SEMI C71-0815
SPECIFICATION AND GUIDE FOR BORON TRICHLORIDE (BCl_3)

This Standard was technically approved by the Gases Global Technical Committee. This edition was approved for publication by the global Audits and Reviews Subcommittee on May 19, 2015. Available at www.semiviews.org and www.semi.org in August 2015; originally published June 2011.

1 Purpose

1.1 The purpose of this Document is to provide specification and guide for boron trichloride (BCl_3) that are used in the semiconductor industry.

2 Scope

2.1 This Specification relates to a geometry of 0.5 µ or less (0.35 to 0.5 range) and describes analytical techniques using gas phase analysis.

2.2 If analytical methods are not complete, the requirements are presented as guides.

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 Boron trichloride is a colorless toxic and corrosive gas at room temperature and atmospheric pressure which fumes in the presence of moist air. It has a choking odor.

4 Referenced Standards and Documents

4.1 *SEMI Standards and Safety Guidelines*

SEMI C3 — Specifications for Gases

4.2 *ISO Standards*[1]

ISO 6145-1 — Preparation of Calibration Gas Mixtures – Dynamic Volumetric Methods – Part 1: Methods of Calibration

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

5 Terminology

5.1 Terminology appropriate to this Standard is defined in SEMI C3.

6 Requirements

6.1 Purity and other requirements for boron trichloride are given in Table 1.

[1] International Organization for Standardization, ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland; Telephone: +41.22.749.01.11, http://www.iso.org

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Table 1 Impurity and Other Requirements for Boron Trichloride

Previous SEMI Reference #	*C3.51 (Specification)*	*C3.33 (Guide)*
Grade	*99.98% (vapor phase)*	*99.9995% (liquid phase)*
Impurities	*Maximum Acceptable Level (ppm)*[#1]	
Nitrogen (N_2)	5	-
Carbon Dioxide (CO_2)	2	-
Chlorine (Cl_2)	10	10 (vapor phase)
Hydrogen Chloride (HCl)	100	1 (vapor phase)
Phosgene ($COCl_2$)	1	1(vapor phase)
Silicon Tetrachloride ($SiCl_4$)	2	-
TOTAL LISTED IMPURITIES (excluding metals)	120	12 (vapor phase)
Impurities	*Maximum Acceptable Level (ppm w)*	
Aluminum (Al)	-	0.5 (liquid phase)
Calcium (Ca)	-	0.5 (liquid phase)
Copper (Cu)	-	0.5 (liquid phase)
Magnesium (Mg)	-	0.5 (liquid phase)
Iron (Fe)	0.5	0.5 (liquid phase)
Nickel (Ni)	0.5	0.5 (liquid phase)
Potassium (K)	-	0.5 (liquid phase)
Silicon (Si)	-	1 (liquid phase)
Sodium (Na)	-	0.5 (liquid phase)
TOTAL IMPURITIES	1	5 (liquid phase)

#1 An analysis of significant figures has not been considered. The number of significant figures will be based on analytical accuracy and precision of the provided procedure.

7 Properties of Boron Trichloride

Table 2 Properties of Boron Trichloride (for information only)

	Metric Units	*US Units*
Molecular Formula	BCl_3	BCl_3
CAS Number	10294-34-5	10294-34-5
Molecular Weight	117.17	117.17
Boiling point at atm	12.4°C	54.3°F
Density of gas at 20°C and 1 atm	5.326 kg/m^3	0.3325 lb/ft^3
Specific gravity	4.12	4.12
Density of liquid at –118°C	1372.8 kg/m^3	85.76 lb/ft^3

8 Analytical Procedures for Boron Trichloride, 99.98% Purity

NOTE 1: The boiling point of boron trichloride is 12.4°C. It is recommended that, prior to the sampling operation, the cylinder should be allowed to reach room temperature to prevent the possibility of any suck-back.

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8.1 *Nitrogen* — This procedure is for the determination of nitrogen in boron trichloride using a gas chromatograph fitted with a backflush valve and a thermal conductivity detector.

8.1.1 *Detection Limits* — 0.5 ppm nitrogen.

8.1.2 *Instrument Parameters*

8.1.2.1 *Columns*

- *Column 1* — Porapak® QS 60/80 mesh 2 m (6 ft.) by 3.2 mm (1/8 in.) OD SS or equivalent.
- *Column 2* — Molecular sieve 5A 60/80 mesh 2 m (6 ft.) by 3.2 mm (1/8 in.) OD SS or equivalent.

8.1.2.2 *Carrier Gas Flow* — Helium with minimum purity of 99.9999%. Flow 25 mL/min.

NOTE 2: The helium carrier gas should contain less than 10 ppb of the impurities it is desired to measure. This is best achieved by using a commercial helium gas purifier.

8.1.2.3 *Sample Volume* — 2.5 mL.

8.1.2.4 *Temperatures*

- *Column Temperature* — 100°C.
- *Detector Temperature* — 100°C.

8.1.2.5 *Bridge Current* — 200 mA.

8.1.3 *Calibration Standard* — 1 to 10 ppm nitrogen in helium.

8.1.3.1 *Calibration* — Construct a calibration curve which contains at least three points covering the range of interest. Verify the standards employed independently by established traceability to recognized national or international standards.

8.1.4 *Operating Procedure*

8.1.4.1 Inject the calibration standard into the column using a gas sampling valve. Adjust the backflush valve operation sequence to present the nitrogen. Record the retention time and peak area. A sample chromatogram is shown in Figure 1.

NOTE 3: Introduce the calibration standard as many times as necessary to achieve the desired precision.

8.1.4.2 Inject the sample to be tested in the same manner as the calibration standard. Record the retention time and peak areas (see Note 1).

8.1.4.3 Repeat ¶ 8.1.4.1.

8.1.4.4 Compare the average peak areas of the nitrogen in the calibration standard to that of the boron trichloride sample being tested. Calculate the concentration of nitrogen using the formula below. The results may not exceed the specification in Table 1 of this Standard.

$$\frac{\text{Sample Peak Area}}{\text{Standard Peak Area}} \times \begin{matrix}\text{Concentration}\\ \text{of Standard}\end{matrix} = \begin{matrix}\text{Concentration}\\ \text{of Sample}\end{matrix} \tag{1}$$

8.2 *Carbon Dioxide* — This procedure is for the determination of carbon dioxide in boron trichloride using a gas chromatograph fitted with a backflush and a thermal conductivity detector.

8.2.1 *Detection Limits* — 0.5 ppm carbon dioxide.

8.2.2 *Instrument Parameters*

8.2.2.1 *Columns*

- *Column 1* — Porapak® QS 60/80 mesh 3 m (10 ft.) by 3.2 mm (1/8 in.) OD SS or equivalent.
- *Column 2* — Porapak® QS 60/80 mesh 2.5 m (8 ft.) by 3.2 mm (1/8 in.) OD SS or equivalent.

8.2.2.2 *Carrier Gas Flow* — Helium with minimum purity of 99.9999%, flow 25 mL/mm (see Note 2).

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