

SEMI C3.55-1011 (Reapproved 0218) SPECIFICATION FOR SILANE (SiH₄), BULK, 99.994% QUALITY

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1 Purpose

1.1 The purpose of this Document is to provide specifications for silane (SiH₄) that is used in the semiconductor industry.

2 Scope

2.1 This Document covers requirements for bulk silane (SiH₄) used in the semiconductor industry.

NOTICE: SEMI Standards and Safety Guidelines do not purport to address all safety issues associated with their use. It is the responsibility of the users of the Documents to establish appropriate safety and health practices, and determine the applicability of regulatory or other limitations prior to use.

3 Referenced Standards and Documents

3.1 *SEMI Standards and Safety Guidelines*

SEMI C3 — Specification for Gases

NOTICE: Unless otherwise indicated, all documents cited shall be the latest published versions.

4 Description

4.1 Silane is a pyrophoric, flammable colorless gas.

5 Specifications

Table 1 Impurity Limits and Other Requirements for Silane

Grade	99.994%
Impurities	Maximum Acceptable Level (ppm)
<i>Gas Phase</i>	
Carbon Monoxide (CO)	0.1
Carbon Dioxide (CO ₂)	0.1
Chlorosilanes (ionizable chlorides) including HCl, reported as chloride (Cl ⁻)	1
Non-methane Hydrocarbons (C ₂ -C ₄)	0.1 total
Hydrogen (H ₂)	50
Methane (CH ₄)	0.1
Nitrogen (N ₂)	1
Argon (Ar)	1
Disiloxane (H ₃ SiOSiH ₃)	1
Methyl Silane (SiH ₃ -CH ₃)	1
Disilane (Si ₂ H ₆)	1
Water (H ₂ O)(vol/vol)	1
Particles	#1

Grade	99.994%
Impurities	Maximum Acceptable Level (ppm)
Total Specified Impurities	57.4
Deposited Layer	
Carbon (C)	0.5 ppma ^{#2}
Oxygen (O)	1 ppma ^{#2}
Aluminum (Al)	0.2 ppba ^{#3}
Antimony (Sb)	0.2 ppba ^{#3}
Arsenic (As)	0.2 ppba ^{#3}
Boron (B)	0.2 ppba ^{#3}
Gallium (Ga)	0.2 ppba ^{#3}
Phosphorus (P)	0.2 ppba ^{#3}
Chromium (Cr)+ Copper (Cu)+ Iron (Fe)+ Nickel (Ni)+ Zinc (Zn)	1.0 ppba total ^{#3}

#1 To be determined between supplier and user.

#2 ppma is defined to be atoms of impurity per 10⁶ atoms of silicon.

#3 ppba is defined to be atoms of impurity per 10⁹ atoms of silicon.

6 Electrical Specification

6.1 Resistivity — Greater than 2,000 ohm-cm (n-type)

7 Properties of Silane (for information only)

Table 2 Properties of Silane

	Metric Units	US Units
Molecular Formula	SiH ₄	SiH ₄
CAS Number	7803-62-5	7803-62-5
Molecular weight	32.112	32.112
Boiling point at 101 kPa (1 atm.)	-112°C	-169°F
Density of gas at 21.1°C (70°F) and 101 kPa (1 atm.)	1.342 kg/m ³	0.0839 lb/ft ³
Specific gravity of gas at 21.1°C and 101 kPa (1 atm) (air = 1)	1.114	1.114
Density of liquid at boiling point	711 kg/m ³	44.39 lb/ft ³

8 Analytical Procedures

NOTE 1: Before performing this or any other analytical operation it is necessary to perform the following:

- Familiarize yourself with the products involved and the potential hazards by consulting the MSDS's for all hazardous substances involved and by consulting the CGA's "Handbook of Compressed Gases" for all gases involved.
- Know how to safely handle and store each hazardous gas by consulting the applicable CGA pamphlets.
- Use all necessary and applicable personal protective equipment.

- Follow all instructions relative to the safe operation of the equipment by consulting the LAC Safety Manual and applicable equipment manufacturers manual(s).

It must be noted that silane is a pyrophoric gas and all sample plumbing must be purged of air completely before introducing silane. Extra special attention must be paid to leak checking all connections and checking the vent plumbing to be certain that effluents are vented properly. If there are any questionable connections or leaks, report this to the supervisor immediately and do not proceed with the analysis.

8.1 Carbon Monoxide, Carbon Dioxide, Argon, Nitrogen and Methane — This procedure is for the determination of carbon monoxide, carbon dioxide, argon, nitrogen and methane in silane using a gas chromatograph with a discharge ionization detector.

8.1.1 Detection Limit — 30 ppb (mole/mole).

8.1.2 Instrument Parameters

8.1.2.1 Column — Haysep® D 60/80, 6.5 m (21.3 ft.) by 3.2 mm (1/8 in.) OD by 2.2 mm (0.085 in.) ID stainless steel; or equivalent.

8.1.2.2 Carrier Flow — 25 mL/min helium.

8.1.2.3 Sample Volume — 1 mL.

8.1.2.4 Temperatures

- **Detector** — 140°C.
- **Column Oven** — 40°C for 4 minutes, to 120°C at 10°C/min., hold 120°C for 8 minutes.
- **Injection Temperature** — 45°C.

8.1.3 Calibration Standards — 1 ppm (mole/mole) for all components to be tested, balance helium.

8.1.4 Operating Procedures

8.1.4.1 Inject the calibration standard and sample as described in § 6.6 of SEMI C3. The order of elution is nitrogen, argon, carbon monoxide, methane, and carbon dioxide.

NOTE 2: Introduce the calibration standard as many times as necessary to achieve the desired precision. Detection limit calculated on these calibrations should achieve at least that listed for this procedure.

8.1.4.2 Compare the average peak area of the calibration standard to that of the silane sample being tested. Calculate the concentrations of the analytes as described in § 6.8 of SEMI C3. The result shall be reported in the unit of concentration needed and to the number of significant digits of the variable with the least number of significant digits. This value may not exceed that specified in Table 1.

8.2 Total Chlorides — This procedure is for the determination of total chlorides in silane by titration of a hydrolyzed sample of silane. (See Note 1.)

8.2.1 Detection Limit — 0.5 ppm (mole/mole).

8.2.2 Instrument Parameters — See Figure 1.

8.2.2.1 Equipment

8.2.2.1.1 Safety purge regulator with proper fittings.

8.2.2.1.2 Flow meter capable of measuring 0.25 standard liters per minute (0.5 SCF/hour) (Brooks or equivalent), calibrated for silane.

8.2.2.1.3 One cylinder of nitrogen with regulator.

8.2.2.1.4 One ice bath.

8.2.2.1.5 Three magnetic stirring bars.

8.2.2.1.6 Two 2000 mL heavy-duty sidearm flasks (Fisher Cat. No. 10-181G or equivalent).

8.2.2.1.7 One #9 one-hole rubber stopper.