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(54) **PHOTORESIST ETCH BACK METHOD FOR GATE LAST PROCESS**

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12, 2008, provisional application No. 61/109,317,
filed on Oct. 29, 2008.

(51) **Int. Cl.**
**H01L 21/4763** (2006.01)
**H01L 21/3205** (2006.01)
(52) **U.S. Cl.** ................ **438/595**; 438/183; 257/E21.626;
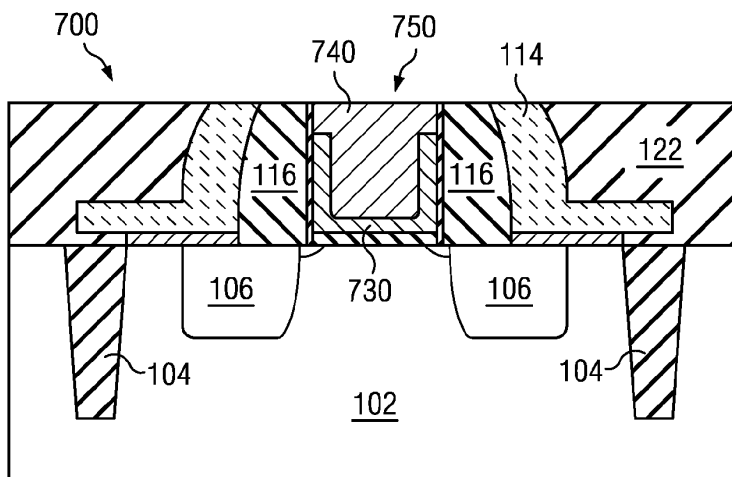257/E21.64
(58) **Field of Classification Search** .................. 438/703,
438/757, 595, 785, 183; 216/108, 109;
257/E21.626, E21.64, E21.593, E21.636,
257/E21.522, E21.635, E21.621
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

| | | | | |
|---|---|---|---|---|
| 5,895,261 | A * | 4/1999 | Schinella et al. | ............. 438/586 |
| 6,376,888 | B1 * | 4/2002 | Tsunashima et al. | ......... 257/407 |
| 6,861,350 | B1 | 3/2005 | Ngo et al. | |
| 7,745,889 | B2 * | 6/2010 | Lin et al. | ........................ 257/412 |
| 2003/0227092 | A1 * | 12/2003 | Liu et al. | ........................ 257/774 |
| 2006/0035425 | A1 * | 2/2006 | Carter et al. | .................. 438/199 |
| 2006/0051880 | A1 | 3/2006 | Doczy et al. | |
| 2006/0166447 | A1 * | 7/2006 | Doczy et al. | .................. 438/287 |
| 2007/0262451 | A1 * | 11/2007 | Rachmady et al. | ........... 257/758 |
| 2008/0179714 | A1 * | 7/2008 | Chou et al. | ..................... 257/635 |
| 2009/0142899 | A1 * | 6/2009 | Jensen et al. | .................. 438/287 |
| 2009/0280631 | A1 * | 11/2009 | Gambino et al. | ............. 438/588 |
| 2010/0140717 | A1 * | 6/2010 | Lavoie et al. | ................. 257/369 |

FOREIGN PATENT DOCUMENTS

| JP | 2001267561 | 9/2001 |
|---|---|---|

OTHER PUBLICATIONS

Chinese Patent Office, Office Action dated Mar. 29, 2011, Application No. 200910169144.9, 9 pages.

* cited by examiner

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(57) **ABSTRACT**

A method is provided for fabricating a semiconductor device. The method includes providing a substrate including a dummy gate structure formed thereon, removing the dummy gate structure to form a trench, forming a first metal layer over the substrate to fill a portion of the trench, forming a protection layer in a remaining portion of the trench, removing a unprotected portion of the first metal layer, removing the protection layer from the trench, and forming a second metal layer over the substrate to fill the trench.

**14 Claims, 7 Drawing Sheets**

100

120
122
114
117
116     116
118
112    106    108    110    108    106    112
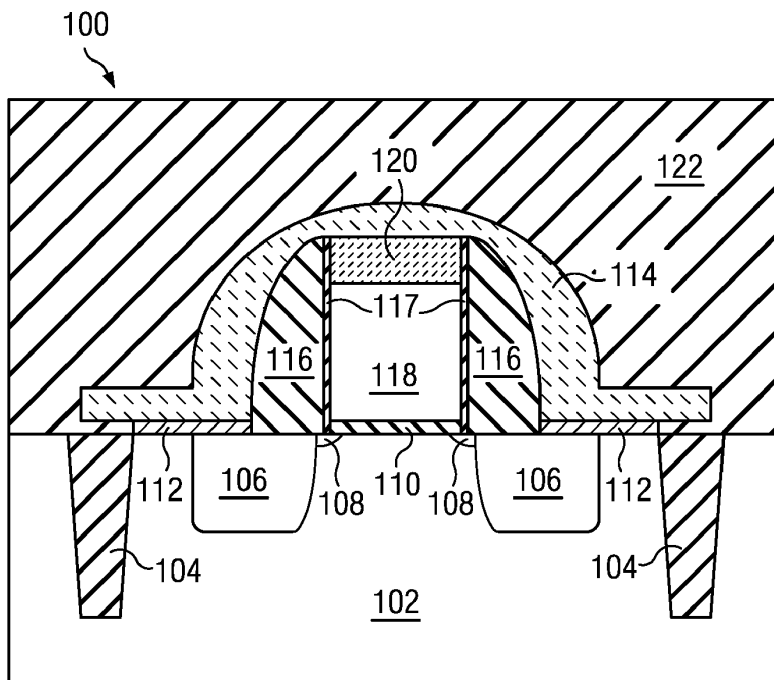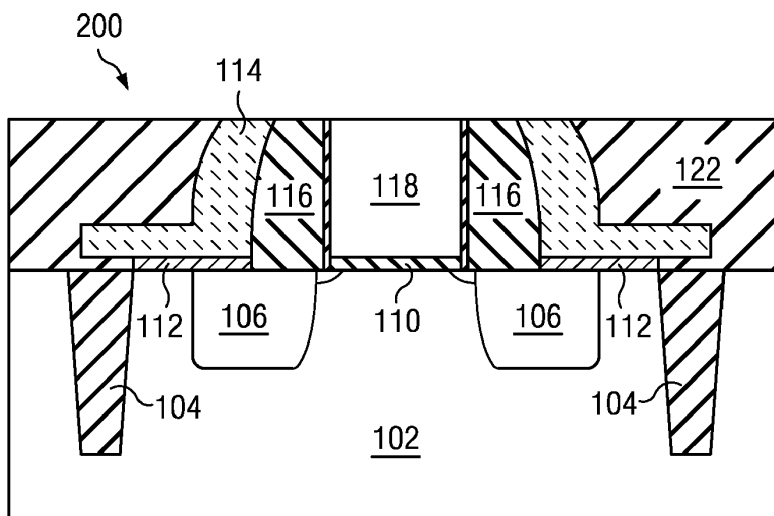104    104
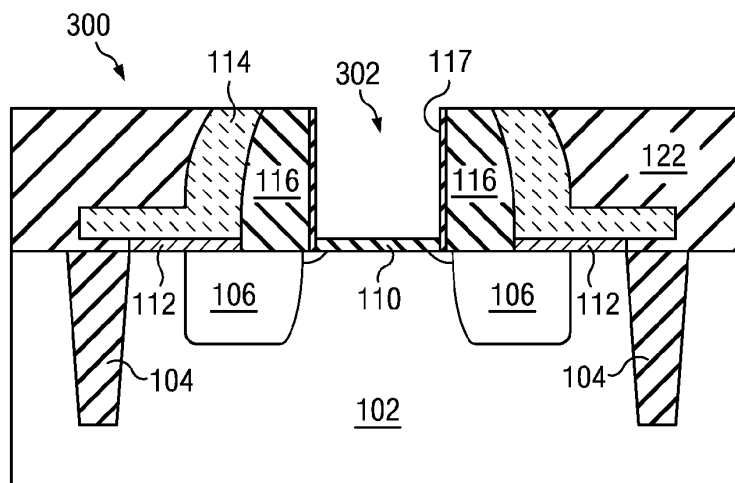102

*Fig. 1*

200

114

116    118    116
122
112    106    110    106    112
104    104
102

*Fig. 2*

Fig. 3



Fig. 4

*Fig. 5*



600

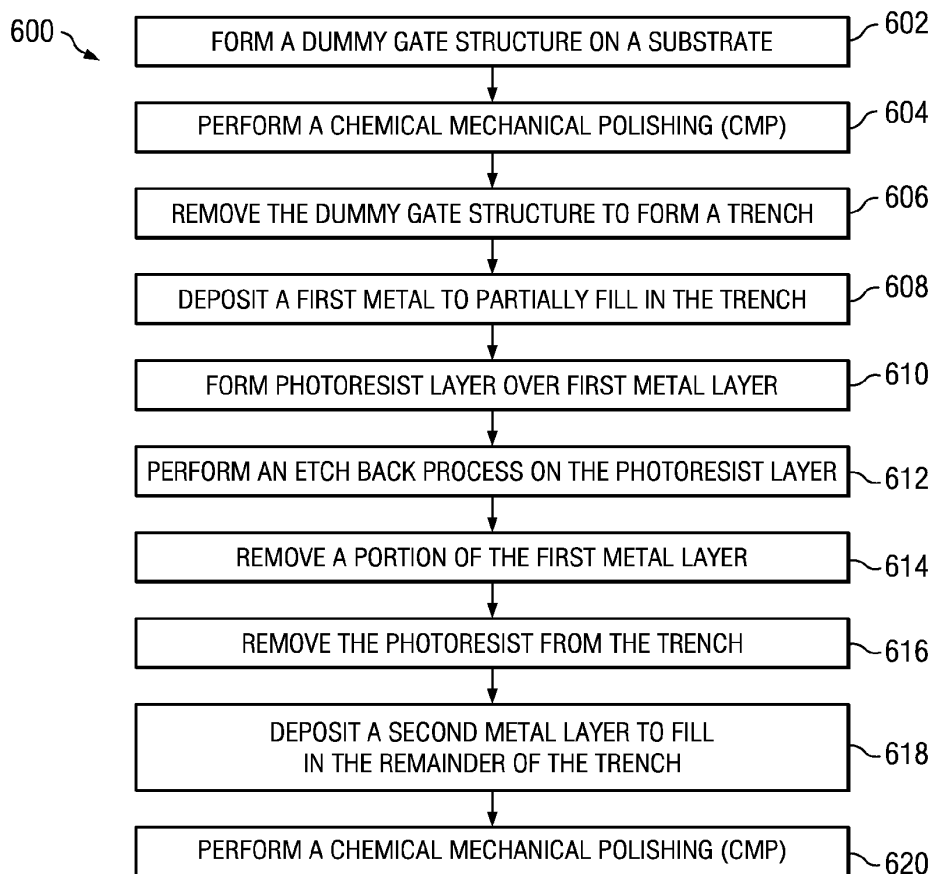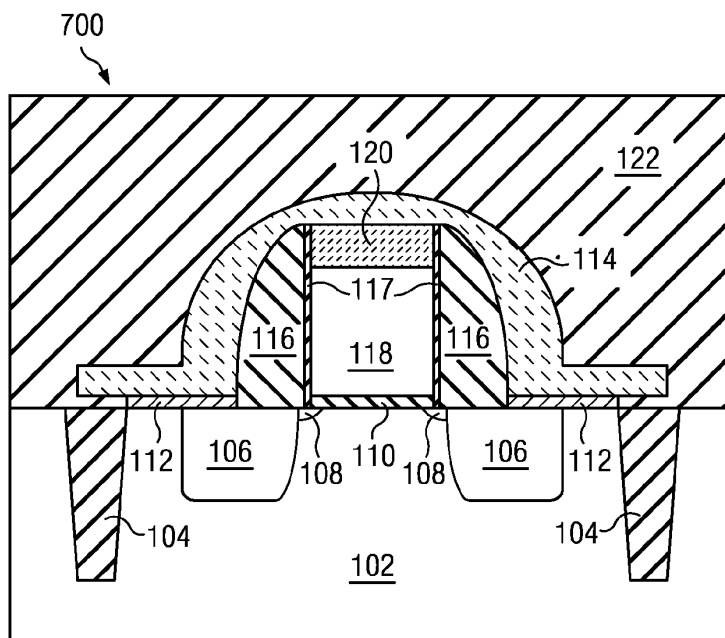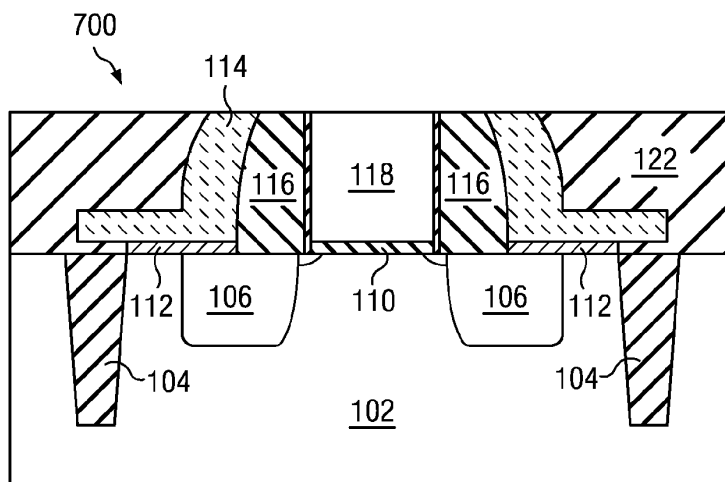| | |
|---|---|
| FORM A DUMMY GATE STRUCTURE ON A SUBSTRATE | 602 |
| PERFORM A CHEMICAL MECHANICAL POLISHING (CMP) | 604 |
| REMOVE THE DUMMY GATE STRUCTURE TO FORM A TRENCH | 606 |
| DEPOSIT A FIRST METAL TO PARTIALLY FILL IN THE TRENCH | 608 |
| FORM PHOTORESIST LAYER OVER FIRST METAL LAYER | 610 |
| PERFORM AN ETCH BACK PROCESS ON THE PHOTORESIST LAYER | 612 |
| REMOVE A PORTION OF THE FIRST METAL LAYER | 614 |
| REMOVE THE PHOTORESIST FROM THE TRENCH | 616 |
| DEPOSIT A SECOND METAL LAYER TO FILL IN THE REMAINDER OF THE TRENCH | 618 |
| PERFORM A CHEMICAL MECHANICAL POLISHING (CMP) | 620 |

*Fig. 6*

Fig. 7



Fig. 8

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