



(51) International Patent Classification:

C01B 33/00 (2006.01) C07F 9/68 (2006.01)
C07F 9/22 (2006.01) C07F 9/90 (2006.01)

75007 Paris (FR). **ZHANG, Peng**; 3040 US Highway 22,
Branchburg, NJ 08876 (US).

(21) International Application Number:

PCT/US2022/053205

(74) **Agent: JIANG, Yan**; Air Liquide, 9811 Katy Freeway,
Suite 100, Houston, TX 77024 (US).

(22) International Filing Date:

16 December 2022 (16.12.2022)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

63/293,328 23 December 2021 (23.12.2021) US

(71) **Applicant: L'AIR LIQUIDE, SOCIETE ANONYME
POUR L'ETUDE ET L'EXPLOITATION DES PRO-
CEDES GEORGES CLAUDE** [FR/FR]; 75, quai d'Orsay,
75007 Paris (FR).

(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, 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.

(71) **Applicant (for KP only): AMERICAN AIR LIQUIDE,
INC.** [US/US]; 46409 Landing Parkway, Fremont, CA
94538 (US).

(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, 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, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI,

(72) **Inventors: LI, Feng**; 3040 US Highway 22, Branchburg,
NJ 08876 (US). **GIRARD, Jean-Marc**; 75, quai d'Orsay,

(54) **Title:** NEW INORGANIC SILYL AND POLYSILYL DERIVATIVES OF GROUP V ELEMENTS AND METHODS OF SYN-
THESIZING THE SAME AND METHODS OF USING THE SAME FOR DEPOSITION

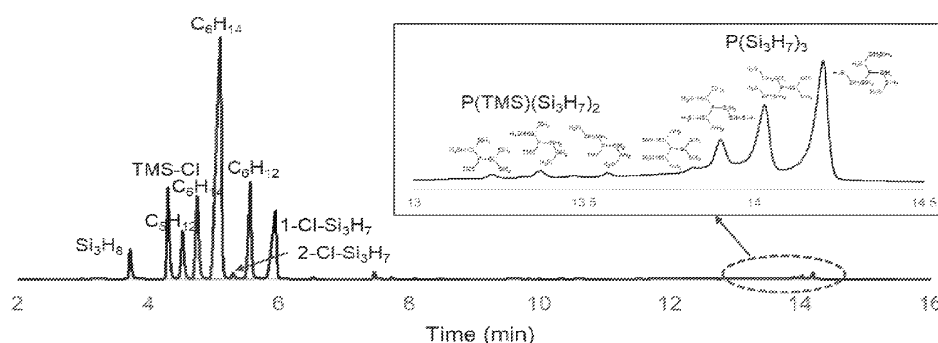


FIG. 1

(57) **Abstract:** Disclosed are Group V element-containing precursors and methods of synthesizing the same and using the same on film depositions. The precursors are $(\text{SiR}_3)_{3-m}\text{A}(\text{Si}_a\text{H}_{2a+1})_m$, $(\text{SiR}_3)_{3-n-p}\text{A}(\text{Si}_a\text{H}_{2a+1})_n(\text{Si}_b\text{H}_{2b+1})_p$ or $\text{A}(\text{Si}_a\text{H}_{2a+1})(\text{Si}_b\text{H}_{2b+1})(\text{Si}_c\text{H}_{2c+1})$ wherein $a = 1$ to 6 ; $b = 1$ to 6 ; $c = 1$ to 6 ; $a \neq b \neq c$; $m = 1$ to 3 ; $n = 1$ to 2 , $p = 1$ to 2 , $n + p = 2$ to 3 ; A = As, P, Sb, Bi; and R is selected from a C_1 to C_{10} , linear, branched or cyclic alkyl, alkenyl, alkynyl group. The synthesis methods include one-step, two-step or three-step reaction(s) between halo(poly)silane(s) and a tris(trialkylsilyl) derivative of A or a one-pot mixing reaction between a mixture of two or three halo(poly)silanes and the tris(trialkylsilyl) derivative of A. The deposition methods include CVD, PECVD, ALD, PEALD, flowable CVD, HW-CVD, Epitaxy, or the like.

[Continued on next page]

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))*