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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
27 January 2022 (27.01.2022)

WIPO | PCT

(10) International Publication Number
WO 2022/020195 A1

(51) International Patent Classification:
H01L 21/02 (2006.01) *C23C 16/455* (2006.01)
C23C 16/34 (2006.01)

(21) International Application Number:
PCT/US2021/041950

(22) International Filing Date:
16 July 2021 (16.07.2021)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
16/935,423 22 July 2020 (22.07.2020) US

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

(72) Inventors: **VATS, Vinayak, Veer**; 3050 Bowers Avenue, Santa Clara, CA 95054 (US). **AHN, Byung Kook**; 3050 Bowers Avenue, Santa Clara, CA 95054 (US). **LEE, SeoYoung**; 3050 Bowers Avenue, Santa Clara, CA 95054 (US). **YU, Hang**; 3050 Bowers Avenue, Santa Clara, CA 95054 (US).

(74) Agent: **MCCORMICK, Daniel, K.**; 1100 Peachtree Street NE, Suite 2800, Mailstop: IP Docketing - 22, Atlanta, GA 30309 (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, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, IT, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, 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, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, 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, KM, ML, MR, NE, SN, TD, TG).

(54) Title: MULTI-LAYER DEPOSITION AND TREATMENT OF SILICON NITRIDE FILMS

(57) Abstract: Exemplary processing methods may include forming a first deposition plasma of a silicon-and-nitrogen-containing precursor. The methods may include depositing a first portion of a silicon nitride material on a semiconductor substrate with the first deposition plasma. A first treatment plasma of a helium-and-nitrogen-containing precursor may be formed to treat the first portion of the silicon nitride material with the first treatment plasma. A second deposition plasma may deposit a second portion of a silicon nitride material, and a second treatment plasma may treat the second portion of the silicon nitride material. A flow rate ratio of helium-to-nitrogen in the first treatment plasma may be lower than a He/N_2 flow rate ratio in the second treatment plasma. A first power level from a plasma power source that forms the first treatment plasma may be lower than a second power level that forms the second treatment plasma.

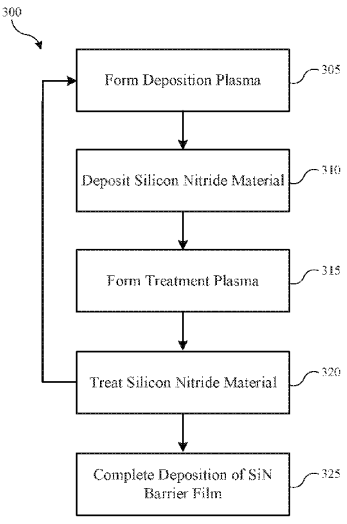


FIG. 3

WO 2022/020195 A1

[Continued on next page]

Published:
— *with international search report (Art. 21(3))*