

SEMI PV21-1016

GUIDE FOR SILANE (SiH₄), USED IN PHOTOVOLTAIC APPLICATIONS

This Standard was technically approved by the Photovoltaic – Materials Global Technical Committee. This edition was approved for publication by the global Audits and Reviews Subcommittee on August 31, 2016. Available at www.semiviews.org and www.semi.org in October 2016; originally published October 2011.

1 Purpose

1.1 This Standard provides a suggested maximum impurity level for silane (SiH₄) that is used in the photovoltaic industry.

2 Scope

2.1 This Standard refers to an ‘as supplied’ product; not point of use. Its quality is determined in a gaseous phase, at a delivery point agreed between the supplier and user, unless specified as a solid ‘deposited layer’ derived from the gaseous source.

2.2 This Standard is a guide and complete analytical methods are not contained within. Some of the available techniques for measuring impurities are shown in § 7.

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 Description

3.1 Silane is a pyrophoric, flammable colorless gas.

4 Referenced Standards and Documents

4.1 *SEMI Standards and Safety Guidelines*

SEMI C10 — Guide for Determination of Method Detection Limits

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

5 Terminology

5.1 None.

6 Properties of Silane

Table 1 Properties of Silane

	<i>Metric Units</i>	<i>US Units</i>
Molecular Formula	SiH ₄	SiH ₄
CAS Number	7803-62-5	7803-62-5
Molecular Weight	32.112	32.112
Boiling Point at 101.3 kPa (1 atm.)	–112°C	–169.6°F
Density of gas at 21.1°C (70°F) and 101.3 kPa (1 atm.)	1.342 kg/m ³	0.0839 lb/ft ³
Specific gravity of gas at 21.1°C and 101.3 kPa (1 atm.) (air = 1)	1.114	1.114
Density of liquid at boiling point.	711 kg/m ³	44.39 lb/ft ³

7 Suggested Values for Silane

Table 2 Suggested Values for Silane

<i>Grade^{#1}</i>		<i>PV Grade 1</i>
		99.995%
<i>Impurities</i>	<i>Available Techniques^{#2}</i>	<i>Maximum Level (ppm-v)</i>
Carbon Monoxide (CO)	GC-DID	0.1
Carbon Dioxide (CO ₂)	GC-DID	0.1
Chlorosilanes (hydrolyzable chlorides) including HCl, reported as chloride (Cl) or Chlorosilanes (MCS, DCS)	IC or GC-DID	1
Hydrogen (H ₂)	GC-DID	50
Methane (CH ₄)	GC-DID	0.1
Nitrogen (N ₂)	GC-DID	1
Oxygen/Argon (O ₂ and Ar combined)	GC-DID	1
Disilane (Si ₂ H ₆)	GC-FID or GC-DID	1
TOTAL SPECIFIED IMPURITIES		54.3

#1 A numerical Grade is defined as the value achieved when the specified impurities are subtracted from 100%.

#2 Unless otherwise indicated, the method detection limits for each technique used will be determined using SEMI C10. Techniques used should have an MDL level lower than the Maximum Level for each impurity. Known analytical interferences should be considered.

#3 GC — gas chromatograph; DID — discharge ionization detector; FID — flame ionization detector;

7.1 Table 3 suggests values for metallic impurities for silane that is not used in insulating layers.

7.2 Standardized test methods are being developed for all parameters at the purity level indicated. Until standardized test methods are published, test methodology shall be determined by user and producer.

Table 3 Suggested Values for Metallic Impurities for Silane

<i>Impurities in a Deposited Layer Derived from the Gaseous Source^{#1} or Obtained Directly from the Gaseous Source</i>		
<i>Impurities</i>	<i>Available Techniques^{#2}</i>	<i>Maximum Level (ppba)^{#1}</i>
Aluminum (Al)	FTIR or FTPL or FL-ICPMS	0.02
Antimony (Sb)	NAA or BD-ICPMS or FTPL	0.02
Arsenic (As)	FTIR or FTPL	0.02
Boron (B)	FTIR or FTPL	0.02
Gallium (Ga)	NAA or BD-ICPMS or FTPL	0.02
Phosphorus (P)	FTIR or FTPL	0.02
Chromium (Cr) + Copper (Cu) + Iron (Fe) + Sodium (Na) + Nickel (Ni) + Zinc (Zn)	NAA or BD-ICPMS or FL-ICPMS	1.0 total

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

#2 Unless otherwise indicated, the method detection limits will be determined using SEMI C10, resulting in value that will be less than or equal to the Maximum Level for each impurity. Analytical methods should be selected accordingly. Known analytical interferences should be considered. Refer to § 7.

#3 NAA — neutron activation analysis; BD-ICPMS — bulk-dissolution inductively coupled plasma mass spectroscopy; FTIR — Fourier transform infrared spectroscopy; FTPL — Fourier transform photo-luminescence; FL-ICPMS — filtration inductively coupled plasma mass spectroscopy.