

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

(19) World Intellectual Property
Organization
International Bureau

(43) International Publication Date
06 June 2024 (06.06.2024)



(10) International Publication Number
WO 2024/118963 A1

(51) International Patent Classification:

H10B 41/50 (2023.01) H10B 43/10 (2023.01)
H10B 43/50 (2023.01) H10B 41/27 (2023.01)
H10B 41/10 (2023.01) H10B 43/27 (2023.01)

(21) International Application Number:

PCT/US2023/081902

(22) International Filing Date:

30 November 2023 (30.11.2023)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

63/429,856 02 December 2022 (02.12.2022) US

(71) Applicant: **APPLIED MATERIALS, INC.** [US/US];
3050 Bowers Avenue, Santa Clara, California 95054 (US).

(72) Inventors: **LEE, HsiangYu**; c/o Applied Materials, Inc.,
3050 Bowers Avenue, Santa Clara, California 95054 (US).
SUBRAHMANYAN, Pradeep; c/o Applied Materials,
Inc., 3050 Bowers Avenue, Santa Clara, California 95054

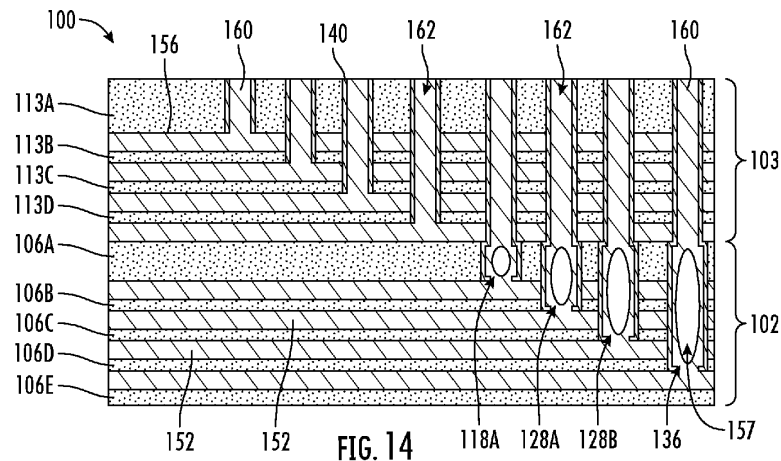
(US). **SUN, Changwoo**; c/o Applied Materials, Inc., 3050
Bowers Avenue, Santa Clara, California 95054 (US).

(74) Agent: **CHAMBERLAIN, Jeffrey M.**; KDW Firm PLLC,
2601 Weston Parkway, Suite 103, Cary, North Carolina
27513 (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, BN, BR, BW, BY, BZ,
CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM,
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG,
KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY,
MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA,
NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO,
RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH,
TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS,
ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, CV,
GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST,
SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ,

(54) Title: WORDLINE CONTACT FORMATION FOR NAND DEVICE



(57) Abstract: Disclosed are approaches for direct wordline contact formation for 3D NAND devices. One method may include providing a first film stack comprising a first plurality of alternating first layers and second layers, and forming a first plurality of contact openings in the first film stack, wherein each contact opening is formed to a different etch depth. The method may further include forming a sacrificial gapfill within the first plurality of contact openings, and forming a second film stack atop the first film stack, wherein the second film stack comprises a second plurality of alternating first layers and second layers. The method may further include forming a second plurality of contact openings in the second film stack, wherein a first set of contact openings of the second plurality of contact openings extends to the sacrificial gapfill, and removing the sacrificial gapfill from the first plurality of contact openings.

[Continued on next page]

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, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*