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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
21 July 2022 (21.07.2022)

WIPO | PCT

(10) International Publication Number
WO 2022/155580 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/US2022/012700

(22) International Filing Date:
18 January 2022 (18.01.2022)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
17/151,240 18 January 2021 (18.01.2021) US

(71) Applicants: **APPLIED MATERIALS, INC.** [US/US]; 3050 Bowers Avenue, Santa Clara, California 95054 (US). **NATIONAL UNIVERSITY OF SINGAPORE** [SG/SG]; 21 Lower Kent Ridge Road, Singapore 119077 (SG).

(72) Inventors: **BARIK, Chandan Kr**; Applied Materials Singapore Technology Pte Ltd, 10 Science Park Road, #02-03, The Alpha Science Park II, Singapore 117684 (SG). **HAVERTY, Michael**; Applied Materials, Inc., 3050 Bowers Avenue, Santa Clara, California 95054 (US). **KALIAPPAN, Muthukumar**; Applied Materials, Inc., 3050 Bowers Avenue, Santa Clara, California 95054 (US). **TRINH, Cong**; Applied Materials, Inc., 3050 Bowers Avenue, Santa Clara, California 95054 (US). **BHUYAN, Bhaskar Jyoti**; Applied Materials, Inc., 3050 Bowers Avenue, Santa Clara, California 95054 (US). **SUDIJONO, John**; Applied Materials Singapore Technology Pte Ltd, 10 Science Park Road, #02-03, The Alpha Science Park II, Singapore 117684 (SG). **TUMMANAPELLI, Anil Kumar**; National University of Singapore, 21 Lower Kent Ridge Road, Singapore 119077 (SG). **WONG, Richard Ming Wah**; National University of Singapore, 21 Lower Kent Ridge Road, Singapore 119077 (SG). **CHEN, Yingqian**; National University of Singapore, 21 Lower Kent Ridge Road, Singapore 119077 (SG).

(74) Agent: **SMIRK, Rebecca A.**; Servilla Whitney LLC, 33 Wood Avenue South, Suite 830, Iselin, New Jersey 08830 (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,

(54) Title: CHALCOGEN PRECURSORS FOR DEPOSITION OF SILICON NITRIDE

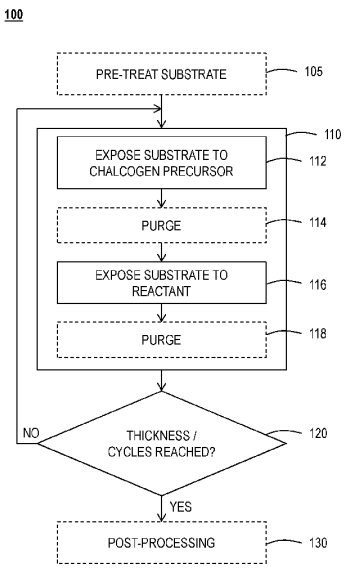


FIG. 1

(57) Abstract: Chalcogen silane precursors are described. Methods for depositing a silicon nitride (Si_xN_y) film on a substrate are described. The substrate is exposed to the chalcogen silane and a reactant to deposit the silicon nitride (Si_xN_y) film. The exposures can be sequential or simultaneous. The chalcogen silane may be substantially free of halogen. The chalcogen may be selected from the group consisting of sulfur (S), selenium (Se), and tellurium (Te).

WO 2022/155580 A1

[Continued on next page]

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).

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