

Methyl Silanes

Methylsilane (1MS), Dimethylsilane (2MS), Trimethylsilane (3MS) and Tetramethylsilane (4MS) have been used in Semiconductor manufacturing as precursors for the Chemical Vapor Deposition (CVD) of various layers, most often low dielectric constant (low-k) films. They also offer excellent barrier properties, typically used for a liner or a cap layer adjacent to other dielectric layers. These low-k layers vary in composition based on co-reactants combined with the Methylsilanes and result in Silicon Carbide (SiC), Silicon Carbonitride (SiCN), and Siliconoxyhydride (SiCO:H); the deposition reaction can typically be performed at relatively low temperature ranges.

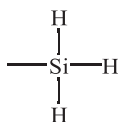
- 1MS and 2MS are utilized mostly for low volume deposition of SiC, SiCN, or SiCO:H depending on the conditions and precursors used.
- 3MS has been used for SiC deposition or SiCO:H deposition, again depending on starting chemistries. This is a production-proven precursor, with current high volume application in Semiconductor fabrication.
- 4MS is currently used for SiC deposition on several advanced technology platforms and it is reported within several application patents.

Physical Properties of Organosilicon Precursors for CVD

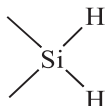
Property	1MS	2MS	3MS	4MS	4M2S	6M2S
V.P. (°C)	-80 @241mm	-80@30mm	25@1218mm	20@589mm	27@195mm	20@23mm
B.P. (°C)	-57	-20	6.7	26.6	86	112
M.P. (°C)	(-157)	(-150)	(-136)	(-99)	(-93)	12
F.P. (°C)	<-40	<-20	<-20	-27	-26	-1
M.W.	46.14	60.17	74.20	88.22	118.32	146.38
CAS #	992-94-9	1111-74-6	993-07-7	75-76-3	814-98-2	1450-14-2

Compounds

Name	MW	bp °C/mm (mp)	D ₄ ²⁰	n _D ²⁰
SIM6515.0 METHYLSILANE 1MS CH ₃ Si	46.14	-57°	(-157°)	0.628 ⁻⁵⁸
CAUTION: CAN FORM EXPLOSIVE MIXTURES WITH AIR ΔHcomb: -2,612 kJ/mole ΔHform: -29 kJ/mole ΔHvap: 19.3 kJ/mole Dipole moment: 0.73 debye Plasma polymerization yields dry process photoresist. ¹ Intermediate for poly(methylsilane) precursor to silicon carbide. ² Deposits SiC on Si and Ge at 400 - 500°C. ³ Source for hydrogenated amorphous silicon carbide films. ⁴ 1. Dabbagh, G. et al. J. Photopolym. Sci. Tech. 1998, 11, 651. 2. Fhang, Z. et al. J. Am. Ceram. Soc. 1991, 74, 670. 3. Takatsuka, T. et al. Appl. Surf. Sci. 2000, 162, 156. 4. Lee, M. et al. in "Chemical Aspects of Electronic Ceramics Processing" Arkles, B. ed., MRS Proc. 1998, 495, 153. HYDROLYTIC SENSITIVITY: 9: reacts extremely rapidly with atmospheric moisture - may be pyrophoric - glove box or sealed system required [992-94-9] TSCA EC 213-598-5 HMIS: 3-4-3-X				



SID4230.0 DIMETHYLSILANE 2MS C ₂ H ₆ Si	60.17	-20°	(-150°)	0.68 ⁻²⁰
ΔHcomb: -2,612 kJ/mole ΔHform: -96 kJ/mole ΔHvap: 23.0 kJ/mole Dipole moment: 0.75 debye CVD precursor for low k dielectric layers in damascene metallization applications Generates cubic silicon carbide by plasma CVD. ¹ Epitaxial growth of cubic silicon carbide carried out by triode plasma CVD. ² 1. Hashim, A. et al. Semiconductor Electronics, IEE Int'l. Conf. Proc. 2006, 646. 2. Yasuiet, K. et al. Appl. Surf. Sci. 2000, 159, 556. HYDROLYTIC SENSITIVITY: 3: reacts with aqueous base [1111-74-6] TSCA EC 214-184-7 HMIS: 3-4-1-X				



Name	MW	bp °C/mm (mp)	D ₄ ²⁰	n _D ²⁰
SIT8570.0				
TRIMETHYLSILANE				
3MS C ₃ H ₁₀ Si	74.20	6.7° (-135.9°)	0.638 ^{6,7}	
ΔHcomb: -3,206 kJ/mole ΔHform: -163 kJ/mole ΔHvap: 24.3 kJ/mole Dipole moment: 0.52 debye		Flashpoint: <-20°C (<-4°F) TOXICITY: ihl rat, LC50: >5,000 ppm/1H Autoignition temperature: 320°C Vapor pressure, 25°: 1,218 mm Critical temperature: 158.85°C Critical pressure: 31.48 atm		
Forms trimethylsilylalkanes from olefins w/Pt catalyst Employed in plasma treatment of surfaces. ¹ Treatment of titanium alloys and stainless steel surfaces inhibits biofilm formation. ² 1. Hendricks, N. et al. Semiconductor Int'l. 2000, 23, 95. 2. Ma, Y. et al. Antimicrob. Agents Chemother. 2012, 56, 5923. F&F: Vol. 1, p 1235; Vol. 2, p 441; Vol. 13, p 101; Vol. 16, p 292. HYDROLYTIC SENSITIVITY: 3: reacts with aqueous base [993-07-7] TSCA EC 213-603-0 HMIS: 2-4-1-X				COMMERCIAL
SIT7555.0				
TETRAMETHYLSILANE, 99+%				
4MS, TMS C ₄ H ₁₂ Si	88.22	26.6-26.7° (-99°)	0.641	1.3588
NMR grade Viscosity: 0.4 cSt ΔHcomb: 3,851 kJ/mole ΔHform: -232 kJ/mole ΔHfus: 6.7 kJ/mole ΔHvap: 26.8 kJ/mole Photoionization threshold: 8.1 eV Ce: 1.838 x 10 ⁻³		Flashpoint: -27°C (-17°F) TOXICITY: ihl rat, LC50: >5,000 ppm/4H Autoignition temperature: 450°C Vapor pressure, 20°: 589 mm Critical temperature: 185°C Critical pressure: 33 atm Heat capacity: 195.2 joules/mole-K Dielectric constant: 1.92		
Intermediate for α-SiC:H thin films by PECVD. ¹ 1. Kim, D. et al. Thin Solid Films 1996, 283, 109. See also GET7550 HYDROLYTIC SENSITIVITY: 1: no significant reaction with aqueous systems [75-76-3] TSCA EC 200-899-1 HMIS: 1-4-0-X				
SIT7541.0				
1,1,2,2-TETRAMETHYLDISILANE				
4M2S, C ₄ H ₁₄ Si ₂	118.32	86-7° (-93°)	0.7202	1.429
Flashpoint: -26°C (-15°F)				
Forms low k carbon doped silicon dioxide films. Forms SiC nanowires by APCVD. ¹ 1. Rho, D., Mat. Res. Soc. Symp. Proc., 2005, 832, 317. HYDROLYTIC SENSITIVITY: 3: reacts with aqueous base [814-98-2] TSCA HMIS: 2-4-1-X				
SIH6109.0				
HEXAMETHYLDISILANE				
6M2S, HMD C ₆ H ₁₈ Si ₂	146.38	112-3°	12-14°	0.7293
Flashpoint: -1°C (30°F) Vapor pressure, 20°: 22.9 mm Ea decomposition at 545°K: 337 kJ/mole Rotational barrier, Si-Si: 4.40 kJ/mole Secondary NMR reference: δ = 0.045				1.4214
Precursor for CVD of silicon carbide. ¹ 1. Thin Solid Films 1999, 252, 13. HYDROLYTIC SENSITIVITY: 1: no significant reaction with aqueous systems [1450-14-2] TSCA EC 215-911-0 HMIS: 2-4-0-X				
25g \$36.00		100g \$117.00		1.5kg \$360.00
SIT7308.0				
TETRAKIS(TRIMETHYLSILYL)SILANE				
C ₁₂ H ₃₆ Si ₅	320.85	(267° sub.)		
m.p. (sealed tube): 319-21°C NMR standard				
Precursor for CVD of amorphous hydrogenated silicon - carbon films. ¹ 1. Wrobel, A. et al. Chem. Mater. 1995, 7, 1403. HYDROLYTIC SENSITIVITY: 1: no significant reaction with aqueous systems [4098-98-0] HMIS: 2-2-0-X				
5g \$82.00		25g \$328.00		