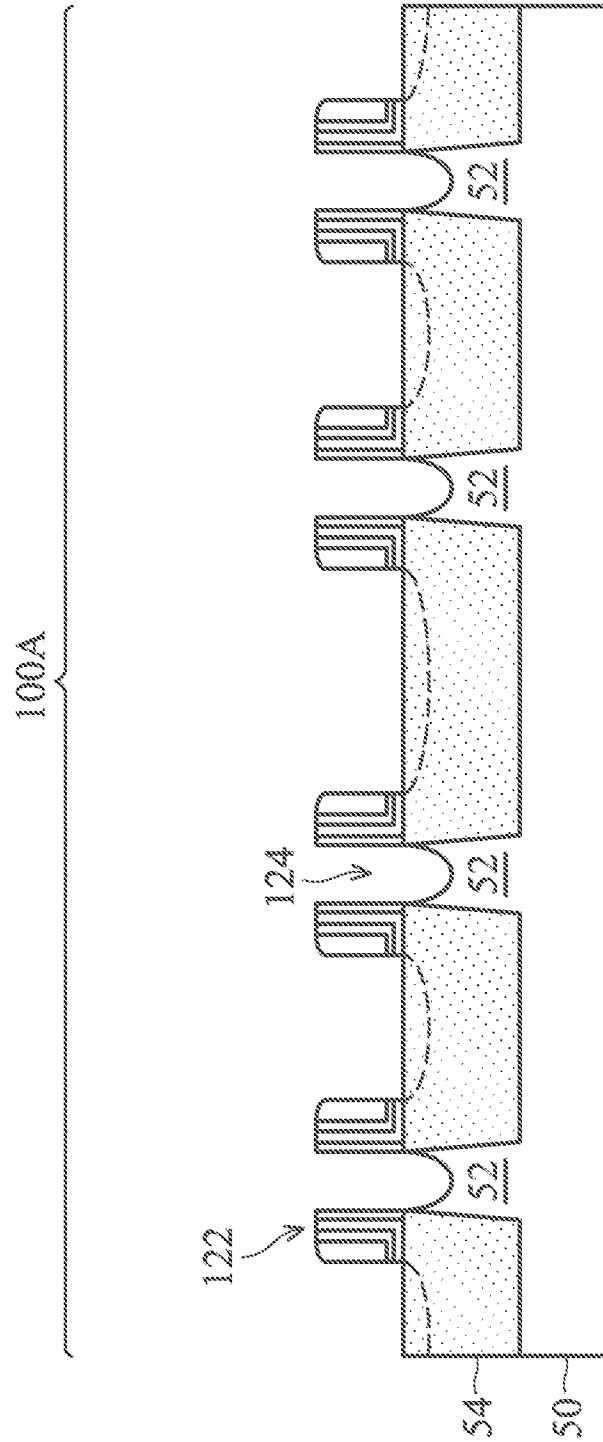


Figure 11C

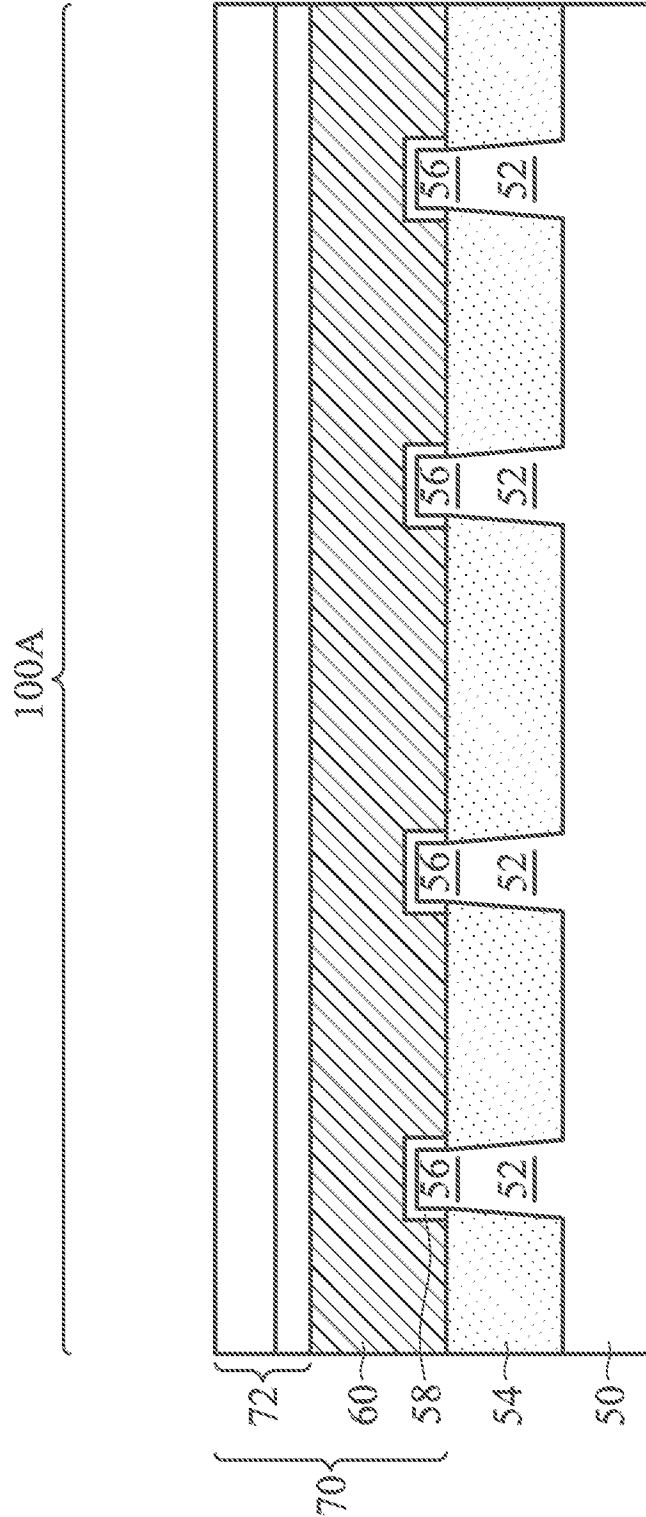
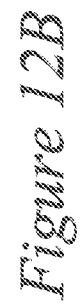


Figure 12A



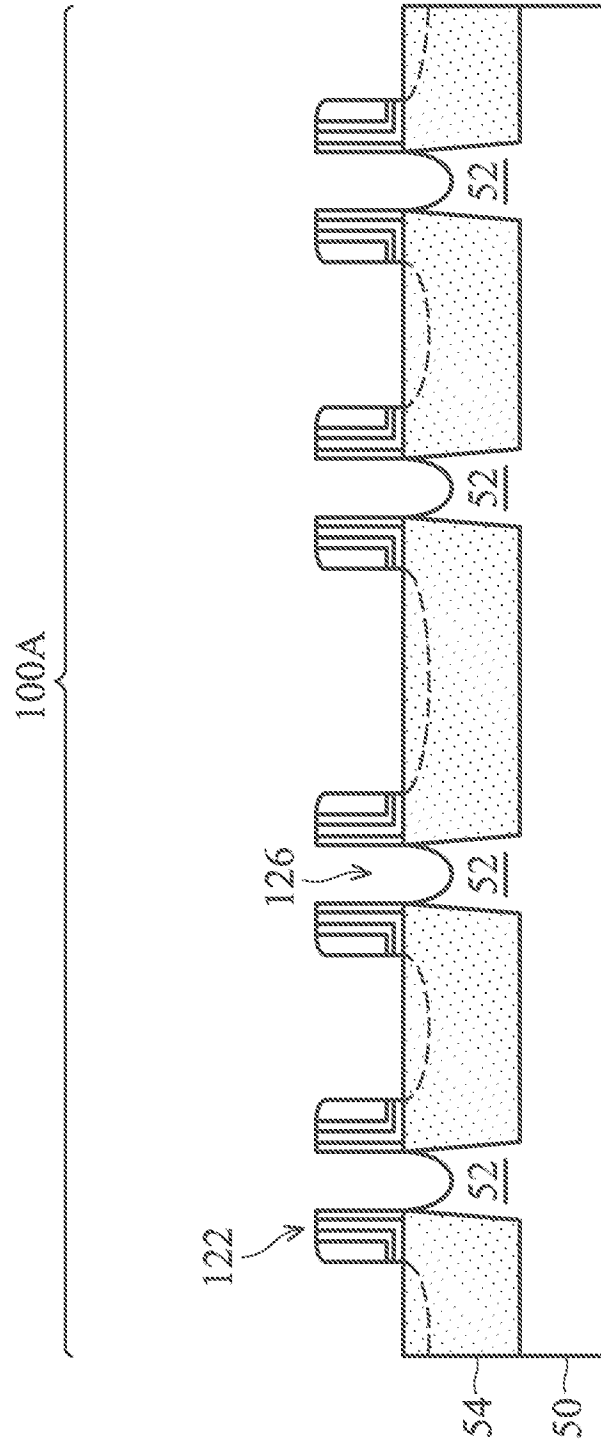


Figure 12C

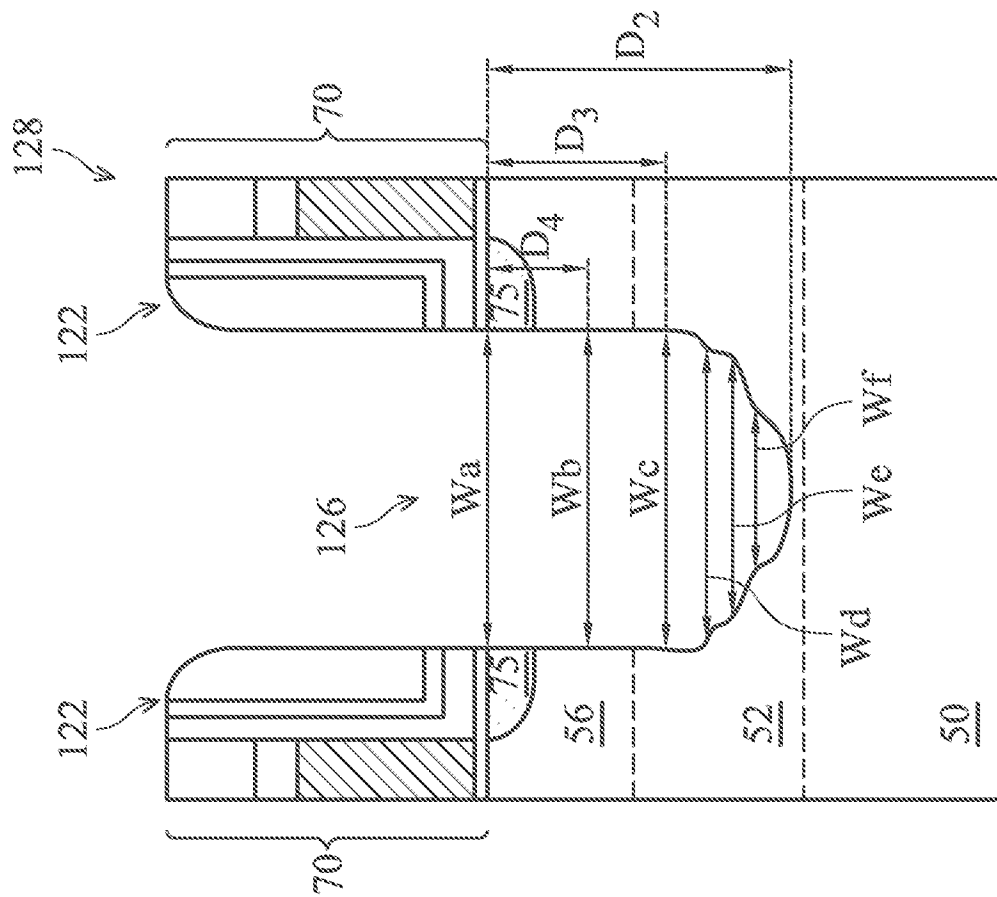


Figure 12D

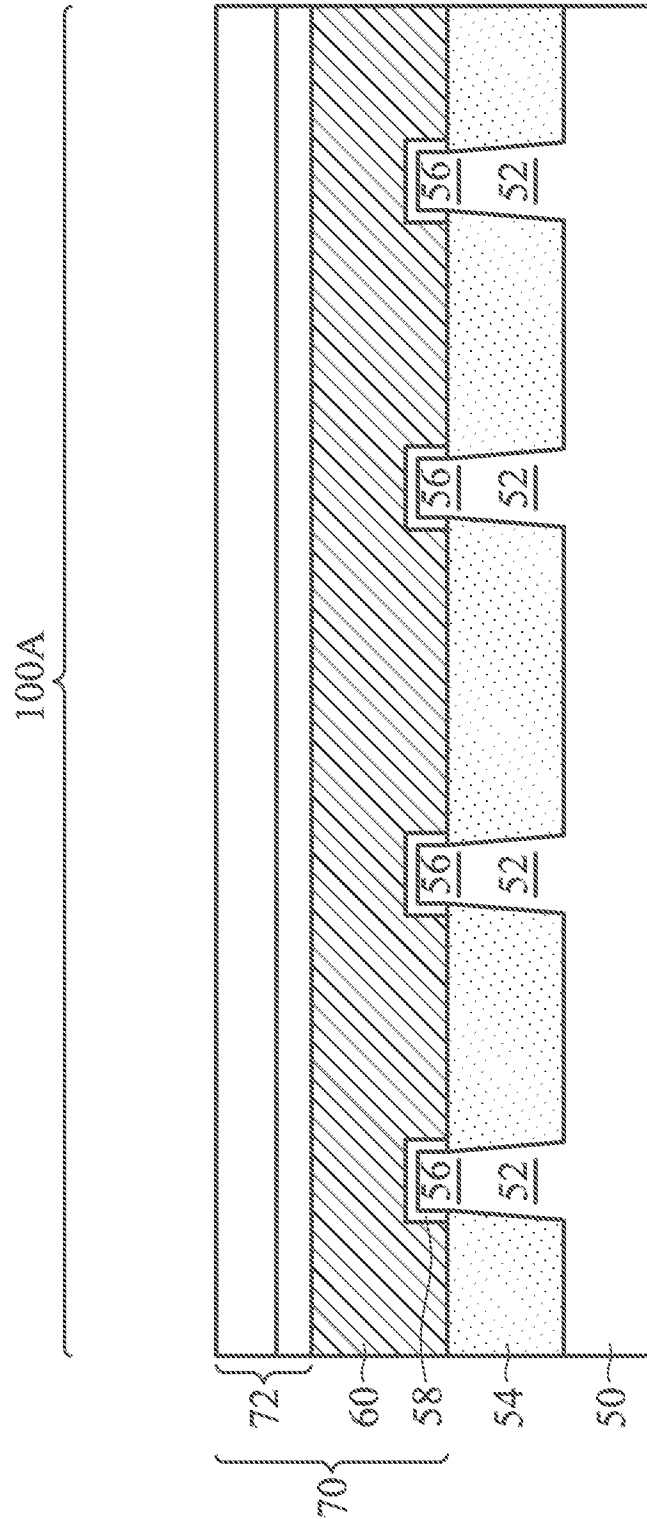


Figure 13A

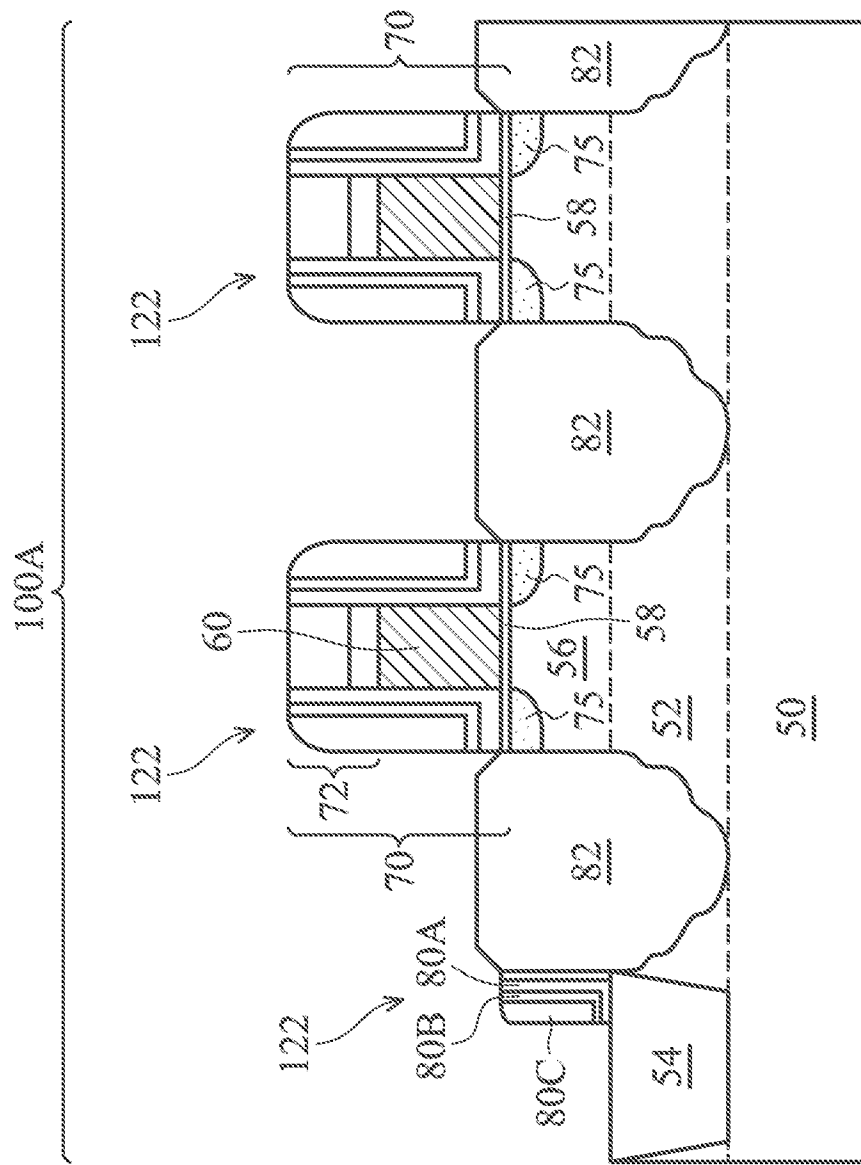


Figure 13B

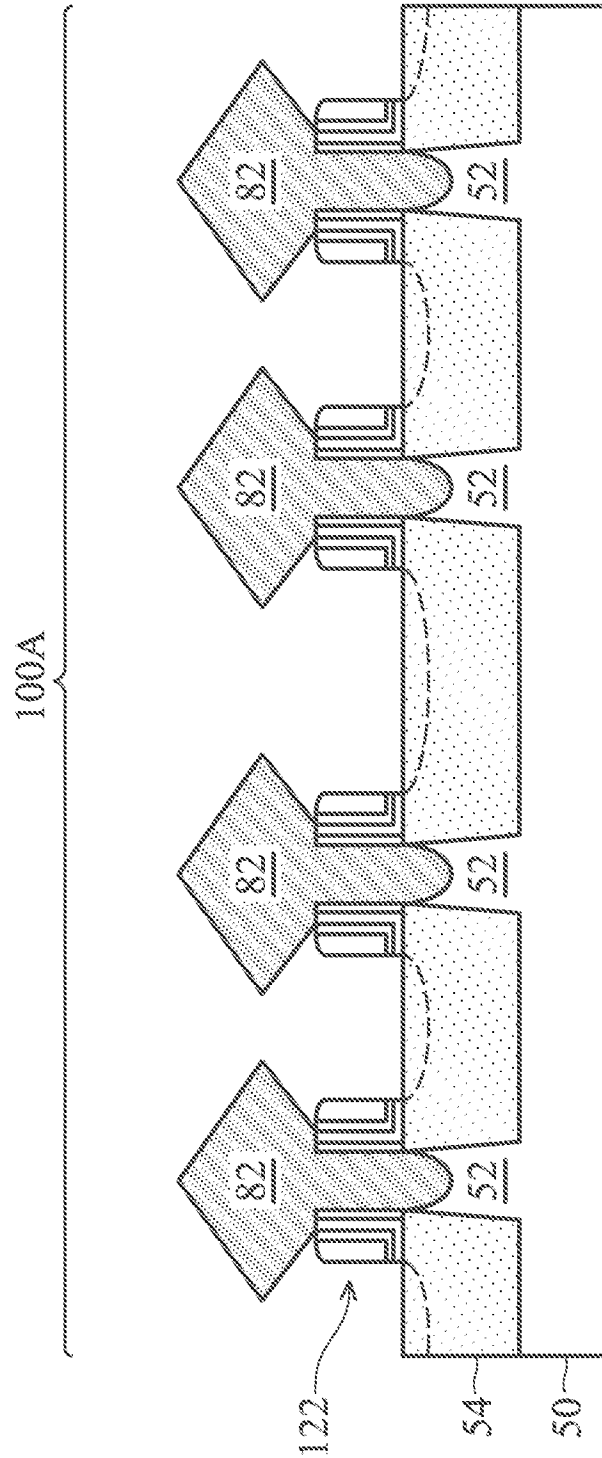


Figure 13C

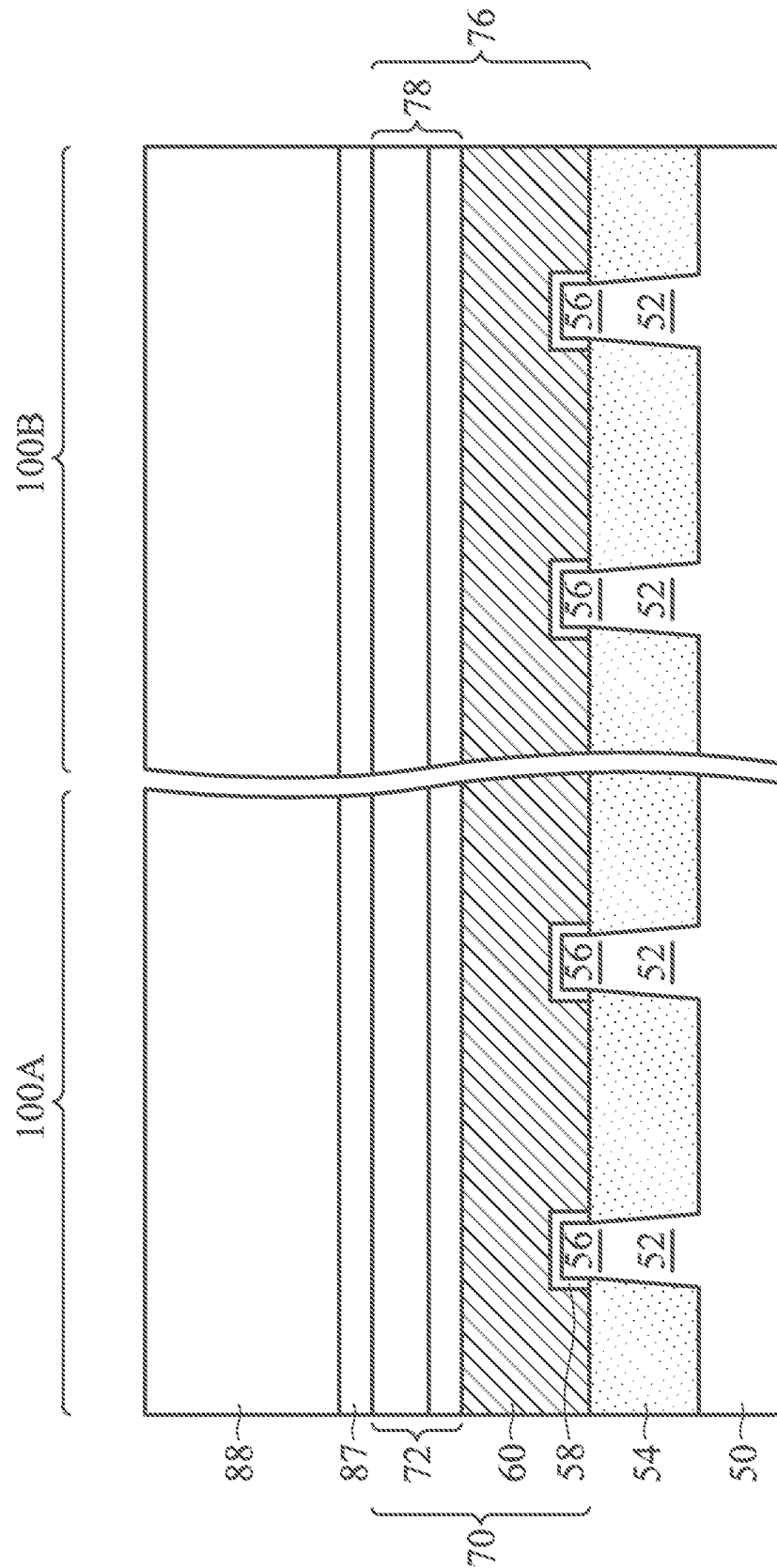


Figure 14A

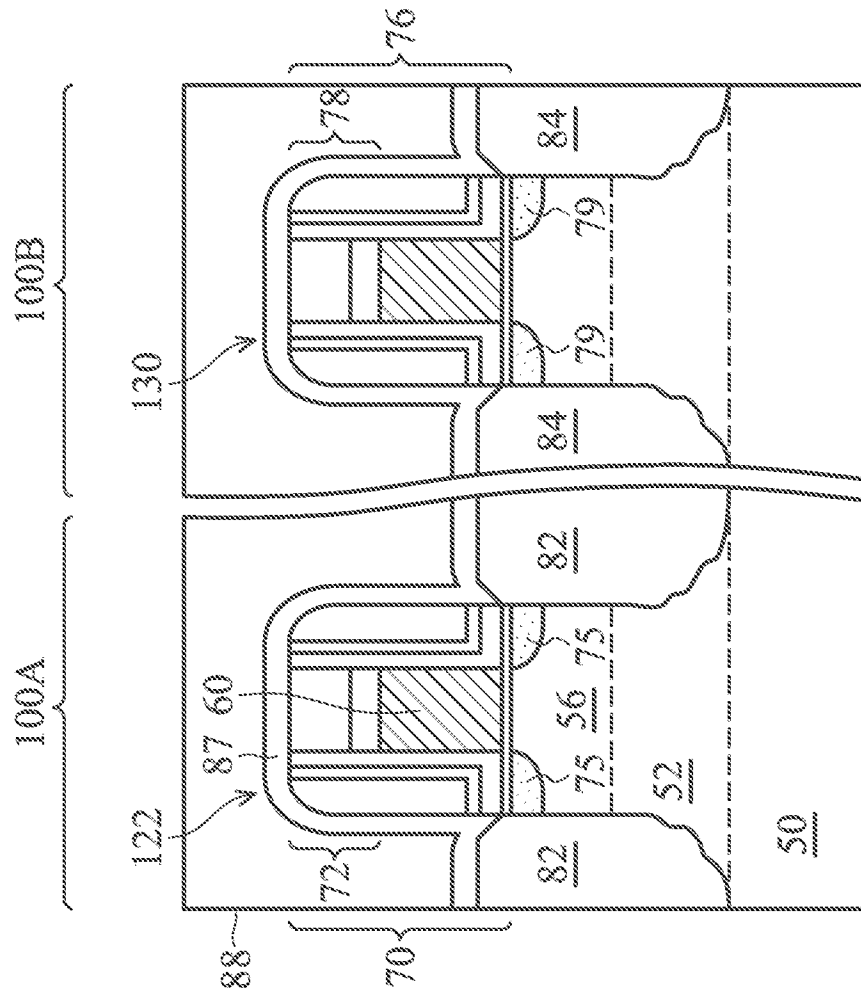


Figure 14B

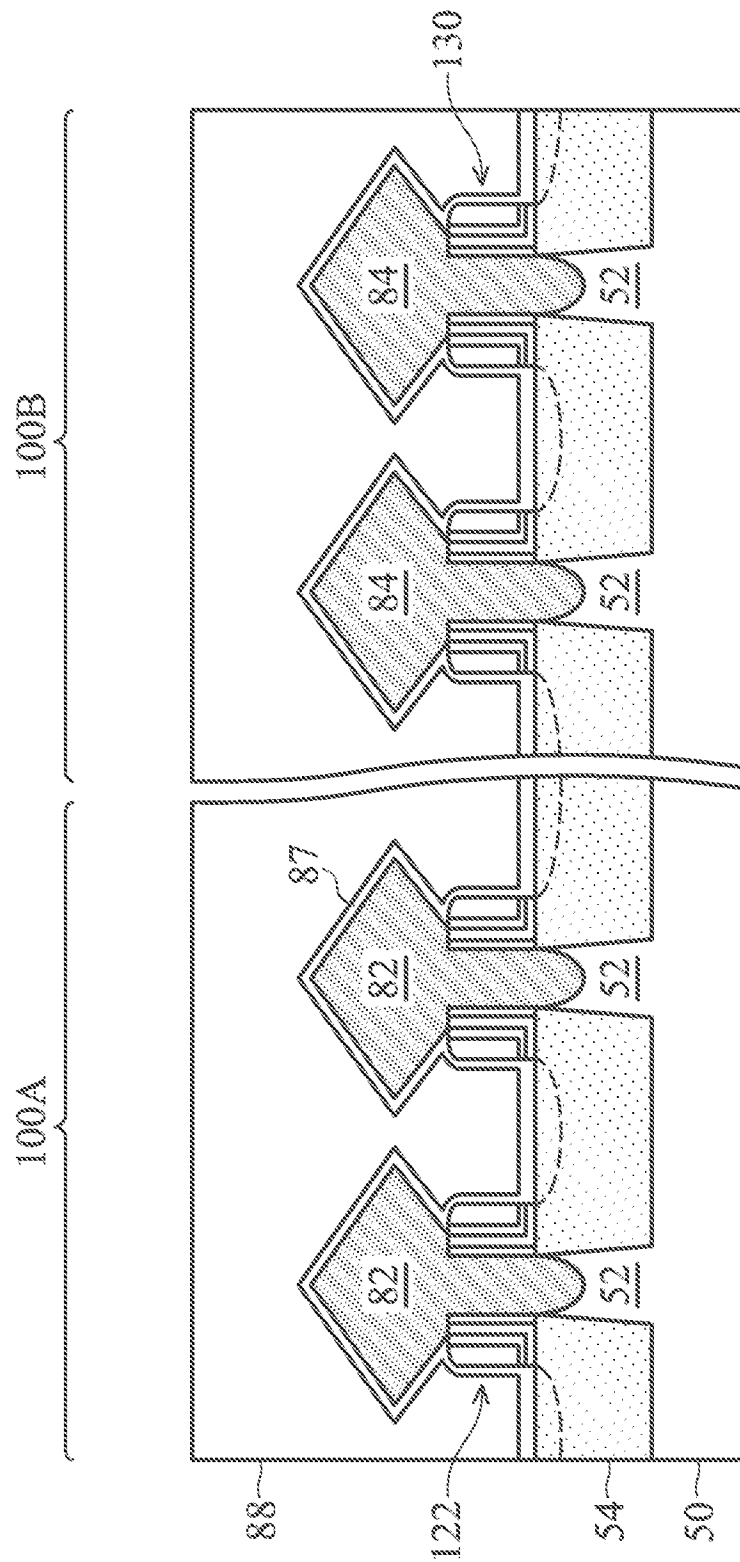


Figure 14C

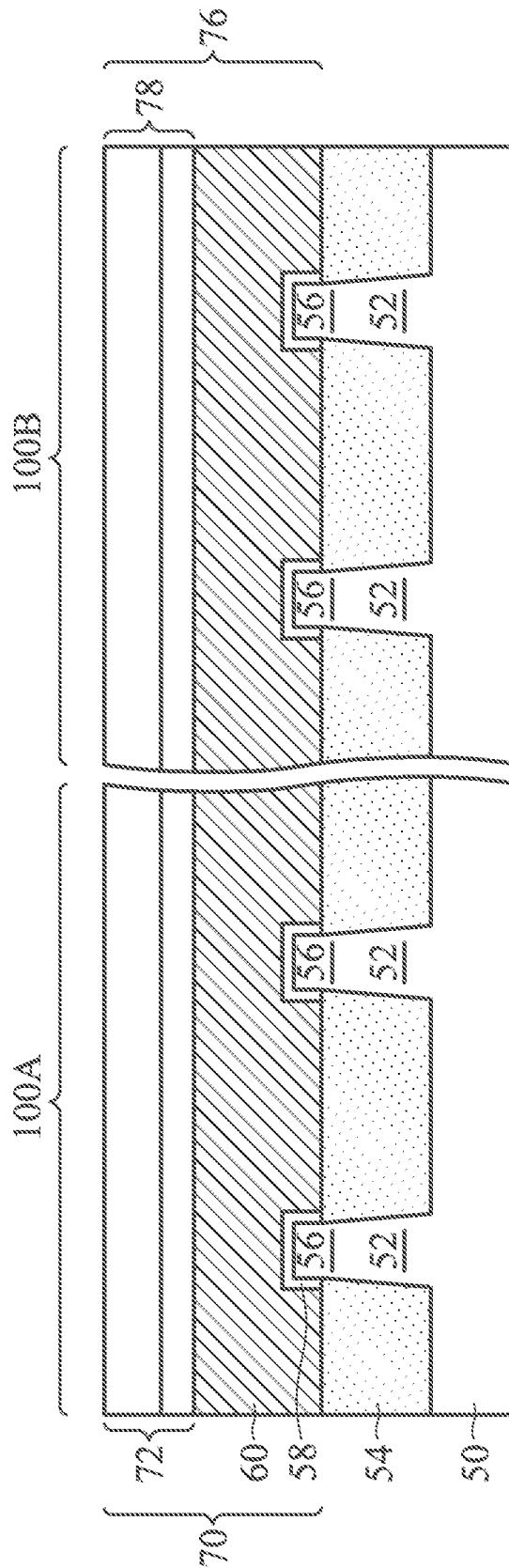


Figure 15A

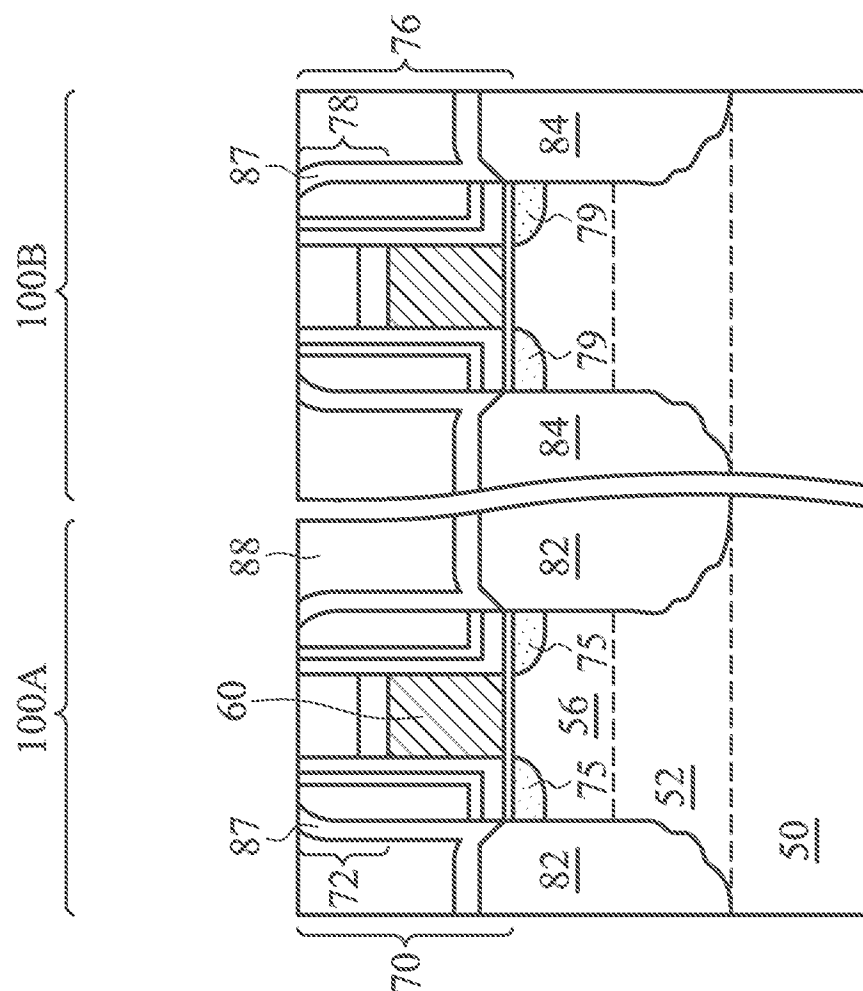


Figure 15B

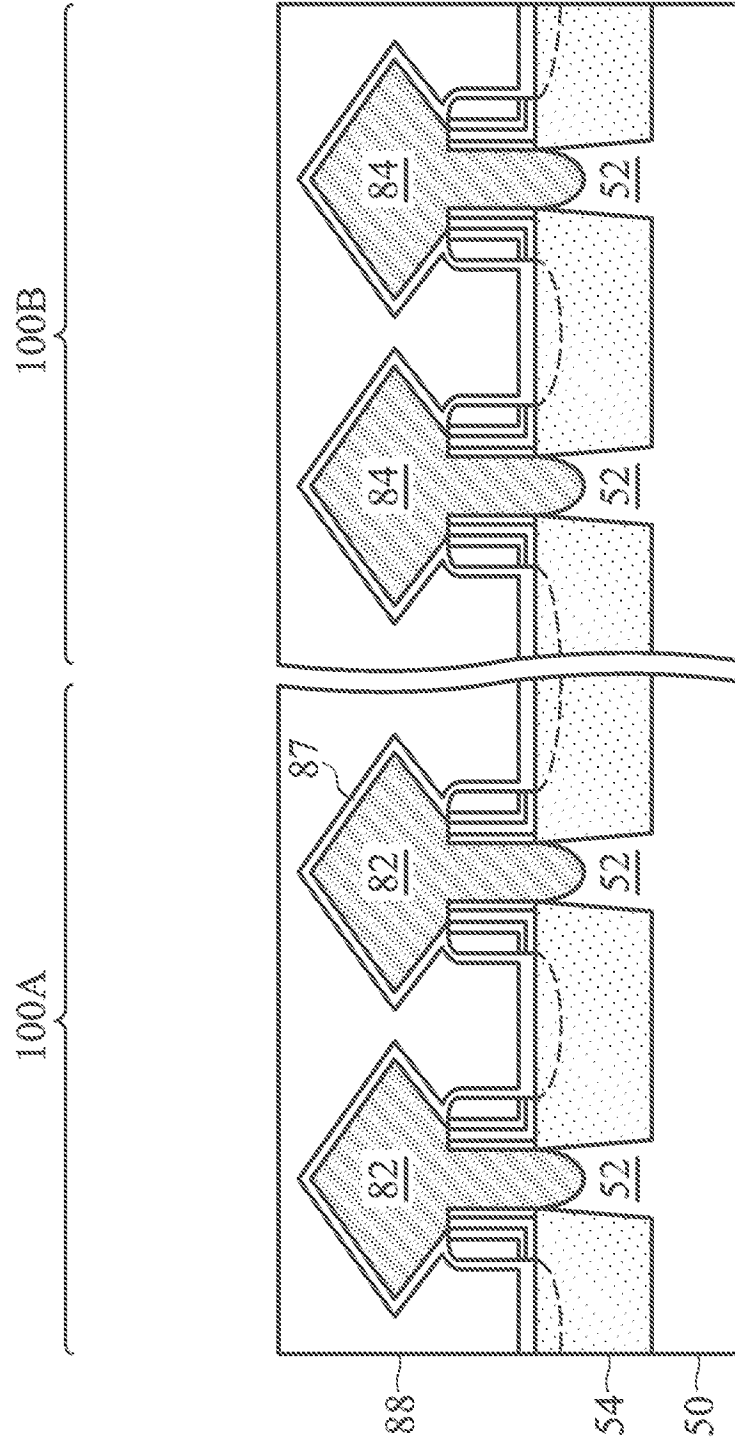


Figure 15C

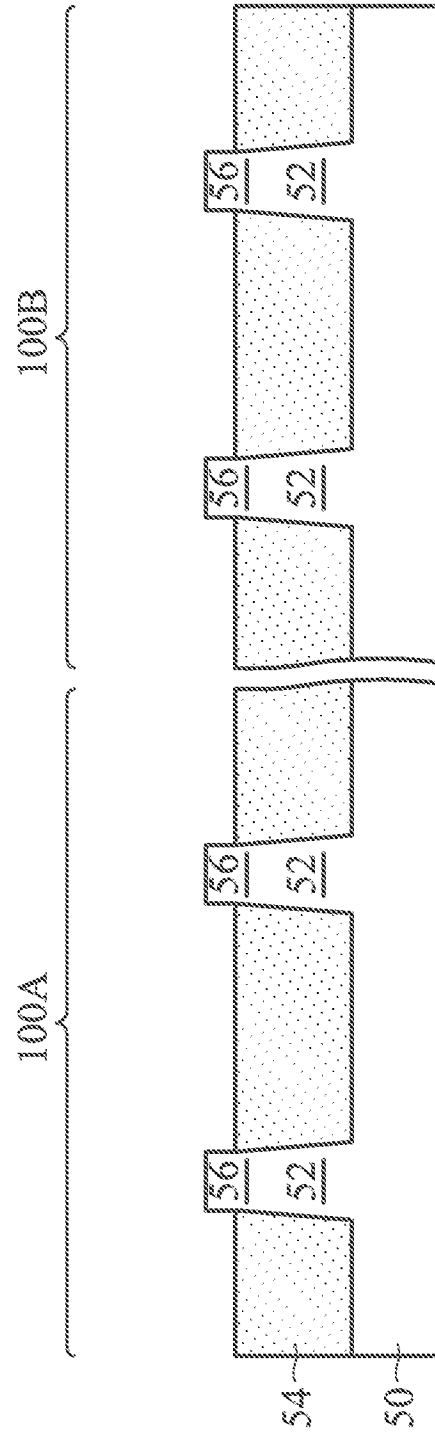


Figure 16A

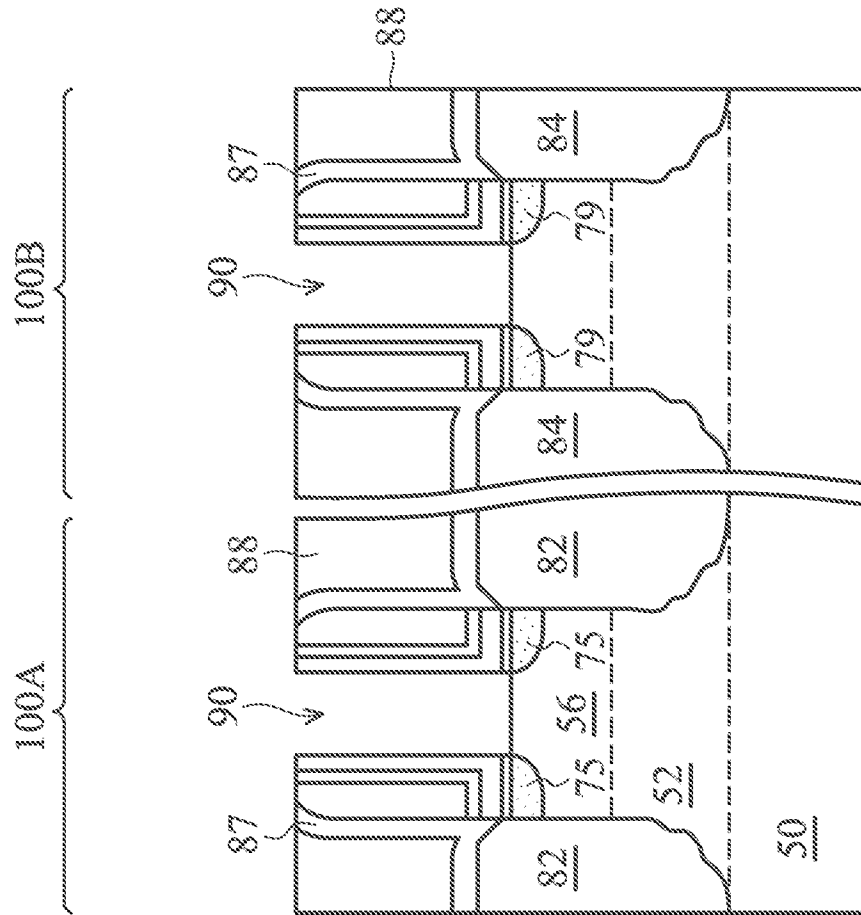


Figure 16B

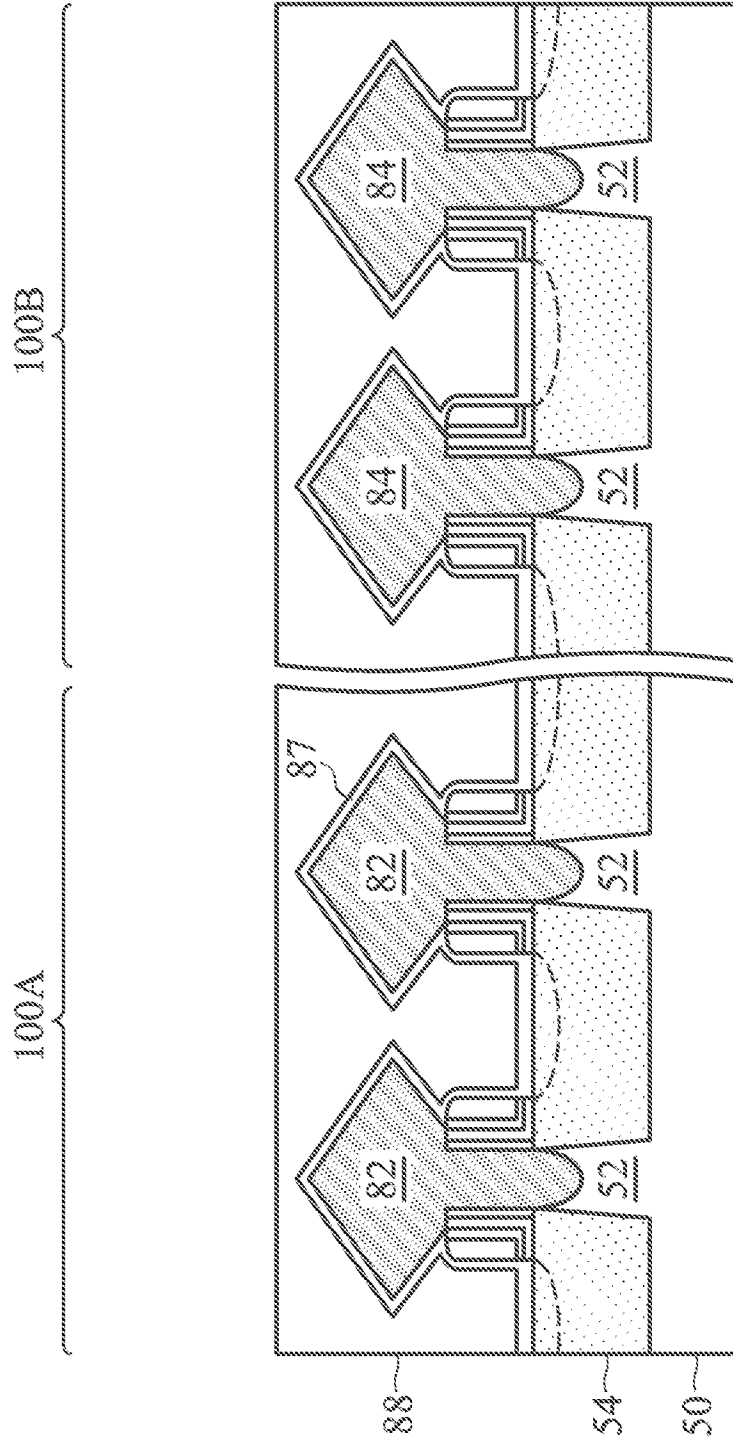


Figure 16C

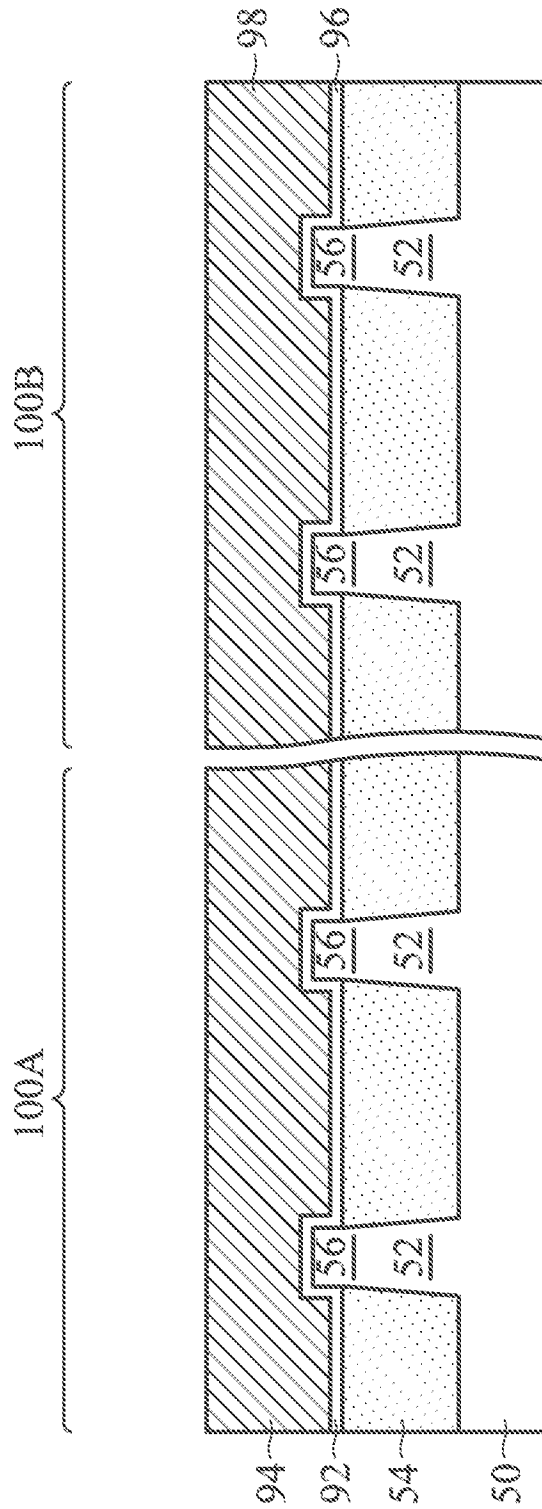


Figure 17A

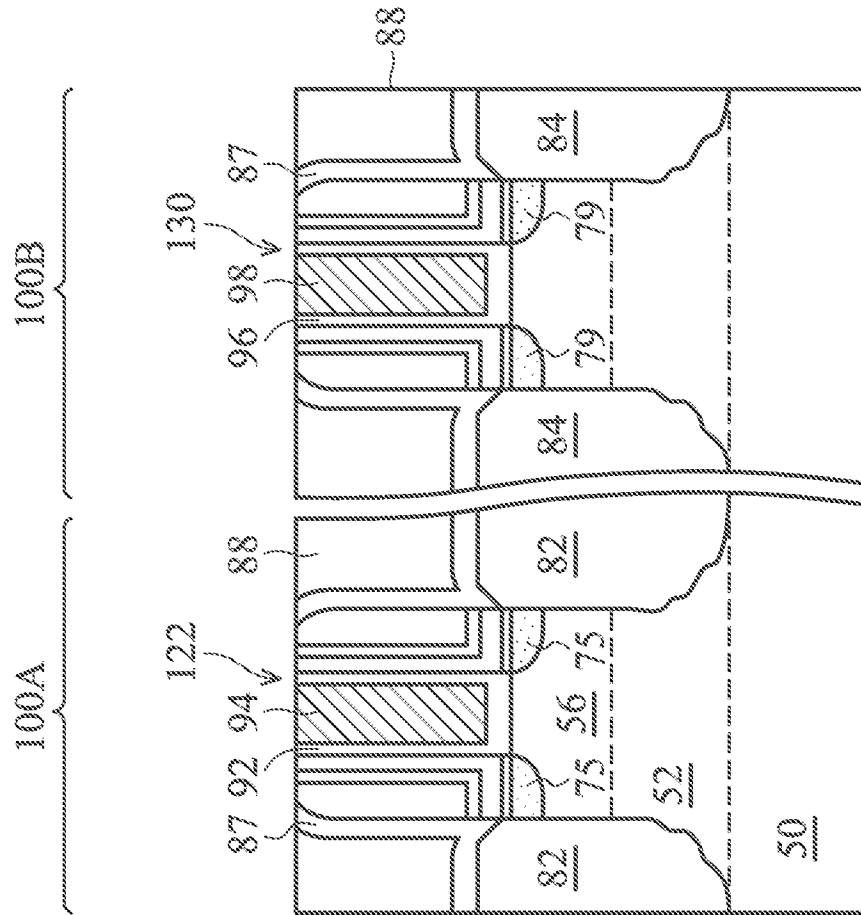


Figure 17B

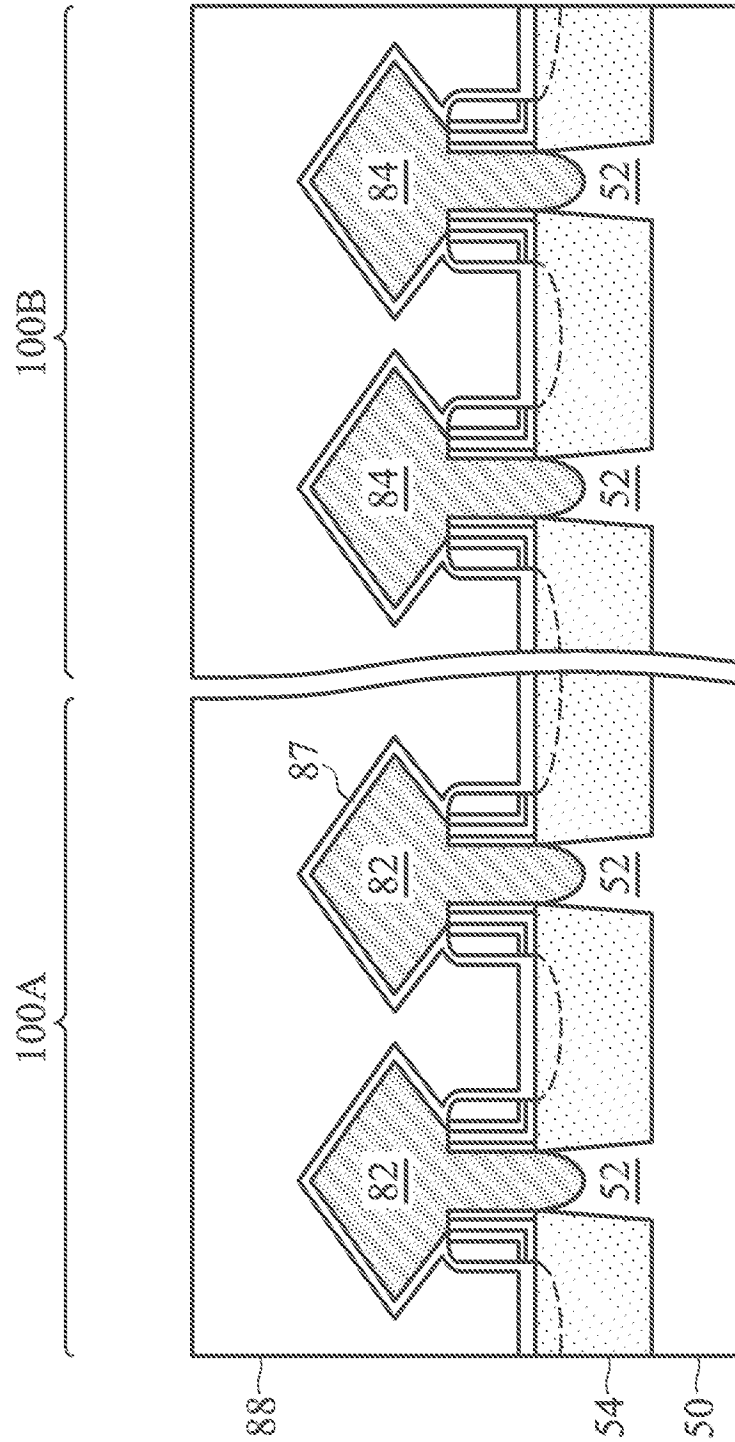


Figure 17C

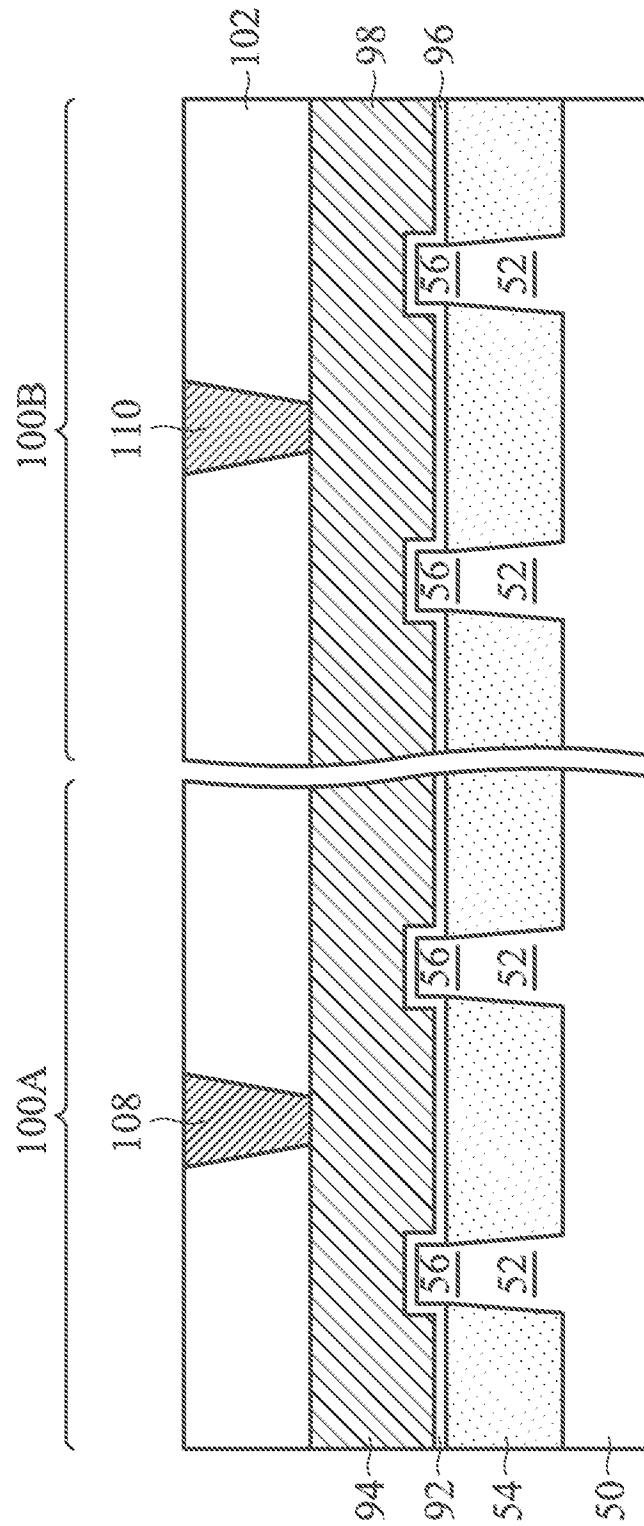
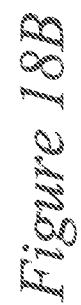


Figure 18A



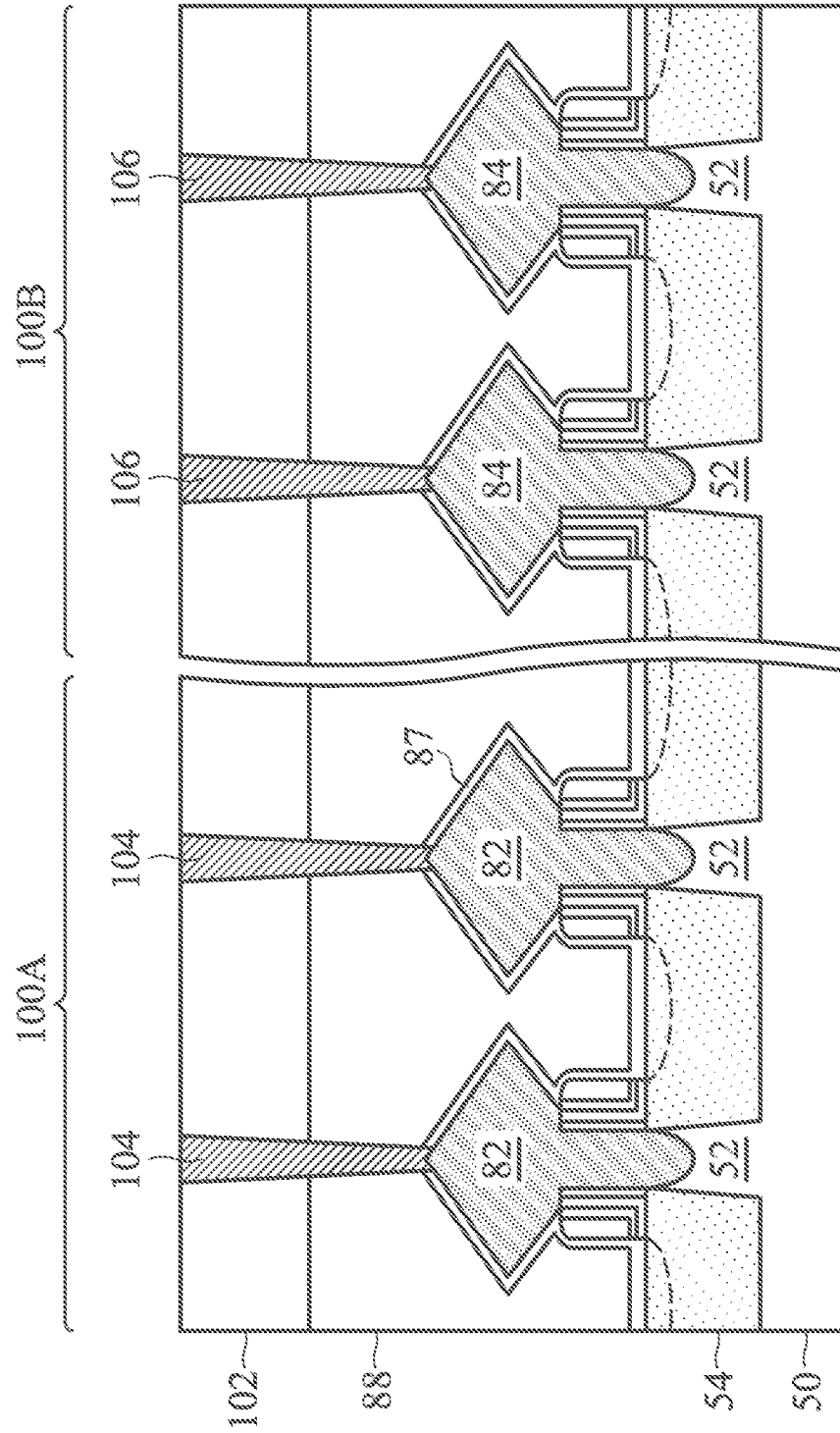


Figure 18C

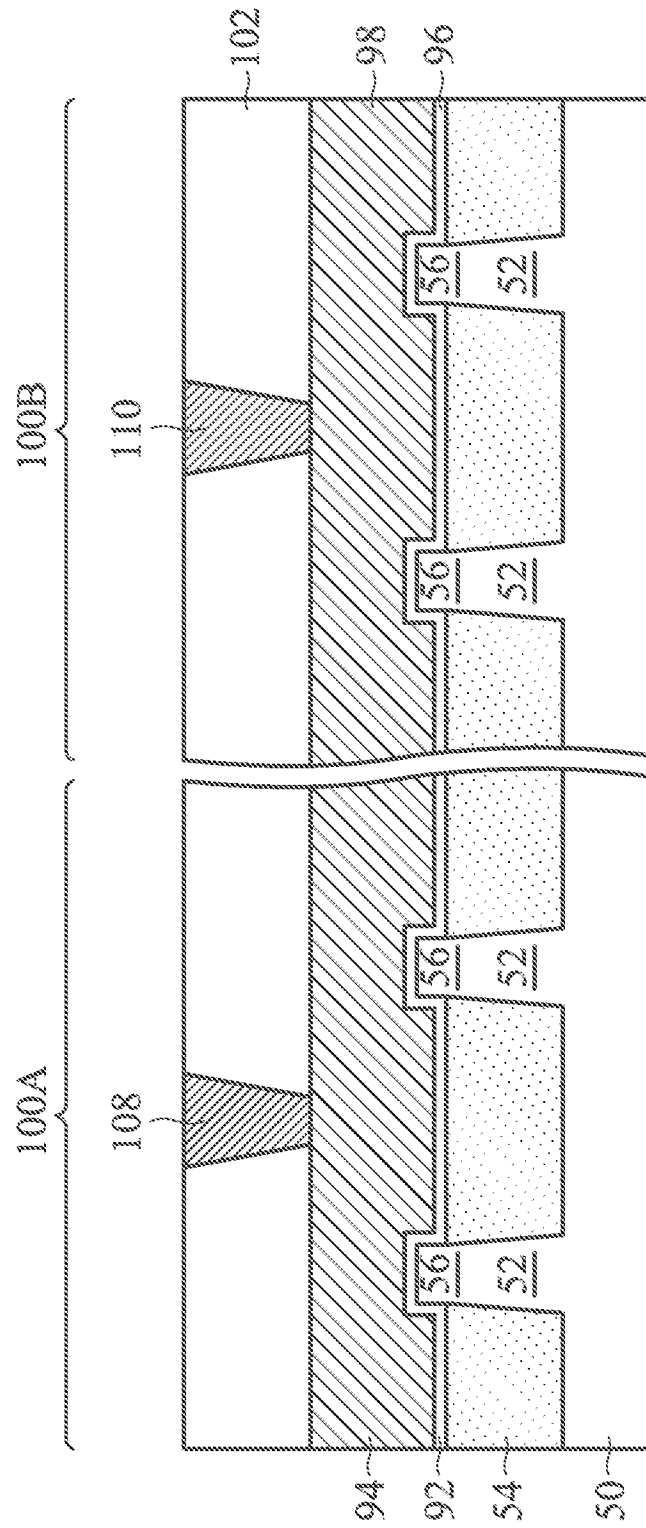


Figure 19A

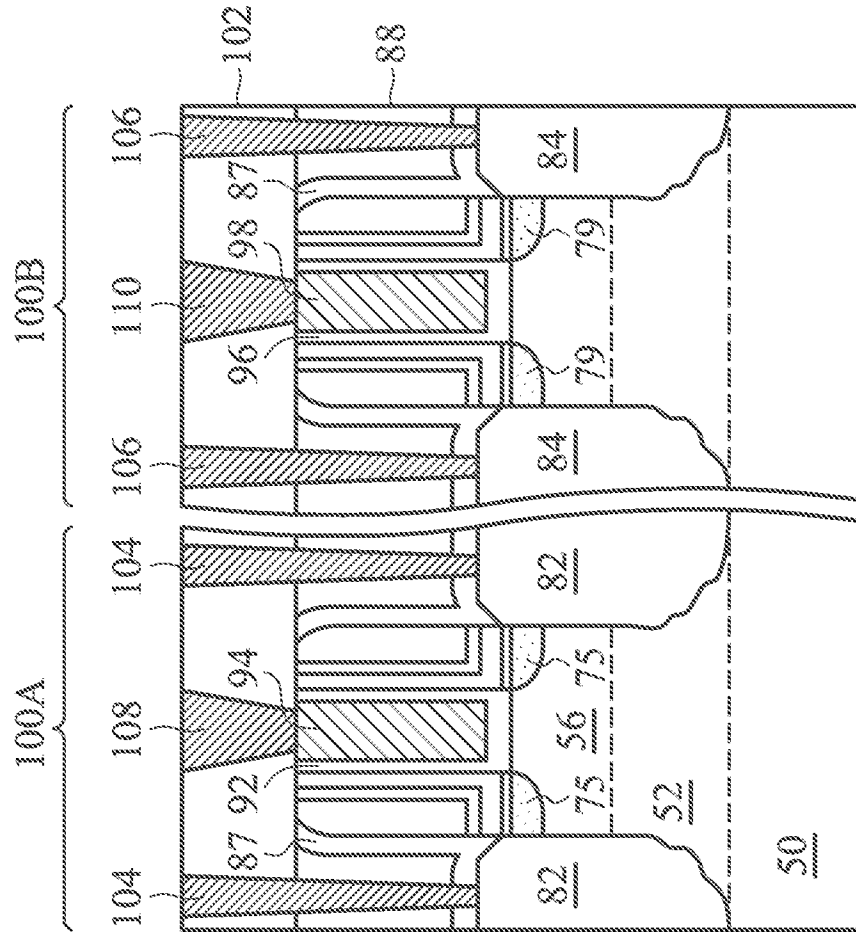


Figure 19B

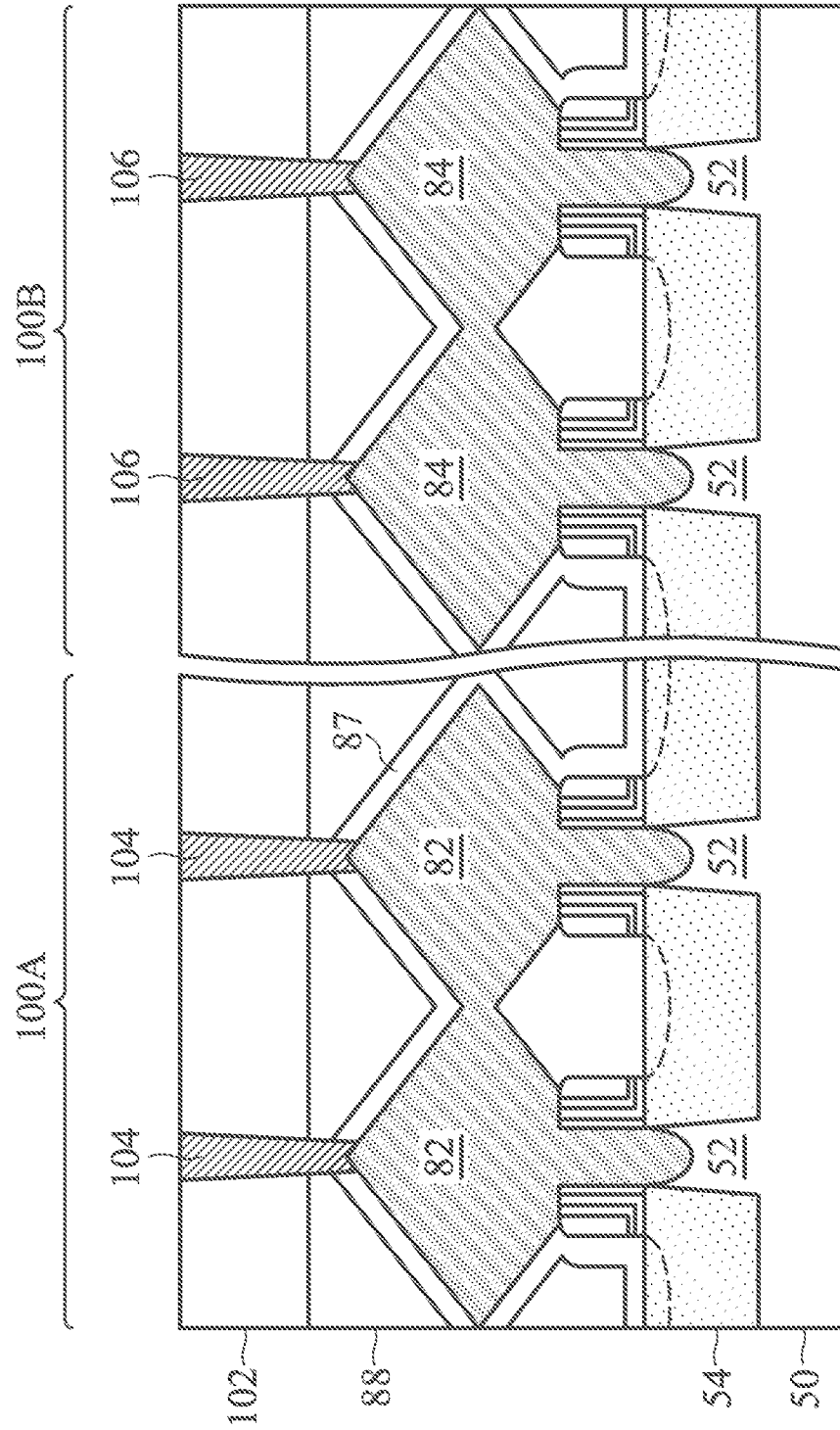


Figure 19C



*Figure 20*

## **DECLARATION**

Title of Invention: FinFET Device and Method of Forming Same

Attorney Docket No.: TSMP20160591US00

As the below named inventor, I hereby declare that:

This declaration is directed to:

- ☐ The attached application, or
- ☐ United States application number or PCT international application number  
\_\_\_\_\_ filed on \_\_\_\_\_.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I have reviewed and understand the contents of the application, including the claims.

I am aware of the duty to disclose to the U.S. Patent and Trademark Office all information known to me to be material to patentability as defined in 37 C.F.R. §1.56.

All statements made of my own knowledge are true and all statements made on information and belief are believed to be true.

I hereby acknowledge that any willful false statement made in this declaration may jeopardize the validity of the application or any patent issuing thereon and is punishable under 18 U.S.C. §1001 by fine or imprisonment of not more than five (5) years, or both.

Inventor Signature Chih-Teng Liao  
Inventor Name: Chih-Teng Liao

Date 2017.2.8

## **DECLARATION**

Title of Invention: FinFET Device and Method of Forming Same

Attorney Docket No.: TSMP20160591US00

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Inventor Signature Chih-Shan Chen

Date 2017, 2, 8

Inventor Name: Chih-Shan Chen

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Attorney Docket No.: TSMP20160591US00

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Inventor Signature Yi Wei Chiu

Date 2017.2.8

Inventor Name: Yi-Wei Chiu

## **DECLARATION**

Title of Invention: FinFET Device and Method of Forming Same

Attorney Docket No.: TSMP20160591US00

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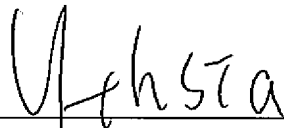
I have reviewed and understand the contents of the application, including the claims.

I am aware of the duty to disclose to the U.S. Patent and Trademark Office all information known to me to be material to patentability as defined in 37 C.F.R. §1.56.

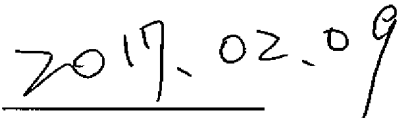
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I hereby acknowledge that any willful false statement made in this declaration may jeopardize the validity of the application or any patent issuing thereon and is punishable under 18 U.S.C. §1001 by fine or imprisonment of not more than five (5) years, or both.

Inventor Signature \_\_\_\_\_



Date \_\_\_\_\_



Inventor Name: Ying Ting Hsia

## **DECLARATION**

Title of Invention: FinFET Device and Method of Forming Same

Attorney Docket No.: TSMP20160591US00

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I hereby acknowledge that any willful false statement made in this declaration may jeopardize the validity of the application or any patent issuing thereon and is punishable under 18 U.S.C. §1001 by fine or imprisonment of not more than five (5) years, or both.

Inventor Signature TC Weng

Date 2017.2.11

Inventor Name: Tzu-Chan Weng

|                                                                                                     |                        |                  |  |
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|                                                                                                     | Filing Date            |                  |  |
|                                                                                                     | First Named Inventor   | Chih-Teng Liao   |  |
|                                                                                                     | Art Unit               |                  |  |
|                                                                                                     | Examiner Name          |                  |  |
|                                                                                                     | Attorney Docket Number | TSMP20160591US00 |  |

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|                   | 3       | 8367498       |                        | 2013-02-05 | Chang et al.                                    |                                                                        |
|                   | 4       | 8440517       |                        | 2013-05-14 | Lin et al.                                      |                                                                        |
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|                   | 6       | 8610240       |                        | 2013-12-17 | Lee et al.                                      |                                                                        |
|                   | 7       | 8680576       |                        | 2014-03-25 | Ching et al.                                    |                                                                        |
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| Art Unit               |                  |  |
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| Attorney Docket Number | TSMP20160591US00 |  |

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|----|---------|--|------------|--------------|--|
| 9  | 8729627 |  | 2014-05-20 | Cheng et al. |  |
| 10 | 8729634 |  | 2014-05-20 | Shen et al.  |  |
| 11 | 8785285 |  | 2014-07-22 | Tsai et al.  |  |
| 12 | 8796759 |  | 2014-08-05 | Perng et al. |  |
| 13 | 8809139 |  | 2014-08-19 | Huang et al. |  |
| 14 | 8828823 |  | 2014-09-09 | Liu et al.   |  |
| 15 | 8836016 |  | 2014-09-16 | Wu et al.    |  |
| 16 | 8841701 |  | 2014-09-23 | Lin et al.   |  |
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|                   | 2       | 20130011983        |                        | 2013-01-10       | Tsai et al.                                     |                                                                          |
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| First Named Inventor   | Chih-Teng Liao   |
| Art Unit               |                  |
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| Art Unit               |                  |
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| Attorney Docket Number | TSMP20160591US00 |

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That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

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See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

**SIGNATURE**

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

|            |                  |                     |            |
|------------|------------------|---------------------|------------|
| Signature  | /Roger C. Knapp/ | Date (YYYY-MM-DD)   | 2017-02-17 |
| Name/Print | Roger C. Knapp   | Registration Number | 46836      |

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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 inspections 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.

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

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                          |                        |                  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|------------------------|------------------|
| <b>Application Data Sheet 37 CFR 1.76</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                          | Attorney Docket Number | TSMP20160591US00 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                          | Application Number     |                  |
| Title of Invention                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | FinFET Device and Method of Forming Same |                        |                  |
| <p>The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.</p> <p>This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.</p> |                                          |                        |                  |

**Secrecy Order 37 CFR 5.2:**

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

**Inventor Information:**

|                                                                                                                                                                                 |                   |                                          |                    |               |                        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|------------------------------------------|--------------------|---------------|------------------------|
| <b>Inventor</b>                                                                                                                                                                 | 1                 |                                          |                    |               | <a href="#">Remove</a> |
| <b>Legal Name</b>                                                                                                                                                               |                   |                                          |                    |               |                        |
| <b>Prefix</b>                                                                                                                                                                   | <b>Given Name</b> | <b>Middle Name</b>                       | <b>Family Name</b> | <b>Suffix</b> |                        |
|                                                                                                                                                                                 | Chih-Teng         |                                          | Liao               |               |                        |
| <b>Residence Information (Select One)</b> <input type="radio"/> US Residency <input checked="" type="radio"/> Non US Residency <input type="radio"/> Active US Military Service |                   |                                          |                    |               |                        |
| <b>City</b>                                                                                                                                                                     | Hsin-Chu          | <b>Country of Residence <sup>i</sup></b> |                    | TW            |                        |
| <b>Mailing Address of Inventor:</b>                                                                                                                                             |                   |                                          |                    |               |                        |
| <b>Address 1</b>                                                                                                                                                                |                   | No. 8, Li-Hsin Rd. 6                     |                    |               |                        |
| <b>Address 2</b>                                                                                                                                                                |                   | Science-Based Industrial Park            |                    |               |                        |
| <b>City</b>                                                                                                                                                                     | Hsin-Chu          | <b>State/Province</b>                    |                    |               |                        |
| <b>Postal Code</b>                                                                                                                                                              | 300-77            | <b>Country <sup>i</sup></b>              | TW                 |               |                        |
| <b>Inventor</b>                                                                                                                                                                 | 2                 |                                          |                    |               | <a href="#">Remove</a> |
| <b>Legal Name</b>                                                                                                                                                               |                   |                                          |                    |               |                        |
| <b>Prefix</b>                                                                                                                                                                   | <b>Given Name</b> | <b>Middle Name</b>                       | <b>Family Name</b> | <b>Suffix</b> |                        |
|                                                                                                                                                                                 | Chih-Shan         |                                          | Chen               |               |                        |
| <b>Residence Information (Select One)</b> <input type="radio"/> US Residency <input checked="" type="radio"/> Non US Residency <input type="radio"/> Active US Military Service |                   |                                          |                    |               |                        |
| <b>City</b>                                                                                                                                                                     | New Taipei City   | <b>Country of Residence <sup>i</sup></b> |                    | TW            |                        |
| <b>Mailing Address of Inventor:</b>                                                                                                                                             |                   |                                          |                    |               |                        |
| <b>Address 1</b>                                                                                                                                                                |                   | No. 8, Li-Hsin Rd. 6                     |                    |               |                        |
| <b>Address 2</b>                                                                                                                                                                |                   | Science-Based Industrial Park            |                    |               |                        |
| <b>City</b>                                                                                                                                                                     | Hsin-Chu          | <b>State/Province</b>                    |                    |               |                        |
| <b>Postal Code</b>                                                                                                                                                              | 300-77            | <b>Country <sup>i</sup></b>              | TW                 |               |                        |
| <b>Inventor</b>                                                                                                                                                                 | 3                 |                                          |                    |               | <a href="#">Remove</a> |
| <b>Legal Name</b>                                                                                                                                                               |                   |                                          |                    |               |                        |

|                                           |                                          |                        |                  |
|-------------------------------------------|------------------------------------------|------------------------|------------------|
| <b>Application Data Sheet 37 CFR 1.76</b> |                                          | Attorney Docket Number | TSMC20160591US00 |
|                                           |                                          | Application Number     |                  |
| Title of Invention                        | FinFET Device and Method of Forming Same |                        |                  |

|                                                                                                                                    |                |             |                                   |        |
|------------------------------------------------------------------------------------------------------------------------------------|----------------|-------------|-----------------------------------|--------|
| Prefix                                                                                                                             | Given Name     | Middle Name | Family Name                       | Suffix |
|                                                                                                                                    | Yi-Wei         |             | Chiu                              |        |
| Residence Information (Select One)    US Residency <input checked="" type="radio"/> Non US Residency    Active US Military Service |                |             |                                   |        |
| City                                                                                                                               | Kaohsiung City |             | Country of Residence <sup>i</sup> | TW     |

**Mailing Address of Inventor:**

|             |                               |                      |    |                                       |
|-------------|-------------------------------|----------------------|----|---------------------------------------|
| Address 1   | No. 8, Li-Hsin Rd. 6          |                      |    |                                       |
| Address 2   | Science-Based Industrial Park |                      |    |                                       |
| City        | Hsin-Chu                      | State/Province       |    |                                       |
| Postal Code | 300-77                        | Country <sup>i</sup> | TW |                                       |
| Inventor    | 4                             |                      |    | <input type="button" value="Remove"/> |
| Legal Name  |                               |                      |    |                                       |

|                                                                                                                                    |                |             |                                   |        |
|------------------------------------------------------------------------------------------------------------------------------------|----------------|-------------|-----------------------------------|--------|
| Prefix                                                                                                                             | Given Name     | Middle Name | Family Name                       | Suffix |
|                                                                                                                                    | Ying Ting      |             | Hsia                              |        |
| Residence Information (Select One)    US Residency <input checked="" type="radio"/> Non US Residency    Active US Military Service |                |             |                                   |        |
| City                                                                                                                               | Kaohsiung City |             | Country of Residence <sup>i</sup> | TW     |

**Mailing Address of Inventor:**

|             |                               |                      |    |                                       |
|-------------|-------------------------------|----------------------|----|---------------------------------------|
| Address 1   | No. 8, Li-Hsin Rd. 6          |                      |    |                                       |
| Address 2   | Science-Based Industrial Park |                      |    |                                       |
| City        | Hsin-Chu                      | State/Province       |    |                                       |
| Postal Code | 300-77                        | Country <sup>i</sup> | TW |                                       |
| Inventor    | 5                             |                      |    | <input type="button" value="Remove"/> |
| Legal Name  |                               |                      |    |                                       |

|                                                                                                                                    |                |             |                                   |        |
|------------------------------------------------------------------------------------------------------------------------------------|----------------|-------------|-----------------------------------|--------|
| Prefix                                                                                                                             | Given Name     | Middle Name | Family Name                       | Suffix |
|                                                                                                                                    | Tzu-Chan       |             | Weng                              |        |
| Residence Information (Select One)    US Residency <input checked="" type="radio"/> Non US Residency    Active US Military Service |                |             |                                   |        |
| City                                                                                                                               | Kaohsiung City |             | Country of Residence <sup>i</sup> | TW     |

**Mailing Address of Inventor:**

|             |                               |                      |    |  |
|-------------|-------------------------------|----------------------|----|--|
| Address 1   | No. 8, Li-Hsin Rd. 6          |                      |    |  |
| Address 2   | Science-Based Industrial Park |                      |    |  |
| City        | Hsin-Chu                      | State/Province       |    |  |
| Postal Code | 300-77                        | Country <sup>i</sup> | TW |  |

|                                           |                                          |                        |                  |
|-------------------------------------------|------------------------------------------|------------------------|------------------|
| <b>Application Data Sheet 37 CFR 1.76</b> |                                          | Attorney Docket Number | TSMP20160591US00 |
|                                           |                                          | Application Number     |                  |
| Title of Invention                        | FinFET Device and Method of Forming Same |                        |                  |

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button.

Add

## Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.  
For further information see 37 CFR 1.33(a).

☐ An Address is being provided for the correspondence Information of this application.

|                 |                            |           |              |
|-----------------|----------------------------|-----------|--------------|
| Customer Number | 43859                      |           |              |
| Email Address   | docketing@slatertmatil.com | Add Email | Remove Email |

## Application Information:

|                                         |                                          |                                           |                          |
|-----------------------------------------|------------------------------------------|-------------------------------------------|--------------------------|
| Title of the Invention                  | FinFET Device and Method of Forming Same |                                           |                          |
| Attorney Docket Number                  | TSMP20160591US00                         | Small Entity Status Claimed               | <input type="checkbox"/> |
| Application Type                        | Nonprovisional                           |                                           |                          |
| Subject Matter                          | Utility                                  |                                           |                          |
| Total Number of Drawing Sheets (if any) | 48                                       | Suggested Figure for Publication (if any) |                          |

## Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

|                                                        |                          |                                            |
|--------------------------------------------------------|--------------------------|--------------------------------------------|
| Application number of the previously filed application | Filing date (YYYY-MM-DD) | Intellectual Property Authority or Country |
|                                                        |                          |                                            |

## Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

## Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32). Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

|                                           |                                                  |                                              |                                                         |
|-------------------------------------------|--------------------------------------------------|----------------------------------------------|---------------------------------------------------------|
| <b>Application Data Sheet 37 CFR 1.76</b> |                                                  | Attorney Docket Number                       | TSPM20160591US00                                        |
|                                           |                                                  | Application Number                           |                                                         |
| Title of Invention                        | FinFET Device and Method of Forming Same         |                                              |                                                         |
|                                           |                                                  |                                              |                                                         |
| Please Select One:                        | <input checked="" type="radio"/> Customer Number | <input type="radio"/> US Patent Practitioner | <input type="radio"/> Limited Recognition (37 CFR 11.9) |
| Customer Number                           | 43859                                            |                                              |                                                         |

## Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.

When referring to the current application, please leave the "Application Number" field blank.

|                                                                                                                       |                               |                          |                                    |
|-----------------------------------------------------------------------------------------------------------------------|-------------------------------|--------------------------|------------------------------------|
| Prior Application Status                                                                                              | Pending                       | Remove                   |                                    |
| Application Number                                                                                                    | Continuity Type               | Prior Application Number | Filing or 371(c) Date (YYYY-MM-DD) |
|                                                                                                                       | Claims benefit of provisional | 62/427,571               | 2016-11-29                         |
| Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the <b>Add</b> button. |                               |                          | Add                                |

## Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)<sup>i</sup> the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

|                                                                                                        |                      |                          |                                          |
|--------------------------------------------------------------------------------------------------------|----------------------|--------------------------|------------------------------------------|
| Application Number                                                                                     | Country <sup>i</sup> | Filing Date (YYYY-MM-DD) | Access Code <sup>i</sup> (if applicable) |
|                                                                                                        |                      |                          |                                          |
| Additional Foreign Priority Data may be generated within this form by selecting the <b>Add</b> button. |                      |                          | Add                                      |

## Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

- ☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
- NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

|                                           |                                          |                        |                  |
|-------------------------------------------|------------------------------------------|------------------------|------------------|
| <b>Application Data Sheet 37 CFR 1.76</b> |                                          | Attorney Docket Number | TSMP20160591US00 |
|                                           |                                          | Application Number     |                  |
| Title of Invention                        | FinFET Device and Method of Forming Same |                        |                  |

## Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

**NOTE:** This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

### 1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

**A. Priority Document Exchange (PDX)** - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

**B. Search Results from U.S. Application to EPO** - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

### 2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

**NOTE:** Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

|                                           |                                          |                        |                  |
|-------------------------------------------|------------------------------------------|------------------------|------------------|
| <b>Application Data Sheet 37 CFR 1.76</b> |                                          | Attorney Docket Number | TSMP20160591US00 |
|                                           |                                          | Application Number     |                  |
| Title of Invention                        | FinFET Device and Method of Forming Same |                        |                  |

## Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                  |                                                  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|--------------------------------------------------|
| <b>Applicant</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 1                                                | <input type="button" value="Remove"/>            |
| <p>If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.</p> <p style="text-align: right;"><input type="button" value="Clear"/></p> |                                                  |                                                  |
| <input checked="" type="radio"/> Assignee                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Legal Representative under 35 U.S.C. 117         | Joint Inventor                                   |
| Person to whom the inventor is obligated to assign.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                  | Person who shows sufficient proprietary interest |
| If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                  |                                                  |
| <div style="border: 1px solid black; height: 20px; width: 100%;"></div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                  |                                                  |
| Name of the Deceased or Legally Incapacitated Inventor: <div style="border: 1px solid black; height: 20px; width: 100%;"></div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                  |                                                  |
| If the Applicant is an Organization check here. <input checked="" type="checkbox"/>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                  |                                                  |
| Organization Name                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Taiwan Semiconductor Manufacturing Company, Ltd. |                                                  |
| <b>Mailing Address Information For Applicant:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                  |                                                  |
| Address 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | No. 8, Li-Hsin Rd. 6                             |                                                  |
| Address 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Science-Based Industrial Park                    |                                                  |
| City                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Hsin-Chu                                         | State/Province                                   |
| Country                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | TW                                               | Postal Code                                      |
| Phone Number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                  | Fax Number                                       |
| Email Address                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                  |                                                  |
| Additional Applicant Data may be generated within this form by selecting the Add button. <input type="button" value="Add"/>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                  |                                                  |

## Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

|                                           |                                          |                        |                  |
|-------------------------------------------|------------------------------------------|------------------------|------------------|
| <b>Application Data Sheet 37 CFR 1.76</b> |                                          | Attorney Docket Number | TSPM20160591US00 |
|                                           |                                          | Application Number     |                  |
| Title of Invention                        | FinFET Device and Method of Forming Same |                        |                  |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                      |                      |                      |                                       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|----------------------|----------------------|---------------------------------------|
| <b>Assignee</b>                                                                                                                                                                                                                                                                                                                                                                                                                                        | 1                    |                      |                      |                                       |
| Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication. |                      |                      |                      |                                       |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                      |                      |                      | <input type="button" value="Remove"/> |
| If the Assignee or Non-Applicant Assignee is an Organization check here.                                                                                                                                                                                                                                                                                                                                                                               |                      |                      |                      | <input type="checkbox"/>              |
| Prefix                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Given Name           | Middle Name          | Family Name          | Suffix                                |
| <input type="text"/>                                                                                                                                                                                                                                                                                                                                                                                                                                   | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/>                  |
| <b>Mailing Address Information For Assignee including Non-Applicant Assignee:</b>                                                                                                                                                                                                                                                                                                                                                                      |                      |                      |                      |                                       |
| Address 1                                                                                                                                                                                                                                                                                                                                                                                                                                              |                      | <input type="text"/> |                      |                                       |
| Address 2                                                                                                                                                                                                                                                                                                                                                                                                                                              |                      | <input type="text"/> |                      |                                       |
| City                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <input type="text"/> | State/Province       | <input type="text"/> |                                       |
| Country <sup>i</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                   | <input type="text"/> | Postal Code          | <input type="text"/> |                                       |
| Phone Number                                                                                                                                                                                                                                                                                                                                                                                                                                           | <input type="text"/> | Fax Number           | <input type="text"/> |                                       |
| Email Address                                                                                                                                                                                                                                                                                                                                                                                                                                          | <input type="text"/> |                      |                      |                                       |
| Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.                                                                                                                                                                                                                                                                                                                                      |                      |                      |                      | <input type="button" value="Add"/>    |

**Signature:**

**NOTE:** This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). However, if this Application Data Sheet is submitted with the **INITIAL** filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

|                                                                                     |                  |           |                   |                                    |
|-------------------------------------------------------------------------------------|------------------|-----------|-------------------|------------------------------------|
| <b>Signature</b>                                                                    | /Roger C. Knapp/ |           | Date (YYYY-MM-DD) | 2017-02-17                         |
| First Name                                                                          | Roger C.         | Last Name | Knapp             | Registration Number                |
|                                                                                     |                  |           |                   | 46836                              |
| Additional Signature may be generated within this form by selecting the Add button. |                  |           |                   | <input type="button" value="Add"/> |

|                                           |                                          |                        |                  |
|-------------------------------------------|------------------------------------------|------------------------|------------------|
| <b>Application Data Sheet 37 CFR 1.76</b> |                                          | Attorney Docket Number | TSMP20160591US00 |
|                                           |                                          | Application Number     |                  |
| Title of Invention                        | FinFET Device and Method of Forming Same |                        |                  |

This collection of information is required by 37 CFR 1.76. 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 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet 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.**

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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 the Freedom of Information Act requires disclosure of these records.
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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 inspections 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.