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(54) **SPACERLESS FIN DEVICE WITH REDUCED PARASITIC RESISTANCE AND CAPACITANCE AND METHOD TO FABRICATE SAME**

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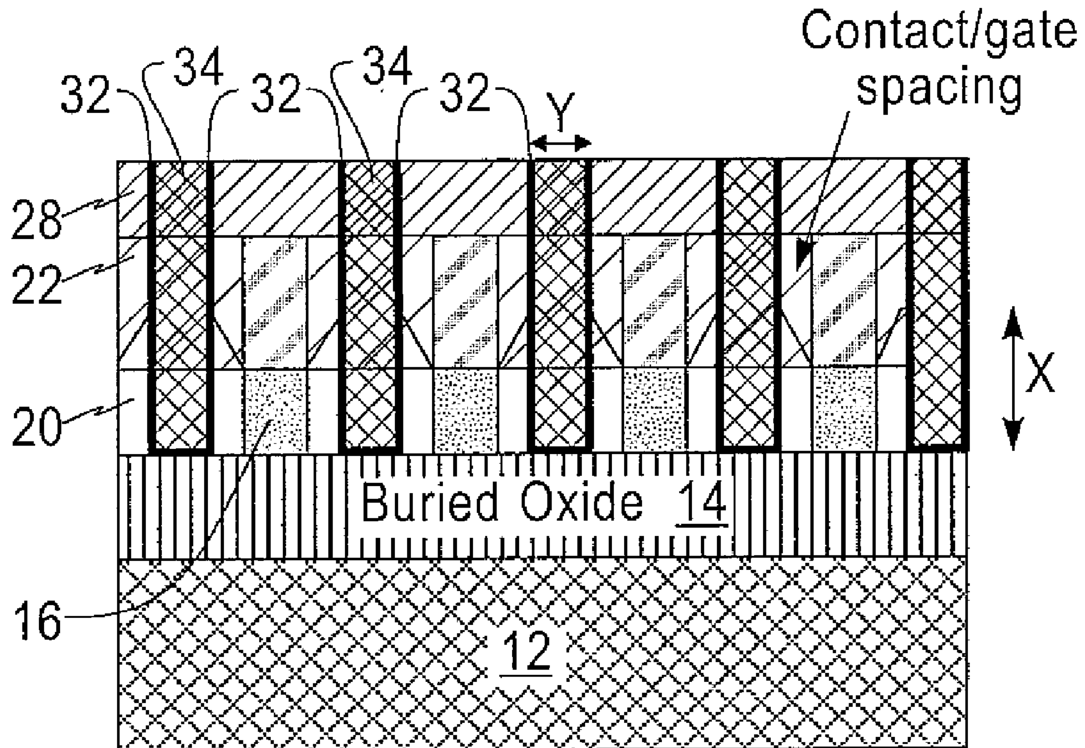
(52) **U.S. Cl.**
CPC *H01L 27/1211* (2013.01)
USPC **257/347**

(57) **ABSTRACT**

A structure includes a substrate having an insulator layer and a plurality of elongated semiconductor fin structures disposed on a surface of the insulator layer. The fin structures are disposed substantially parallel to one another. The structure further includes a plurality of elongated sacrificial gate structures each comprised of silicon nitride. The sacrificial gate structures are disposed substantially parallel to one another and orthogonal to the plurality of fin structures, where a portion of each of a plurality of adjacent fin structures is embedded within one of the sacrificial gate structures leaving other portions exposed between the sacrificial gate structures. The structure further includes a plurality of semiconductor source/drain (S/D) structures disposed over the exposed portions of the fin structures between the sacrificial gate structures. The embodiments eliminate a need to form a conventional spacer on the fin structures.



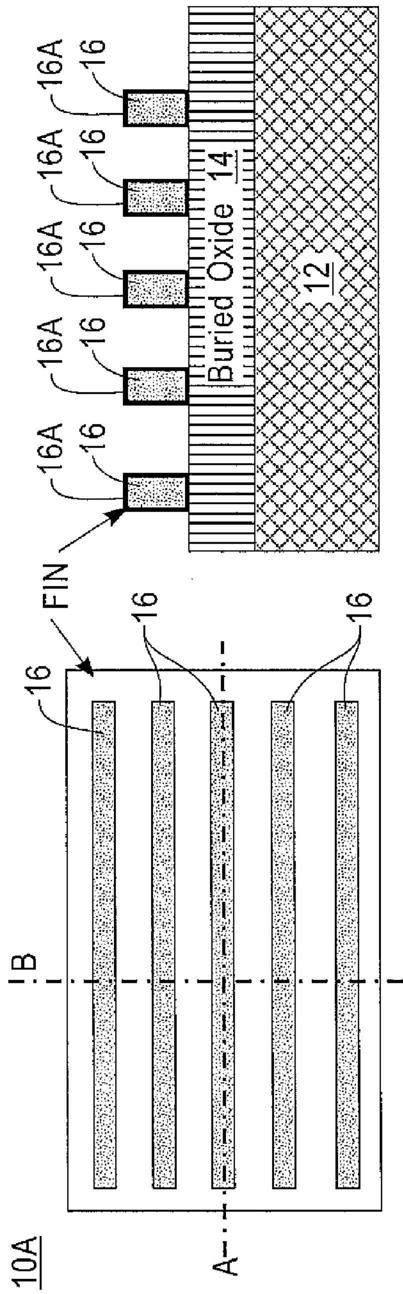


FIG. 1B

FIG. 1

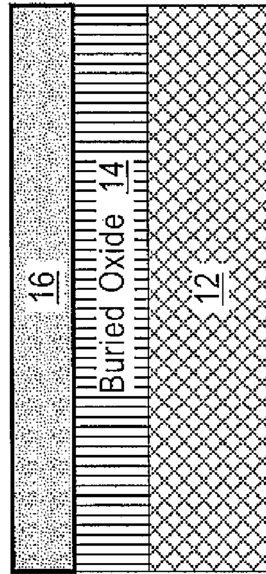


FIG. 1A

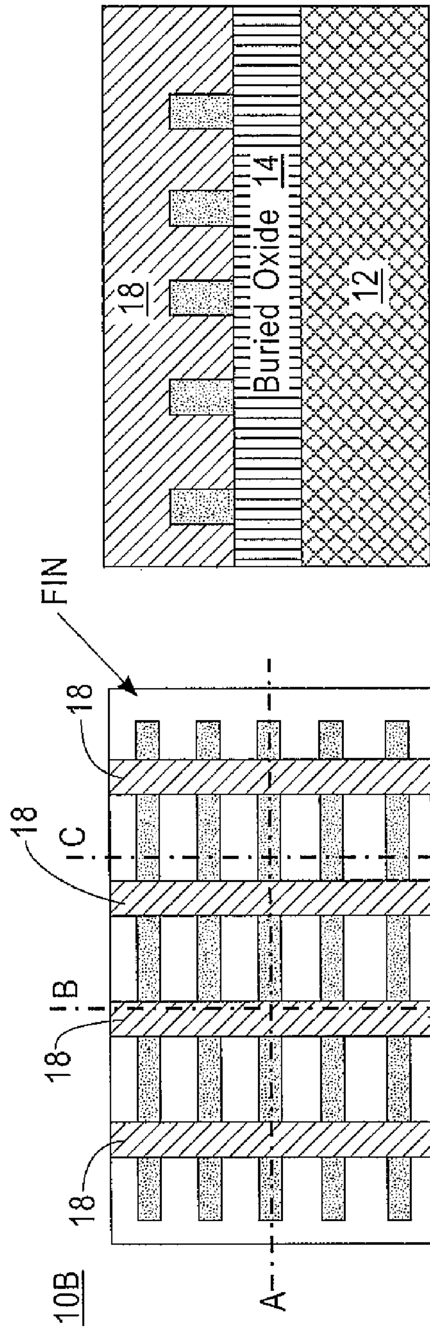


FIG. 2

FIG. 2B

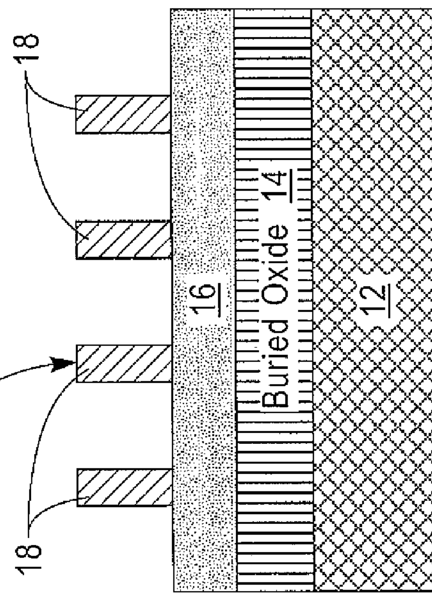


FIG. 2A

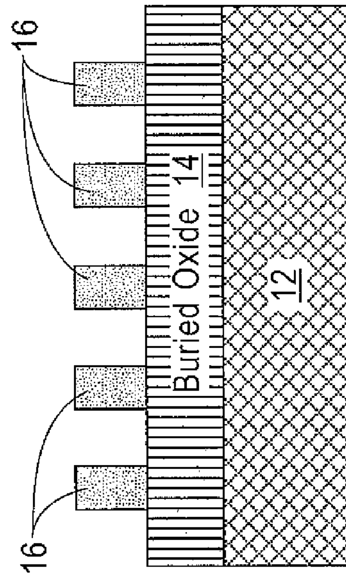


FIG. 2C

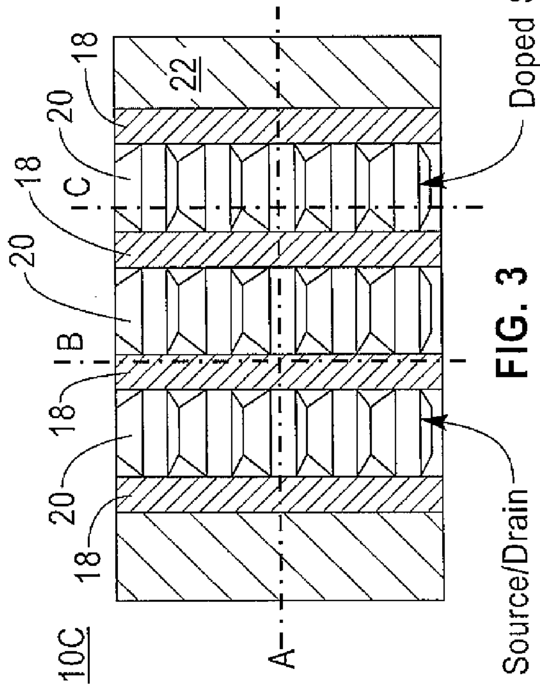


FIG. 3

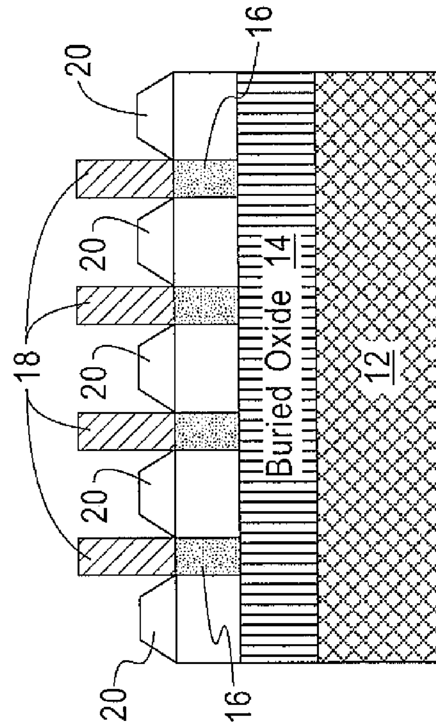


FIG. 3A

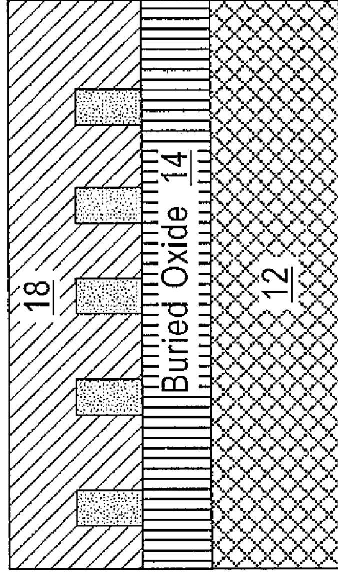


FIG. 3B

FIG. 3C

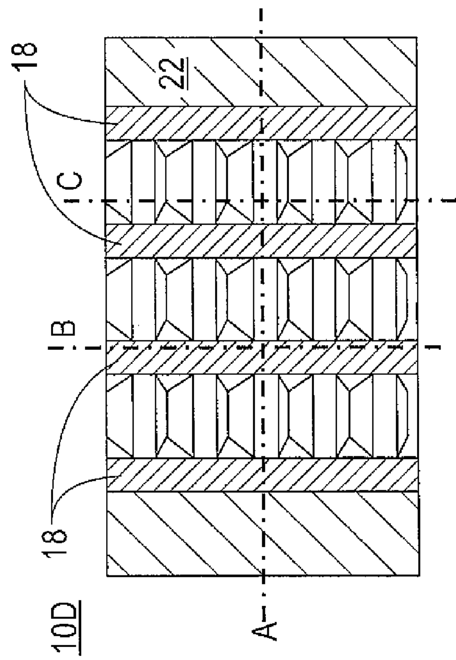


FIG. 4

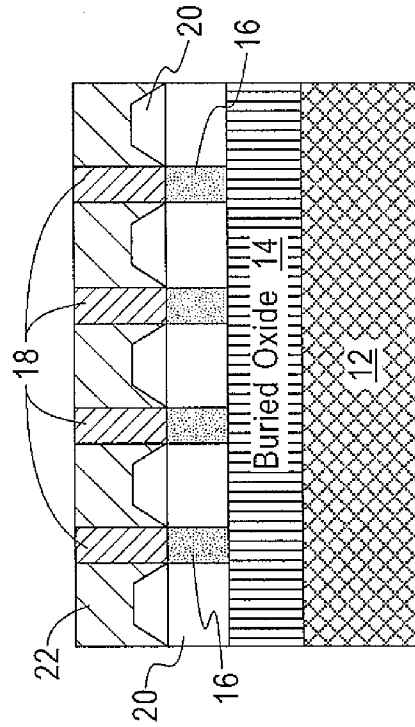


FIG. 4A

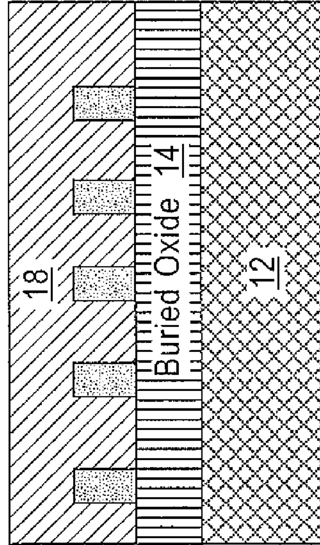


FIG. 4B

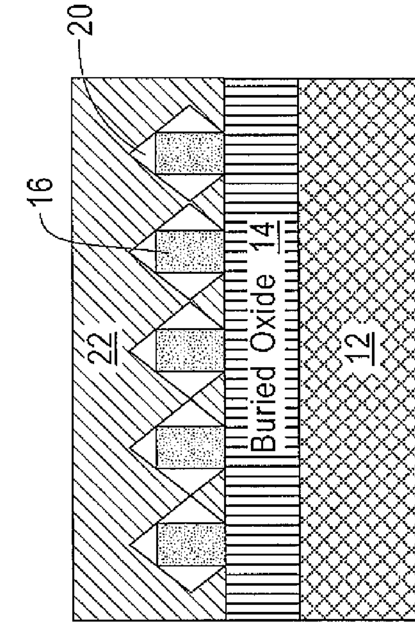


FIG. 4C

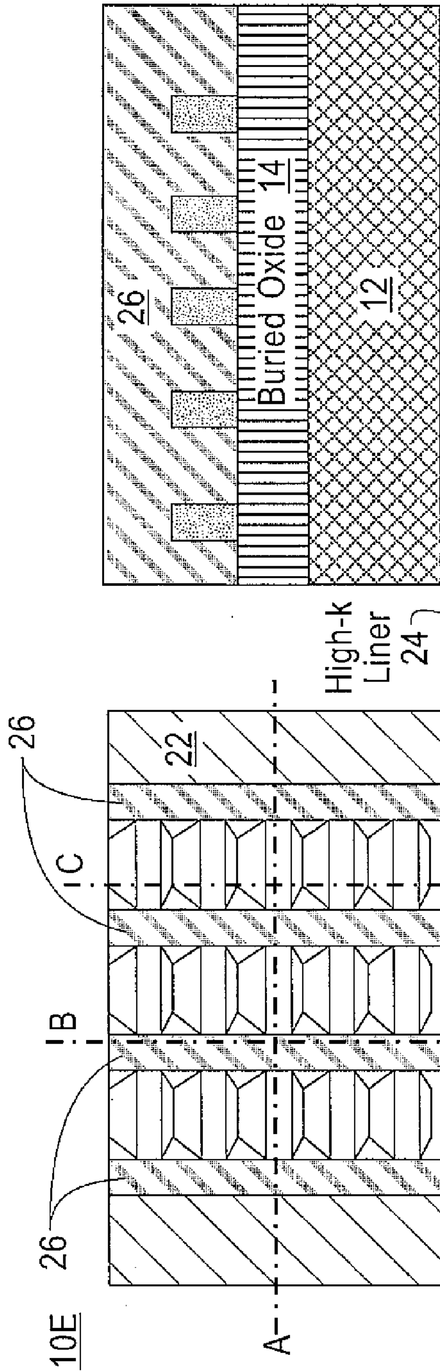


FIG. 5

FIG. 5B

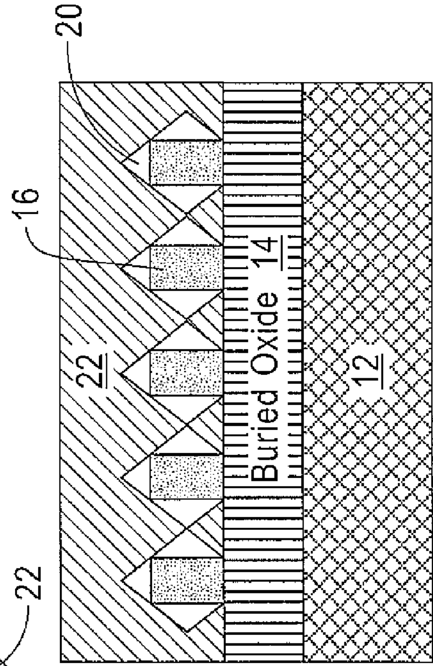


FIG. 5C

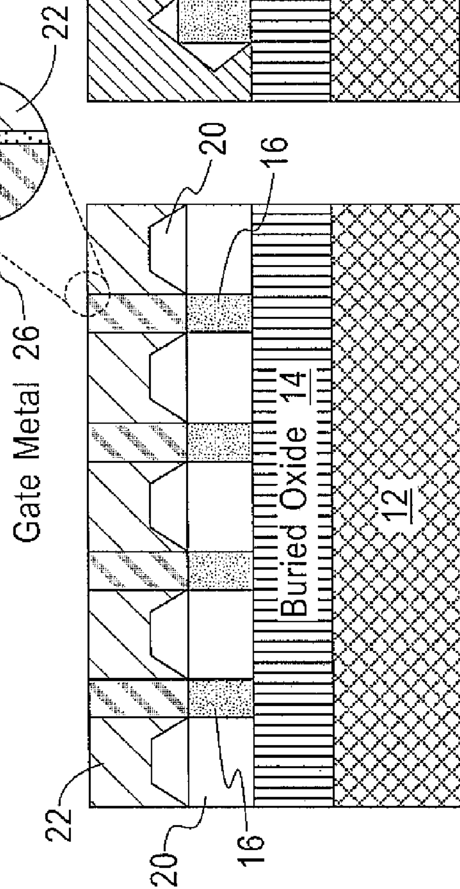


FIG. 5A

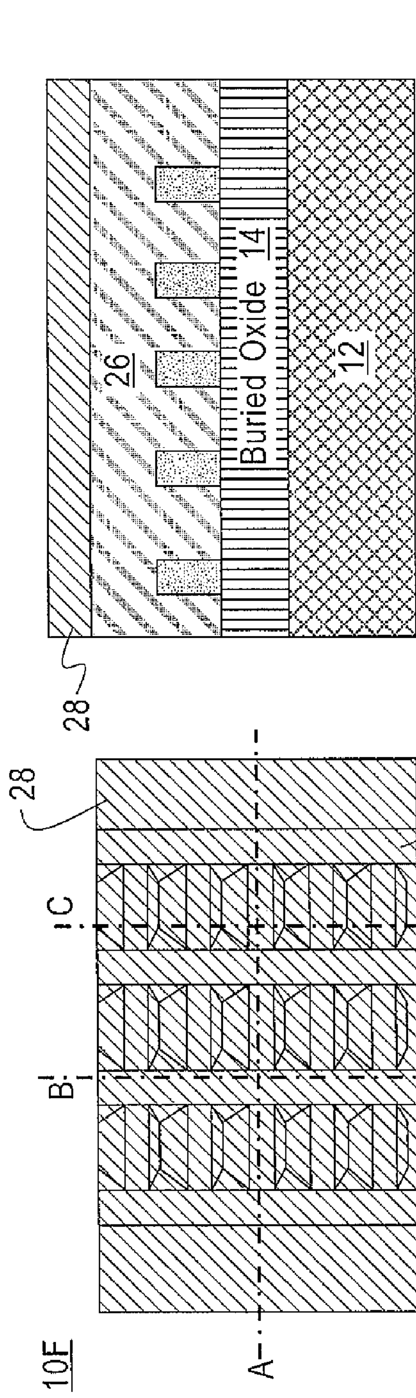


FIG. 6B

FIG. 6

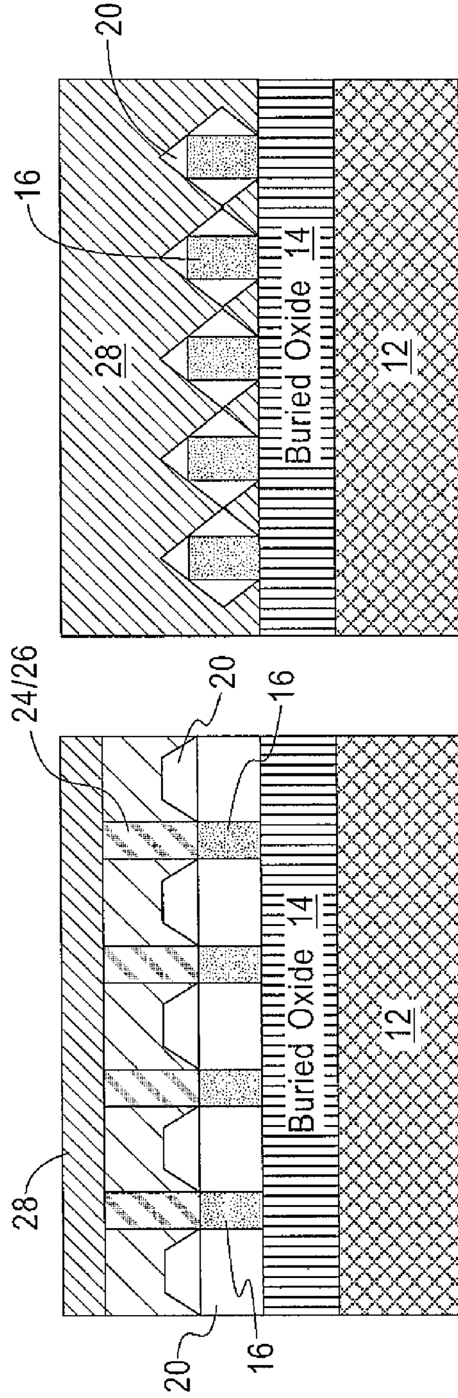


FIG. 6C

FIG. 6A

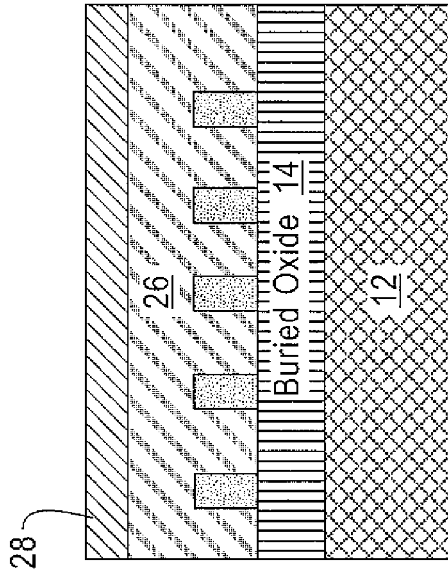


FIG. 7B

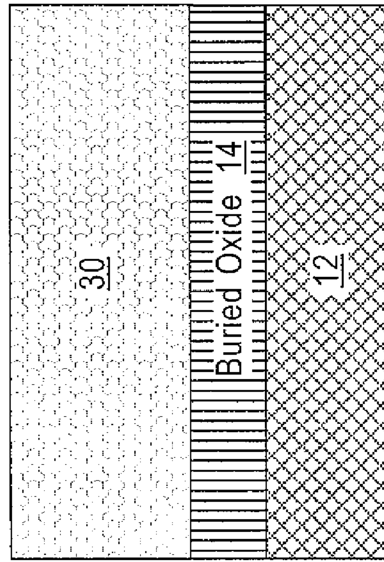


FIG. 7C

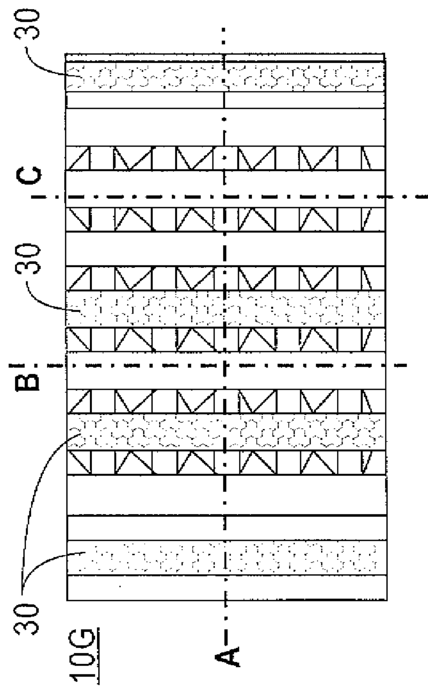


FIG. 7

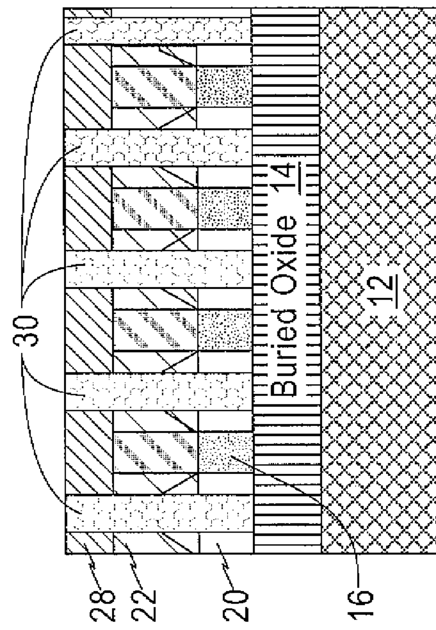


FIG. 7A

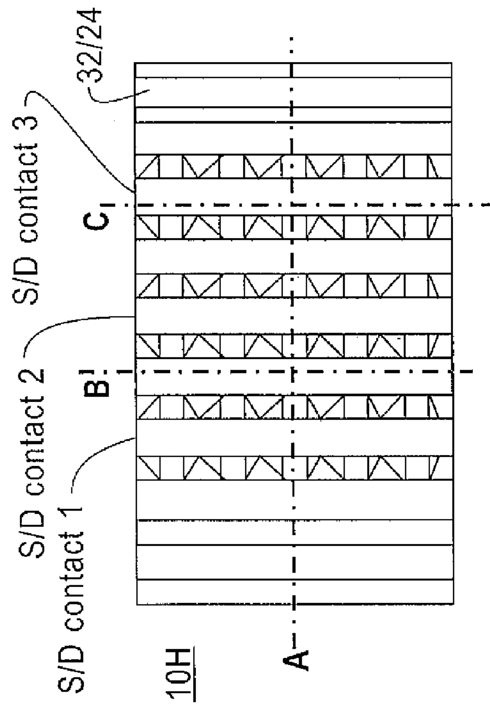


FIG. 8

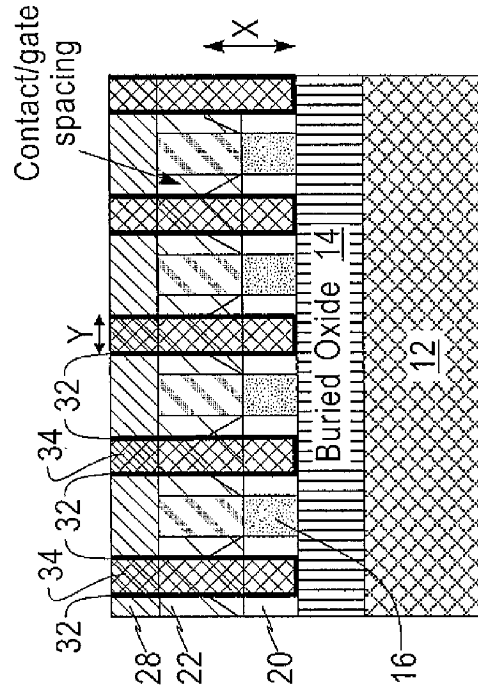


FIG. 8A

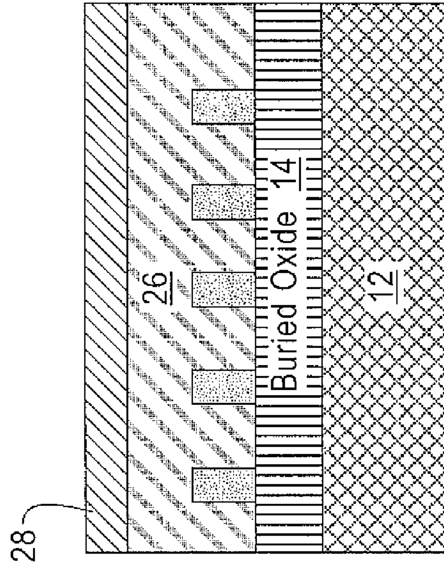


FIG. 8B

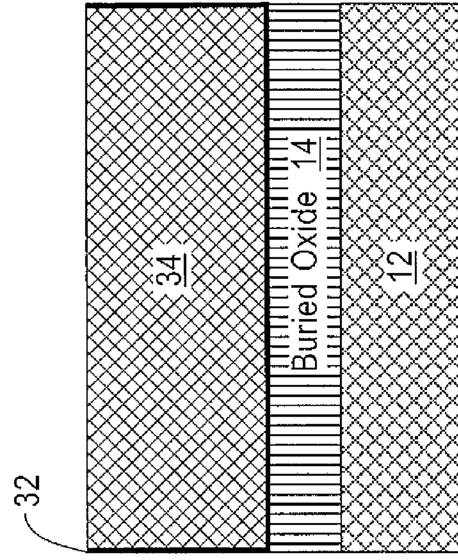


FIG. 8C

SPACERLESS FIN DEVICE WITH REDUCED PARASITIC RESISTANCE AND CAPACITANCE AND METHOD TO FABRICATE SAME

CROSS-REFERENCE TO A RELATED PATENT APPLICATION

[0001] This patent application is a continuation patent application of copending U.S. patent application Ser. No. 14/071,461, filed Sep. 4, 2013, the disclosure of which is incorporated by reference herein in its entirety.

TECHNICAL FIELD

[0002] The exemplary embodiments of this invention relate generally to semiconductor devices and fabrication techniques and, more specifically, relate to the fabrication of semiconductor transistor devices, such as those used in random access memory (RAM) and logic circuitry, using a silicon on insulator (SOI) material.

BACKGROUND

[0003] In SOI technology a thin silicon layer is formed over an insulating layer, such as silicon oxide, which in turn is formed over a bulk substrate. This insulating layer is often referred to as a buried oxide (BOX) layer or simply as a BOX. For a single BOX SOI wafer the silicon layer can be divided into active regions by shallow trench isolation (STI) which intersects the BOX and provides total isolation for active device regions formed in the silicon layer. Sources and drains of field effect transistors (FETs) can be formed, for example, by the growth of in-situ doped silicon or by ion implantation of N-type and P-type dopant material into the silicon layer. A field effect transistor channel region between a source/drain pair can be created so as to underlie a gate structure using, for example, an elongated 'fin' structure that is defined in the silicon layer when a FinFET device is being fabricated.

[0004] One problem that can be present in a conventional FinFET device is the presence of a substantial amount of parasitic resistance and capacitance, both of which can detrimentally affect the device performance.

SUMMARY

[0005] In accordance with a first aspect of this invention there is provided a method to fabricate a device. The method comprises providing a substrate comprised of an insulator layer having a plurality of elongated semiconductor fin structures disposed on a surface of the insulator layer, the fin structures being disposed substantially parallel to one another. The method further comprises forming on the surface of the insulator layer a plurality of elongated sacrificial gate structures each comprised of silicon nitride. The sacrificial gate structures are disposed substantially parallel to one another and orthogonal to the plurality of fin structures. A portion of each of a plurality of adjacent fin structures is embedded within one of the sacrificial gate structures leaving other portions exposed between the sacrificial gate structures. The method further comprises epitaxially depositing a plurality of semiconductor source/drain (S/D) structures over the exposed portions of the fin structures between the sacrificial gate structures and forming a layer of oxide over the S/D structures. The method further comprises removing the sacrificial gate structures and replacing the removed sacrificial gate structures with gate structures each comprised of a layer of gate dielectric and gate metal. The method further comprises forming trenches parallel to and between the gate structures. The trenches extend through the layer of oxide and through an underlying portion of the S/D structures to the surface of the insulator layer. The method further comprises forming S/D contacts in the trenches.

[0006] In accordance with another aspect of this invention there is provided a structure that comprises a substrate comprised of an insulator layer having a plurality of elongated semiconductor fin structures disposed on a surface of the insulator layer, the fin structures being disposed substantially parallel to one another. The structure further comprises a plurality of elongated sacrificial gate structures each comprised of silicon nitride. The sacrificial gate structures are disposed substantially parallel to one another and orthogonal to the plurality of fin structures, where a portion of each of a plurality of adjacent fin structures is embedded within one of the sacrificial gate structures leaving other portions exposed between the sacrificial gate structures. The structure further includes a plurality of semiconductor source/drain (S/D) structures disposed over the exposed portions of the fin structures between the sacrificial gate structures.

[0007] In accordance with yet another aspect of this invention there is provided a structure that comprises a substrate comprised of an insulator layer having a plurality of elongated semiconductor fin structures disposed on a surface of the insulator layer, the fin structures being disposed substantially parallel to one another. The structure further includes a plurality of elongated gate structures each comprised of gate dielectric and gate metal. The gate structures are disposed substantially parallel to one another and orthogonal to the plurality of fin structures, where a portion of each of a plurality of adjacent fin structures is embedded within one of the gate structures leaving other portions exposed between the gate structures. The structure further includes a plurality of semiconductor source/drain (S/D) structures over the exposed portions of the fin structures between the gate structures and a layer of oxide over the S/D structures and between the elongated gate structures. The elongated gate structures are embedded in the layer of oxide. The structure further includes a plurality of elongated S/D contacts disposed between and parallel to the elongated gate structures. The S/D contacts are embedded in the layer of oxide and extend through the layer of oxide and through an underlying portion of the S/D structures to the surface of the insulator layer. In the structure a portion of the layer of oxide is disposed between a S/D contact and an adjacent gate structure.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0008] FIGS. **1**-**8** are each an enlarged top view of a structure showing various processing stages or steps that are performed in accordance with embodiments of this invention.

[0009] More specifically, FIG. **1** shows the structure after patterning of a plurality of fins, where FIG. **1**A is a cross-sectional view taken through the structure shown in FIG. **1** along the section line labeled A in FIG. **1**, and FIG. **1**B is a cross-sectional view taken through the structure shown in FIG. **1** along the section line labeled B in FIG. **1**;

[0010] FIG. **2** shows the structure after the patterning of a replacement (dummy) gate nitride, where FIG. **2**A is a cross-sectional view taken through the structure shown in FIG. **2** along the section line labeled A in FIG. **2**, FIG. **2**B is a cross-sectional view taken through the structure shown in

FIG. **2** along the section line labeled B in FIG. **2**, and FIG. **2**C is a cross-sectional view taken through the structure shown in FIG. **2** along the section line labeled C in FIG. **2**;

[0011] FIG. **3** shows the structure after the selective epitaxial growth of faceted source/drains (S/Ds), where FIG. **3**A is a cross-sectional view taken through the structure shown in FIG. **3** along the section line labeled A in FIG. **3**, FIG. **3**B is a cross-sectional view taken through the structure shown in FIG. **3** along the section line labeled B in FIG. **3**, and FIG. **3**C is a cross-sectional view taken through the structure shown in FIG. **3** along the section line labeled C in FIG. **3**;

[0012] FIG. **4** shows the structure after a layer of oxide is deposited and planarized, where FIG. **4**A is a cross-sectional view taken through the structure shown in FIG. **4** along the section line labeled A in FIG. **4**, FIG. **4**B is a cross-sectional view taken through the structure shown in FIG. **4** along the section line labeled B in FIG. **4**, and FIG. **4**C is a cross-sectional view taken through the structure shown in FIG. **4** along the section line labeled C in FIG. **4**;

[0013] FIG. **5** shows the structure after the dummy gate nitride of FIG. **2** is replaced with a gate dielectric and gate metal, where FIG. **5**A is a cross-sectional view taken through the structure shown in FIG. **5** along the section line labeled A in FIG. **5**, FIG. **5**B is a cross-sectional view taken through the structure shown in FIG. **5** along the section line labeled B in FIG. **5**, and FIG. **5**C is a cross-sectional view taken through the structure shown in FIG. **5** along the section line labeled C in FIG. **5**;

[0014] FIG. **6** shows the structure after it is covered with an insulator, where FIG. **6**A is a cross-sectional view taken through the structure shown in FIG. **6** along the section line labeled A in FIG. **6**, FIG. **6**B is a cross-sectional view taken through the structure shown in FIG. **6** along the section line labeled B in FIG. **6**, and FIG. **6**C is a cross-sectional view taken through the structure shown in FIG. **6** along the section line labeled C in FIG. **6**;

[0015] FIG. **7** shows the structure after patterning and etching S/D contact holes, where FIG. **7**A is a cross-sectional view taken through the structure shown in FIG. **7** along the section line labeled A in FIG. **7**, FIG. **7**B is a cross-sectional view taken through the structure shown in FIG. **7** along the section line labeled B in FIG. **7**, and FIG. **7**C is a cross-sectional view taken through the structure shown in FIG. **7** along the section line labeled C in FIG. **7**; and

[0016] FIG. **8** shows the structure after deposition of a contact hole liner and contact metal, where FIG. **8**A is a cross-sectional view taken through the structure shown in FIG. **8** along the section line labeled A in FIG. **8**, FIG. **8**B is a cross-sectional view taken through the structure shown in FIG. **8** along the section line labeled B in FIG. **8**, and FIG. **8**C is a cross-sectional view taken through the structure shown in FIG. **8** along the section line labeled C in FIG. **8**.

DETAILED DESCRIPTION

[0017] Described below is a replacement gate process for forming a multi-fin FinFET device that can be characterized as being 'spacerless', i.e., there is no need to form a spacer around a gate stack or sacrificial gate stack precursor structure as in conventional practice.

[0018] FIGS. **1**, **1**A and **1**B shows a portion of a structure, a wafer structure, also referred to as a first intermediate structure **10**A that is comprised of a substrate **12** having an overlying layer of insulator or BOX **14**. The substrate **12** can be formed from any suitable supporting material such as bulk silicon and can have any desired thickness. The BOX **14** can be formed from silicon oxide (SiO_2) and can have a thickness in a range of, for example, about 100 nm or less to about 200 nm or more, with 150 nm being one suitable and typical thickness. In FIGS. **1**, **1**A and **1**B it can be seen that a silicon-on-insulator layer that overlies the BOX **14** has been patterned and etched to form a plurality of fins **16**. Each fin **16** can have a height measured from the top surface of the BOX **14** of, for example, about 30 nm and a width in a range of about, for example, 5 nm to about 15 nm. A thin layer (e.g., thickness about 1 nm-2 nm) of a protective oxide (SiO_2) **16**A can be formed on exposed surfaces of the fins **16**. The fins **16** can be substantially parallel to one another and substantially equally spaced apart, although this is not a requirement.

[0019] Note that while the example shown in FIGS. **1** and **1**B depicts the presence of five fins **16**, in practice there can be many more than five fins present on a typical integrated circuit wafer embodiment.

[0020] FIGS. **2** and **2**A-**2**C show a second intermediate structure **10**B after patterning and the deposition of sacrificial replacement (dummy or precursor) gate nitride structures **18**. The nitride structures **18** can be formed from silicon nitride (Si_3N_4) and can have a height (measured from the top surface of the fins **16**) of about 50 nm and an exemplary width in a range of about 15 nm to about 35 nm. The dimensions of the nitride structures **18** substantially define the dimensions of the actual metal gate structures that are formed subsequently (see FIG. **5**). The nitride structures **18** are elongated structures that are parallel to one another and are formed to run orthogonal to the fins **16** and to cross over and partially embed a portion of a plurality of adjacent fins **16** (as can be most clearly seen in FIG. **2**B).

[0021] It can be noted that in conventional practice sacrificial replacement (dummy) gate structures are typically formed from, for example, amorphous silicon (a-Si) or polysilicon and not from silicon nitride as in this invention.

[0022] FIGS. **3** and **3**A-**3**C show a third intermediate structure **10**C after the selective epitaxial growth (e.g., using VPE or LPE or MBE or any suitable epitaxial growth procedure) of faceted source/drains (S/Ds) **20** over the fins **16** and between the gate nitride structures **18**. It can be noted that the S/Ds **20** are grown without requiring a spacer (e.g., a SiO_2 spacer) to be formed around the dummy gate structures **18** since the dummy gate structures **18** are themselves composed of silicon nitride. The S/Ds **20** can be formed from in-situ doped silicon (e.g., doped with phosphorus (P) for an NFET and doped with boron (B) for a PFET) and masks can be selectively applied and removed so as to deposit the P-type S/Ds followed by the N-type S/Ds (or vice versa). The S/D doping concentration can be about 10^{20} atoms/cm^3 and the dopants can be diffused and activated by the use of a flash (millisecond) anneal (e.g., 1200° C.). The S/Ds **20** can have an exemplary thickness of about 20 nm measured from the top surface of the BOX **14**. Other suitable types of N-type and P-type dopants can be used.

[0023] Note that in some less preferred embodiments the S/Ds **20** could be epitaxially grown from substantially intrinsic silicon and then implanted with suitable P-type and N-type dopants.

[0024] The faceted irregular shape of the S/Ds **20** is largely a result of the crystal orientation preferred epitaxial growth of the silicon. However a non-preferred crystal orientation epitaxy can also be employed to minimize or eliminate the facets.

[0025] The two centrally located replacement gate structures **18** will eventually define two adjacent active transistor devices, while the two replacement gate structures at the far left and the far right are associated with what will be "dummy", non-functional devices.

[0026] FIGS. **4** and **4**A-**4**C show a fourth intermediate structure **10**D after a layer **22** of oxide, e.g., SiO_2, is deposited and planarized down to the top surfaces of the sacrificial replacement gate nitride structures **18**, resulting in a final thickness of the oxide layer **22** being about equal to the height of the replacement gate nitride structures **18** or, in this non-limiting embodiment, about 50 nm. A chemical-mechanical polish (CMP) procedure is one suitable technique to planarize the oxide layer **22**. Note that in FIG. **4** the underlying S/Ds **20** would not actually be visible from the top surface of the structure **10** at this point in the fabrication process as they would be covered by the oxide layer **22**. It can also be noted that at this point the sacrificial replacement gate nitride structures **18** and the S/Ds **20** are embedded in the oxide layer **22**.

[0027] FIGS. **5** and **5**A-**5**C show a fifth intermediate structure **10**E after the dummy gate nitride **18** that was deposited in FIG. **2** is replaced with a gate structure comprised of a gate dielectric (liner) **24** and gate metal **26**. A wet chemical etch using, for example, phosphoric acid (H_3PO_4) can be used to remove the dummy gate nitride **18**. A layer of the gate dielectric **24**, for example a layer of high dielectric constant (high-k) material, is then deposited into the openings followed by the deposition of a selected gate metal or metals **26**. The high-k liner **24** and gate metal **26** is shown more clearly in the partial enlarged view depicted in FIG. **5**A.

[0028] In general the high-k material can comprise a dielectric metal oxide having a dielectric constant that is greater than the dielectric constant of silicon nitride (7.5). The high-k dielectric layer **24** may be formed by methods well known in the art including, for example, chemical vapor deposition (CVD), atomic layer deposition (ALD), molecular beam deposition (MBD), pulsed laser deposition (PLD), liquid source misted chemical deposition (LSMCD), etc. The dielectric metal oxide comprises a metal and oxygen, and optionally nitrogen and/or silicon. Exemplary high-k dielectric materials include HfO_2, ZrO_2, La_2O_3, Al_2O_3, TiO_2, $SrTiO_3$, $LaAlO_3$, Y_2O_3, HfO_xN_y, ZrO_xN_y, $La_2O_xN_y$, $Al_2O_xN_y$, TiO_xN_y, $SrTiO_xN_y$, $LaAlO_xN_y$, $Y_2O_xN_y$, a silicate thereof, and an alloy thereof. Each value of x is independently from 0.5 to 3 and each value of y is independently from 0 to 2. The thickness of the high-k dielectric layer **24** may be from about 1 nm to about 10 nm, and more preferably from about 1.5 nm to about 3 nm. The high-k dielectric layer **24** can have an effective oxide thickness (EOT) on the order of, or less than, about 1 nm. The gate metal **26** can be deposited directly on the surface of the high-k dielectric layer **24** by, for example, chemical vapor deposition (CVD), physical vapor deposition (PVD), or atomic layer deposition (ALD). As non-limiting examples the gate metal **26** can include a metal system selected from one or more of TiN, TiC, TaN, TaC, TaSiN, HfN, W, Al and Ru.

[0029] FIG. **6** and FIGS. **6**A-**6**C show a sixth intermediate structure **10**F after it is covered with an insulator layer **28**, such as a middle-of-line (MOL) insulator such as SiO_2. A thickness of the insulator layer **28** may be, for example, about 20 nm.

[0030] FIG. **7** and FIGS. **7**A-**7**C show a seventh intermediate structure **10**G after patterning and etching S/D contact apertures or holes (trenches) **30** between and parallel to the gate structures. The etch can be a multi-step etch that first etches the oxide layers **28** and **22** and that then etches an underlying portion of the silicon of the S/Ds **20** down to the top surface of the BOX **14**. The width of the S/D contact openings **30** can be, for example, about 10 nm assuming as a non-limiting example a gate pitch of about 45 nm and a gate width of about 15 nm.

[0031] FIG. **8** and FIGS. **8**A-**8**C show an eighth intermediate structure **10**H after deposition of a S/D contact hole liner **32**, such as titanium (Ti) or TiN, and a S/D contact **34**, such as tungsten (W). Assuming an aspect ratio of about 1:5 for the S/D contact openings **30** the openings are readily fillable by TiN and W. The S/D contacts can be deposited by, for example, chemical vapor deposition (CVD) or by atomic layer deposition (ALD).

[0032] Note at this point that the gate structures and the S/D contacts are substantially embedded in the oxide layer **22**.

[0033] Processing can continue to form gate contacts where needed.

[0034] As can be seen in FIG. **8** there are three functional S/D contacts formed labeled as 1, 2 and 3. Between S/D contacts 1 and 2 is a first multi-fin FET and between S/D contacts 2 and 3 is a second multi-fin FET. The S/D contact 2 is thus common to both multi-fin FETs. As but one example the S/Ds **20** underlying the S/D contact 1 can function as a drain for the first multi-fin FET and are biased during operation via the S/D contact 1 to some positive or negative potential, the S/Ds **20** underlying the S/D contact 2 can function as a common source for both the first and second multi-fin FETs and are biased during operation to some common potential (e.g., circuit ground) via the S/D contact 2, and the S/Ds **20** underlying the S/D contact 3 can function as a drain for the second multi-fin FET and are biased during operation via the S/D contact 2 to some positive or negative potential (which could be the same potential applied to the S/D contact 1).

[0035] In FIG. **8**A it can be seen that the S/D contact area (X) is independent of gate pitch since it is vertical and depends only on the height of the fin **16** versus the typical dimension (Y) that does depend on gate pitch. The increased contact area that is made possible serves to reduce the associated resistance between the fin **16** and the S/Ds **20**.

[0036] Further, there is a low value of parasitic capacitance between the gate **26** and the S/D contact **34** since the intervening material is an oxide, e.g., SiO_2 having a dielectric constant of 3.9, as opposed to a conventional nitride gate spacer having a larger dielectric constant value. The use of these embodiments thus eliminates the need to form a conventional spacer on the fin **16** which can be a difficult process to perform reliably and uniformly. As a result the structure and process can be characterized as being a "spacerless" structure and process.

[0037] Further, the use of this process eliminates the troublesome epitaxial "mouse ear" that can occur due to epitaxial silicon grown on a conventional polysilicon dummy gate structure during S/D formation. This is avoided because the conventional polysilicon dummy gate structure is replaced by the silicon nitride dummy gate structure **18**.

[0038] Assuming by example the value of 45 nm for the gate pitch, the gate width of 15 nm and the width of the contact **34** of 10 nm, the misalignment margin is about 10 nm on each side, a value significantly greater than typical modern tool misalignment specifications.

[0039] It is pointed out that certain aspects and embodiments of this invention can be employed with other than SOI substrates, such as with bulk substrates.

[0040] It is to be understood that although the exemplary embodiments discussed above with reference to FIGS. **1-8** can be used on common variants of the FET device including, e.g., FET devices with multi-fingered FIN and/or gate structures and FET devices of varying gate width and length, and can also be used with nanowire type devices.

[0041] Integrated circuit dies can be fabricated with various devices such as a field-effect transistors, bipolar transistors, metal-oxide-semiconductor transistors, diodes, resistors, capacitors, inductors, etc., having contacts that are formed using methods as described herein. An integrated circuit in accordance with the present invention can be employed in applications, hardware, and/or electronic systems. Suitable hardware and systems in which such integrated circuits can be incorporated include, but are not limited to, personal computers, communication networks, electronic commerce systems, portable communications devices (e.g., cell phones), solid-state media storage devices, functional circuitry, etc. Systems and hardware incorporating such integrated circuits are considered part of this invention. Given the teachings of the invention provided herein, one of ordinary skill in the art will be able to contemplate other implementations and applications of the techniques of the invention.

[0042] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

[0043] The corresponding structures, materials, acts, and equivalents of all means or step plus function elements in the claims below are intended to include any structure, material, or act for performing the function in combination with other claimed elements as specifically claimed. The description of the present invention has been presented for purposes of illustration and description, but is not intended to be exhaustive or limited to the invention in the form disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art without departing from the scope and spirit of the invention. The embodiment was chosen and described in order to best explain the principles of the invention and the practical application, and to enable others of ordinary skill in the art to understand the invention for various embodiments with various modifications as are suited to the particular use contemplated.

[0044] As such, various modifications and adaptations may become apparent to those skilled in the relevant arts in view of the foregoing description, when read in conjunction with the accompanying drawings and the appended claims. As but some examples, the use of other similar or equivalent semiconductor fabrication processes, including deposition processes, etching processes maybe used by those skilled in the art. Further, the exemplary embodiments are not intended to be limited to only those materials, metals, insulators, dopants, dopant concentrations, layer thicknesses and the like that were specifically disclosed above. Any and all such and similar modifications of the teachings of this invention will still fall within the scope of this invention.

What is claimed is:

1. A structure, comprising:

a substrate comprised of an insulator layer having a plurality of elongated semiconductor fin structures disposed on a surface of the insulator layer, the fin structures being disposed substantially parallel to one another;

a plurality of elongated sacrificial gate structures each comprised of silicon nitride, the sacrificial gate structures being disposed substantially parallel to one another and orthogonal to the plurality of fin structures, where a portion of each of a plurality of adjacent fin structures is embedded within one of the sacrificial gate structures leaving other portions exposed between the sacrificial gate structures; and

a plurality of semiconductor source/drain (S/D) structures disposed over the exposed portions of the fin structures between the sacrificial gate structures.

2. The structure as in claim **1**, further comprising a layer of oxide disposed over the S/D structures.

3. The structure as in claim **2**, where the layer of oxide is comprised of SiO_2.

4. The structure as in claim **1**, where said plurality of semiconductor source/drain (S/D) structures are comprised of in-situ doped silicon.

5. A structure, comprising:

a substrate comprised of an insulator layer having a plurality of elongated semiconductor fin structures disposed on a surface of the insulator layer, the fin structures being disposed substantially parallel to one another;

a plurality of elongated gate structures each comprised of gate dielectric and gate metal, the gate structures being disposed substantially parallel to one another and orthogonal to the plurality of fin structures, where a portion of each of a plurality of adjacent fin structures is embedded within one of the gate structures leaving other portions exposed between the gate structures;

a plurality of semiconductor source/drain (S/D) structures over the exposed portions of the fin structures between the gate structures;

a layer of oxide over the S/D structures and between the elongated gate structures, where the elongated gate structures are embedded in the layer of oxide; and

a plurality of elongated S/D contacts disposed between and parallel to the elongated gate structures, where the S/D contacts are embedded in the layer of oxide and extend through the layer of oxide and through an underlying portion of the S/D structures to the surface of the insulator layer, where

a portion of the layer of oxide is disposed between a S/D contact and an adjacent gate structure.

6. The structure as in claim **5**, where the layer of oxide is comprised of SiO_2.

7. The structure as in claim **5**, where the S/D structures are comprised of in-situ doped silicon.

8. The structure as in claim **5**, where the gate dielectric is a comprised of a high dielectric constant (high-k) material.

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