(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
24 January 2002 (24.01.2002)

PCT

(10) International Publication Number
WO 02/07201 A3

(51) International Patent Classification[7]: H01L 21/3065, 21/336, 29/78

(21) International Application Number: PCT/US01/22456

(22) International Filing Date: 17 July 2001 (17.07.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09/617,356 17 July 2000 (17.07.2000) US

(71) Applicant: GENERAL SEMICONDUCTOR, INC. [US/US]; 10 Melville Park Road, Melville, NY 11747-3113 (US).

(72) Inventors: HSHIEH, Fwu-Iuan; 20768 Sevilla Lane, Saratoga, CA 95070 (US). SO, Koon, Chong; 591 Woodview Terrace, Fremont, CA 94539 (US). TSUI, Yan, Man; 4409 Drywood Court, Union City, CA 94587 (US).

(74) Agent: MAYER, Stuart, H.; Mayer Fortkort & Williams, PC, 251 North Avenue West, 2nd Floor, Westfield, NJ 07090 (US).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.

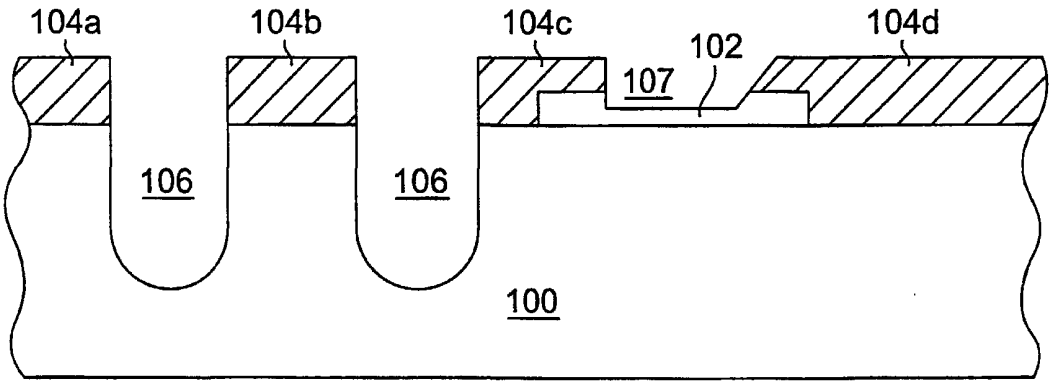
(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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:
18 April 2002

[Continued on next page]

(54) Title: METHOD FOR ETCHING TRENCHES FOR THE FABRICATION OF SEMICONDUCTOR DEVICES



(57) Abstract: In a first aspect of the invention, a modified semiconductor substrate is provided. The modified substrate comprises: 1) a semiconductor substrate; 2) at least one buffer layer provided over at least a portion of the substrate; and 3) a plurality of trenches comprising: a) a plurality of internal trenches that extend into the semiconductor substrate and b) at least one shallow peripheral trench that extends into the at least one buffer layer but does not extend into the semiconductor substrate. In another aspect, a method of selectively providing trenches in a semiconductor substrate is provided. According to a further aspect of the invention, a trench DMOS transistor structure that includes at least one peripheral trench and a plurality of internal trenches is provided. The structure comprises: 1) a substrate of a first conductivity type; 2) a body region on the substrate having a second conductivity type, wherein the peripheral and internal trenches extend through the body region; 3) an insulating layer that lines each of the peripheral and internal trenches; 4) a first conductive electrode overlying each insulting layer; and 5) source regions of the first conductivity type in the body region adjacent to the each internal trench, but not adjacent to the at least one peripheral trench.

WO 02/07201 A3

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.

INTERNATIONAL SEARCH REPORT

' -national Application No
PCT/US 01/22456

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01L21/3065 H01L21/336 H01L29/78

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 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, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 420 489 A (AMERICAN TELEPHONE & TELEGRAPH) 3 April 1991 (1991-04-03) abstract ---	1-28
A	MACK C A: "EVALUATING PROXIMITY EFFECTS USING 3-D OPTICAL LITHOGRAPHY SIMULATION THIS TOOL WILL IMPROVE THE MATCH OF RESIST IMAGE TO TARGET DEVICE PATTERN" SEMICONDUCTOR INTERNATIONAL, NEWTON, MAS, IL, US, vol. 19, no. 8, July 1996 (1996-07), pages 237-238,240,242, XP001052677 ISSN: 0163-3767 cited in the application the whole document --- -/--	1-28

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in 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	Date of mailing of the international search report
8 February 2002	18/02/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Le Meur, M-A

1

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

national Application No
PCT/US 01/22456

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 1998, no. 12, 31 October 1998 (1998-10-31) & JP 10 199859 A (HITACHI LTD), 31 July 1998 (1998-07-31) abstract	1-28
A	US 6 063 669 A (TAKAISHI YOSHIHIRO) 16 May 2000 (2000-05-16) figures 5C,5D,5E	12
X	US 6 031 265 A (HSHIEH FWU-IUAN) 29 February 2000 (2000-02-29) figures 4A-4H	22-28
X	US 5 877 528 A (SO KOON CHONG) 2 March 1999 (1999-03-02) figures 4A-4E	22-28
X	EP 0 726 603 A (SILICONIX INC) 14 August 1996 (1996-08-14) column 9, line 35 - line 48	22-28
A	EP 0 580 213 A (SILICONIX INC) 26 January 1994 (1994-01-26) column 6, line 2 - line 7; figures 5A-5J	22-28
A	US 5 981 999 A (LIU CHUNG-MIN ET AL) 9 November 1999 (1999-11-09) figure 5	22-28
A	US 5 864 159 A (TAKAHASHI HIDEKI) 26 January 1999 (1999-01-26) figure 23	22-28

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

national Application No
PCT/US 01/22456

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0420489 A	03-04-1991	US 5057462 A	15-10-1991
		DE 69031856 D1	05-02-1998
		DE 69031856 T2	16-04-1998
		EP 0420489 A2	03-04-1991
		ES 2110412 T3	16-02-1998
		JP 2065920 C	24-06-1996
		JP 3170929 A	24-07-1991
		JP 7099431 B	25-10-1995
JP 10199859 A	31-07-1998	NONE	
US 6063669 A	16-05-2000	JP 2751909 B2	18-05-1998
		JP 9232535 A	05-09-1997
		KR 230023 B1	15-11-1999
US 6031265 A	29-02-2000	NONE	
US 5877528 A	02-03-1999	TW 392306 B	01-06-2000
EP 0726603 A	14-08-1996	DE 69602114 D1	27-05-1999
		DE 69602114 T2	19-08-1999
		EP 0726603 A2	14-08-1996
		US 5917216 A	29-06-1999
EP 0580213 A	26-01-1994	US 5430324 A	04-07-1995
		DE 580213 T1	08-12-1994
		EP 0580213 A1	26-01-1994
		JP 6204483 A	22-07-1994
		KR 185677 B1	20-03-1999
		US 5605852 A	25-02-1997
US 5981999 A	09-11-1999	NONE	
US 5864159 A	26-01-1999	JP 8167711 A	25-06-1996
		DE 69510020 D1	08-07-1999
		DE 69510020 T2	02-03-2000
		EP 0717450 A2	19-06-1996
		EP 0881692 A2	02-12-1998