Silicon-Precursor Gases

Silicon-precursor gases such as silane and dichlorosilane are used in epitaxial and chemical vapor deposition (CVD) processes to deposit layers of silicon or silicon compounds.

Dopant Gases

Dopant gases are a source of controllable impurities to modify local electrical properties of the semiconductor material. Specifically, a dopant contributes either an electron deficiency (p dopant) or an electron (n dopant) to the local structure of the molecule's crystal lattice, which in turn alters the conductivity of the material. For silicon, the p and n dopants are found in Groups III and V, respectively of the periodic table.

Dopants are available in liquid, solid and gaseous states. The common gaseous n dopants are arsine and phosphine, while the common gaseous p dopant is diborane. Dopants are used in epitaxial deposition, diffusion and ion implantation.

A major growth area for arsine and phosphine use is the fabrication of III-V devices, using a vapor phase epitaxy (VPE) or, more frequently, the metal organic chemical vapor deposition (MOCVD) method.

Etchant Gases

Many gases are used in etching process. Halocarbons are used typically to etch silicon compounds or for chamber cleaning, whereas the other chlorine or fluorine compounds are usually required for etching metallic interconnects. The choice of gas strongly depends on the ability of a given mixture of gases to selectively etch one film in the presence of another with a sufficient degree of profile control. For CVD chamber cleaning, NF_3 has become the preferred molecule in many tools.

Atmospheric/Purge Cylinder Gases

Atmospheric/purge gases in cylinders are used for purging certain processing systems and equipment when a semiconductor manufacturer is concerned about possible back-contamination of the house purge lines. Argon, helium, hydrogen and nitrogen are supplied to semiconductor manufacturers in cylinders, as well as in discrete deliveries of bulk liquids. Since these gases represent cylinder deliveries, they are classified as semiconductor process gases.

Some processes, such as sputtering, require only small volumes of gas, making the single-cylinder usage of argon, for example, more economical. Sputtering technology requires the process to be run under vacuum conditions and argon ions are accelerated in an electric field. Through physical bombardment, the argon ions knock molecules off the surface of a solid target. The ejected material from gas, is a strong oxidizing agent at temperatures greater than 300 °C.

Tungsten hexafluoride is a colorless, non-flammable, corrosive liquid. It is used as a CVD source of tungsten, or in combination with silane.

Mixtures

At Praxair's Kingman Semiconductor Process Gases Center, process gas mixtures are blended to the tight tolerances required by the electronics industry. The blending systems were designed to reduce cylinder-to-cylinder and batch-to-batch variation. Computer modeling used in application of the blending systems helps ensure that contamination control levels and blending tolerances meet specifications required by the industry.

Chlorosilicons

Praxair is the largest supplier of semiconductor process grade chlorosilicon products in North America with bulk transfilling facilities at Kingman, Ariz.; and Bethlehem, Pa. Trichlorosilane, silicon tetrachloride and dichlorosilane are supplied coast to coast on Praxair trucks.

Praxair manufactures a complete line of gas handling equipment featuring the most advanced technologies, including gas cabinets, panels and controllers. See page F45-F47 for details.

The Purest Product

The semiconductor process gases production centers are designed to meet the critical quality requirements of the semiconductor industry. These requirements demand not only producing consistent semiconductor process gases, but also maintaining purity throughout the filling operation directly into the process reactor.

In North America, Praxair has several centers that handle semiconductor process grade gases. These advanced production facilities enable Praxair to set new standards of quality and consistency for all our semiconductor grade products.

Product Description	Grade	Purity %	Specifications Page Number)
Silicon-Precursor Gases			
Dichlorosilane	2.7	99.7	C18
(SiH_2Cl_2)	2.0	99.0	C18
Disilane (Si_2H_6)	4.8	99.998	C19
Silane (SiH_4)	6.0	99.9999	C55
	4.7	99.997	C55
	4.0	99.99	C55
Silicon Tetrachloride ($SiCl_4$)	4.0	99.99	C56
	3.8	99.98	C56
	3.0	99.9	C56
Trichlorosilane ($SiHCl_3$)	3.5	99.95	C60
	3.0	99.9	C60
Etchant Gases			
Boron Trichloride (BCl_3)	3.6	99.96	C9
Chlorine (Cl_2)	5.0	99.999	C18
	4.0	99.99	C18
Halocarbon – 14 (CF_4)	4.7	99.997	C22
	3.7	99.97	C22
Halocarbon – 22 (CHF_4)	3.0	99.9	C23
Halocarbon – 23 (CHF_4)	4.5	99.995	C24
	2.0	99.0	C24
Halocarbon – 116 (C_2F_6)	4.6	99.996	C25
	3.6	99.96	C25
Halocarbon – 218 (C_3F_8)	3.6	99.96	C27
Hydrogen Bromide (HBr)	4.5	99.995	C34
Hydrogen Chloride (HCl)	5.0	99.999	C35
Nitrogen Trifluoride (NF_3)	4.0	99.99	C48
Sulfur Hexafluoride (SF_6)	4.5 2.8	99.995 99.8	C59

Product Description	Grade	Purity %	Specifications (Section C, Page Number)
Atmospheric/Purge Cylinder Gases			
Argon (Ar)	6.0	99.9999	C6
	5.5	99.9995	C6
	5.0	99.999	C6
Helium (He)	6.0	99.9999	C31
	5.5	99.9995	C31
	5.0	99.999	C31
Hydrogen (H_2)	6.0	99.9999	C33
	5.5	99.9995	C33
	5.0	99.999	C33
Nitrogen (N_2)	6.0	99.9999	C46
	5.5	99.9995	C46
	5.0	99.999	C46
Oxygen (O_2)	5.0	99.999	C51
	4.0	99.99	C51
Xenon (Xe)	5.0	99.999	C62
Dopant Gases			
Arsine (AsH_3)	6.0	99.9999	C8
	5.7	99.9997	C8
Boron Trifluoride (BF_3)	2.5	99.5	C10
	1.5EN	95.0	C8
Phosphine (PH_3)	6.0	99.9999	C52
	5.7	99.9997	C52
Reactant Gases			
Ammonia (NH_3)	6.5	99.99995	C5
	5.5	99.9995	C5
	5.0	99.999	C5
Carbon Dioxide (CO_2)	4.8	99.998	C15
	4.0	99.99	C15
Nitrous Oxide (N_2O)	5.5	99.9995	C49
	4.8	99.998	C49
Sulfur Dioxide (SO_2)	3.8	99.98	C58
Tungsten	5.0	99.999	C61

Gas Mixtures

Please contact your Praxair representative for information regarding our complete selection of process gas and inert mixtures.