

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
12 July 2007 (12.07.2007)

PCT

(10) International Publication Number
WO 2007/078957 A3

(51) International Patent Classification:
H01L 21/336 (2006.01) *H01L 29/786* (2006.01)

(74) Agents: VINCENT, Lester, J. et al.; BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP, 12400 Wilshire Boulevard, 7th Floor, Los Angeles, California 90025 (US).

(21) International Application Number:
PCT/US2006/048554

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(22) International Filing Date:
18 December 2006 (18.12.2006)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
11/322,795 29 December 2005 (29.12.2005) US

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

(71) Applicant (for all designated States except US): INTEL CORPORATION [US/US]; 2200 Mission College Boulevard, Santa Clara, CA 95052 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): DOYLE, Brian, S. [IR/US]; 11156 NW Montreux Lane, Portland, OR 97229 (US). BRASK, Justin, K. [CA/US]; 12748 NW Bayonne Lane, Portland, OR 97229 (US). MAJUMDAR, Amlan [IN/US]; 222 SW Harrison Street, Apt. 21G, Portland, OR 97201 (US). DATTA, Suman [IN/US]; 16659 NW Talkingstick Way, Beaverton, OR 97006 (US). KAVALIEROS, Jack [US/US]; 14260 NW Belle Court, Portland, OR 97229 (US). RADOSAVLJEVIC, Marko [US/US]; 4129 NW Chapparral Terrace, Beaverton, OR 97006 (US). CHAU, Robert, S. [US/US]; 8875 SW 171st Avenue, Beaverton, OR 97007 (US).

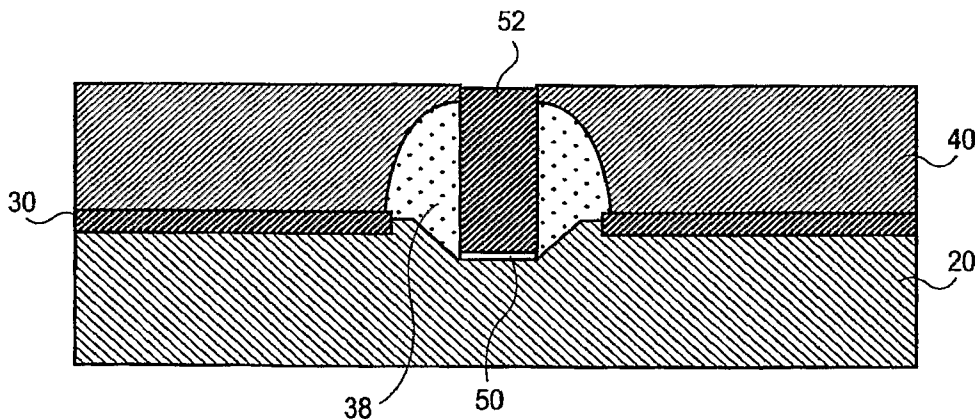
Published:

- with international search report
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

(88) Date of publication of the international search report:
30 August 2007

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: METHOD AND STRUCTURE FOR REDUCING THE EXTERNAL RESISTANCE OF A THREE-DIMENSIONAL TRANSISTOR THROUGH USE OF EPITAXIAL LAYERS



(57) Abstract: The fabrication of a tri-gate transistor formed with a replacement gate process is described. A nitride dummy gate, in one embodiment, is used allowing the growth of epitaxial source and drain regions immediately adjacent to the dummy gate. This reduces the external resistance.



WO 2007/078957 A3

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2006/048554

A. CLASSIFICATION OF SUBJECT MATTER INV. H01L21/336 H01L29/786		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) H01L		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2005/020020 A1 (COLLAERT NADINE [BE] ET AL) 27 January 2005 (2005-01-27) paragraph [0039] - paragraph [0062]	1, 2, 4-8, 14-20
X	US 2005/148137 A1 (BRASK JUSTIN K [US] ET AL) 7 July 2005 (2005-07-07) paragraph [0058] - paragraph [0080]; figures 6A-0	18-20
Y	US 2005/153485 A1 (AHMED SHIBLY S [US] ET AL) 14 July 2005 (2005-07-14) paragraph [0028] - paragraph [0035]	1-20
Y	US 6 686 231 B1 (AHMED SHIBLY S [US] ET AL) 3 February 2004 (2004-02-03) column 6, line 32 - line 50	1-20
	-/--	
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C.		<input checked="" type="checkbox"/> See patent family annex.
* Special categories of cited documents :		
"A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed		"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family
Date of the actual completion of the international search <p align="center">20 June 2007</p>		Date of mailing of the international search report <p align="center">26/06/2007</p>
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2260 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016		Authorized officer <p align="center">Hoffmann, Niels</p>

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2006/048554

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2004/132237 A1 (KANEMOTO KEI [JP]) 8 July 2004 (2004-07-08) paragraph [0034] - paragraph [0057] -----	1,2,5-7, 14,15, 18-20
A	ROSNER W ET AL: "Nanoscale finFETs for low power applications" SEMICONDUCTOR DEVICE RESEARCH SYMPOSIUM, 2003 INTERNATIONAL DEC. 10-12, 2003, PISCATAWAY, NJ, USA, IEEE, 10 December 2003 (2003-12-10), pages 452-453, XP010686761 ISBN: 0-7803-8139-4 the whole document -----	1-20
A	US 6 967 175 B1 (AHMED SHIBLY S [US] ET AL) 22 November 2005 (2005-11-22) column 3, line 41 - column 7, line 58 -----	1-20
A	US 6 764 884 B1 (YU BIN [US] ET AL) 20 July 2004 (2004-07-20) column 3, line 33 - column 6, line 56 -----	1-20
A	YANG-KYU CHOI ET AL: "Sub-20nm CMOS FinFET technologies" INTERNATIONAL ELECTRON DEVICES MEETING 2001. IEDM. TECHNICAL DIGEST. WASHINGTON, DC, DEC. 2 - 5, 2001, NEW YORK, NY : IEEE, US, 2 December 2001 (2001-12-02), pages 1911-1914, XP010575157 ISBN: 0-7803-7050-3 the whole document -----	1-20
A	VERHEYEN P ET AL: "25% DRIVE CURRENT IMPROVEMENT FOR P-TYPE MULTIPLE GATE FET (MUGFET) DEVICES BY THE INTRODUCTION OF RECESSED SiO ₂ IN THE SOURCE AND DRAIN REGIONS" VLSI TECHNOLOGY, 2005. DIGEST OF TECHNICAL PAPERS. 2005 SYMPOSIUM ON KYOTO, JAPAN JUNE 14-16, 2005, PISCATAWAY, NJ, USA, IEEE, 14 June 2005 (2005-06-14), pages 194-195, XP001240795 ISBN: 4-900784-00-1 the whole document -----	1-20

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2006/048554

Patent document cited in search report	A1	Publication date	Patent family member(s)	Publication date
US 2005020020	A1	27-01-2005	NONE	
US 2005148137	A1	07-07-2005	US 2005156171	A1 21-07-2005
US 2005153485	A1	14-07-2005	CN 1902741 A GB 2426124 A KR 20060123480 A WO 2005071727 A1	24-01-2007 15-11-2006 01-12-2006 04-08-2005
US 6686231	B1	03-02-2004	AU 2003286831 A1 WO 2004053963 A1 US 2004110097 A1	30-06-2004 24-06-2004 10-06-2004
US 2004132237	A1	08-07-2004	JP 3654285 B2 JP 2004128314 A	02-06-2005 22-04-2004
US 6967175	B1	22-11-2005	NONE	
US 6764884	B1	20-07-2004	CN 1771589 A DE 112004000578 T5 GB 2417134 A JP 2006522486 T KR 20050119679 A WO 2004093181 A1	10-05-2006 23-02-2006 15-02-2006 28-09-2006 21-12-2005 28-10-2004