

CHEMICAL VAPOR DEPOSITION ©GELEST

The growth of thin films via chemical vapor deposition (CVD) is an industrially significant process with a wide array of applications, notably in microelectronic device fabrication. Chemical vapor deposition (CVD) is carried out by passing a volatilized precursor (such as a silane, organometallic or metal coordination complex) over a heated substrate. Thermal decomposition of the precursor produces a thin-film deposit, and ideally, the ligands associated with the precursor are cleanly lost to the gas phase as reaction products. Compared to other thin-film production techniques, CVD offers several significant advantages, most notably the potential for effecting selective deposition and lower processing temperatures. Many metal CVD depositions are autocatalytic. Growth of such thin films is characterized by an induction period, which is a consequence of the higher barriers that relate to the activation of the precursor on a non-native substrate.

CVD is the preferred deposition method for fabricating optical storage, as it is a well established method with good scalability, reproducibility, and uniformity. It is also capable of high rates and good composition control. However, standard CVD techniques become limited in the formation of electronic storage, where the material must be deposited in trenches with high aspect ratios. Here the atomic layer deposition (ALD) method is a specialized CVD technique that is becoming more popular especially in depositing thin films for microelectronic applications. Benefits of the ALD method compared to the other methods are film uniformity, precise thickness control, excellent step coverage, and high reproducibility. Films can even be deposited routinely even onto curved substrates.

Silanes can be applied to substrates under dry aprotic conditions by CVD, which favors monolayer deposition. Although under proper conditions almost all silanes can be applied to substrates in the vapor phase, those with vapor pressure >5 torr at 100°C have achieved the greatest number of commercial applications. In closed chamber designs, substrates are supported above or adjacent to a silane reservoir and the reservoir is heated to achieve 5mm vapor pressure. Alternatively, vacuum can be applied until silane evaporation is seen. The silane can also be prepared in toluene solution, which when refluxed allows sufficient silane to vaporize through its inherent partial pressure. Here, the substrate temperature should be maintained between 50°-120°C to promote reaction. Cyclic azasilanes deposit the quickest (usually <5 mins). Amine functional silanes also deposit rapidly (~30 mins) without a catalyst. Other silanes require extended reaction times, usually 4-24 hours. Such silane reactions can be promoted by adding catalytic amounts of amines.

Using differing precursor and reactive gases allows films of varied composition to be made. SnO₂, ZnO, and Pt films can be grown using the following precursors and reactants respectively: tetramethyltin and oxygen; diethylzinc and oxygen; and dimethylplatinum(II) cyclooctadiene ((COD)PtMe₂) and hydrogen. Gelest, Inc. offers a range of metal-organic precursors for CVD applications for microelectronics. Precursors are available for commonly employed metals, such as silicon, copper, aluminum, titanium, tantalum and tungsten. These precursors are volatile solids or liquids and can be used to deposit metal thin films in typical CVD or atomic layer deposition (ALD) processes. Typical applications are for metal interconnects or diffusion barriers. In addition, metal-organic precursors that are volatile and reactive in the gas phase are employed for CVD. A wide variety of co-reactants and reaction conditions can be used to deposit mainly metal, metal oxides or metal nitrides. As such, Gelest, Inc. offers a product line of metal alkoxide, substituted diketone, amide, alkyl and halogen complexes.

Vapor pressure data for silanes

Octadecyltrichlorosilane: 0.67kPa at 20°C
Trifluoropropyltrimethoxysilane: 100kPa at 143-145°C
Tridecafluoro : 133Pa at 50-52°C
Heptadecafluoro : 133Pa at 85-87°C

Key Products:

Silanes:	
SIT7110.0	Tetraethoxysilane 98%
SIT8570.0	Trimethylsilane
SIC2268.5	2-Chloroethylsilane
SIO6640.0	n-Octadecyltrichlorosilane
SIT8175.0	Tridecafluoro-1,1,2,2-tetrahydrooctyltriethoxysilane

High purity Silanes:

SIA0610.1	3-Aminopropyltriethoxysilane 99+%
SIH6110.1	Hexamethylsilazane 99%
SIM6560.1	Methyltrimethoxysilane 99%

Metal-Organics:

AKC253	Copper II Hexafluoropentanedionate
GET7100	Tetraethoxygermane
GET7550	Tetramethylgermane
SIE4885.0	Erbium tris[bis(trimethylsilyl)amide]
OMTI080	Titanium tetrakis(dimethylamide)
AKE282	Erbium 2,2,6,6-tetramethyl-3,5-heptanedionate
AKC252.8	Copper I hexafluoropentanedionate vinyltrimethylsilane complex
AKC253	Copper II Hexafluoropentanedionate
OMAL008	Alane-trimethylamine complex
OMAL082	Triisobutylaluminum
INTA070	Tantalum pentabromide
INTU030	>Tungsten hexacarbonyl
INMO030	Molybdenum hexacarbonyl
SNT7560	Tetramethyl tin
SNT7261	Tetra-n-butyl tin
SNH6120	Hexamethylditin
OMZN017	Diethyl zinc
OMZN040	Diphenyl zinc
SIZ9700.0	Zinc bis(hexamethyldisilazide)
OMPT021	Dimethylplatinum(II) cyclooctadiene complex

Silicones:

SIO6699.0	1,2,3,4,5,6,7,8-Octamethylcyclotetrasilazane
SIT7530.0	1,3,5,7-Tetramethylcyclotetrasiloxane