



(43) International Publication Date
28 June 2012 (28.06.2012)

(10) International Publication Number
WO 2012/087581 A2

(51) International Patent Classification:
H01L 29/78 (2006.01) *H01L 21/336* (2006.01)

(21) International Application Number:
PCT/US2011/063813

(22) International Filing Date:
7 December 2011 (07.12.2011)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
12/975,278 21 December 2010 (21.12.2010) US

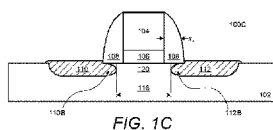
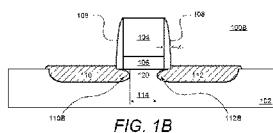
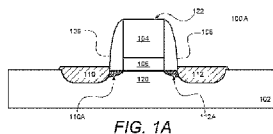
(71) Applicant (for all designated States except US): **INTEL CORPORATION** [US/US]; 2200 Mission College Boulevard, Santa Clara, California 95052 (US).

(72) Inventors; and
(75) Inventors/Applicants (for US only): **MURTHY, Anand S.** [US/US]; 10934 NW Lucerne Ct., Portland, Oregon 97229 (US). **GLASS, Glenn A.** [US/US]; 6220 SW Madhatter Ln., Beaverton, Oregon 97008 (US). **GHANI, Tahir** [US/US]; 2501 NW 229th Avenue, Hillsboro, Oregon 97124 (US). **PILLARISETTY, Ravi** [US/US]; 1330 SW 3rd Ave., Apt. 1103, Portland, Oregon 97201 (US). **MUKHERJEE, Niloy** [IN/US]; 7732 SW Carrollon Drive, Beaverton, Oregon 97007 (US). **KAVALIEROS, Jack T.** [US/US]; 3734 NW Bronson Crest Loop, Portland, Oregon 97229 (US). **KOTLYAR, Roza** [US/US]; 1167 SW Chestnut Drive, Portland, Oregon 97219 (US). **RACHMADY, Willy** [US/US]; 10945 SW Nutcracker Ct., Beaverton, Oregon 97007 (US). **LIU, Mark Y.** [US/US]; 14214 NW Tradewinds Street, Portland, Oregon 97007 (US).

(74) Agents: **MALONEY, Neil F.** et al.; Finch & Maloney PLLC, c/o CPA GLOBAL, P.O. Box 52050, Minneapolis, Minnesota 55402 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, 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, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(54) Title: TRANSISTORS WITH HIGH CONCENTRATION OF BORON DOPED GERMANIUM



(57) Abstract: Techniques are disclosed for forming transistor devices having source and drain regions with high concentrations of boron doped germanium. In some embodiments, an in situ boron doped germanium, or alternatively, boron doped silicon germanium capped with a heavily boron doped germanium layer, are provided using selective epitaxial deposition in the source and drain regions and their corresponding tip regions. In some such cases, germanium concentration can be, for example, in excess of 50 atomic % and up to 100 atomic %, and the boron concentration can be, for instance, in excess of $1 \times 10^{20} \text{ cm}^{-3}$. A buffer providing graded germanium and/or boron concentrations can be used to better interface disparate layers. The concentration of boron doped in the germanium at the epi-metal interface effectively lowers parasitic resistance without degrading tip abruptness. The techniques can be embodied, for instance, in planar or non-planar transistor devices.



WO 2012/087581 A2



(84) **Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*