SEMI C3.27-1102 (Reapproved 0118)
SPECIFICATION FOR BORON TRIFLUORIDE (BF_3) IN CYLINDERS, 99.0% QUALITY

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 16, 2017. Available at www.semiviews.org and www.semi.org in January 2018; originally published in 1984; previously published October 2011.

1 Purpose

1.1 The purpose of this Document is to provide a specification for boron trifluoride (BF_3) used in the semiconductor industry.

2 Scope

2.1 This Document covers requirements for boron trifluoride (BF_3) used in the semiconductor industry.

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

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 trifluoride is a colorless gas. It fumes in moist air and has a pungent odor. Boron trifluoride is nonflammable and does not support combustion.

4 Referenced Standards and Documents

4.1 *SEMI Standards and Safety Guidelines*

SEMI C1 — Guide for the Analysis of Liquid Chemicals

SEMI C3 — Specification for Gases

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 Specifications

6.1 *Quality* — 99.0%.

Table 1 Impurity Limits and Other Requirements for Boron Trifluoride (BF_3)

Impurities	*Maximum Acceptable Level (ppm)*[#1]
Gases not soluble in water	0.94%
Particles	[#2]
Silicon Tetrafluoride (SiF_4)	200
Sulfur Dioxide (SO_2)	21
Total Sulfates (SO_4^{-2})	7
TOTAL IMPURITIES	9628

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

#2 To be determined between supplier and user.

7 Physical Constants (for information only)

Table 2 Properties of Boron Trifluoride (BF_3)

	Metric Units	*US Units*
Molecular Weight	67.81	67.81
Boiling point at 1 atm	−100.4°C	−149.0°F
Density of gas at 70°C (21.1°F) and 1 atm	3.076 g/L	0.192 lb/ft^3
Specific gravity of gas	2.7	2.7
Critical Pressure	49.2 atm	723 psia
Critical Temperature	−12.25°C	9.95°F

8 Analytical Procedures

8.1 *Sampling Procedures* — Boron trifluoride is sampled separately for water-soluble gases and water-insoluble gases. The water-soluble components are collected in a plastic bottle which contains chopped ice. After the ice melts, weighed aliquots of the solution are taken for individual determinations. The water-insoluble components are collected in a modified gas collection tube.

8.1.1 *Apparatus*

8.1.1.1 Balance, l000-g capacity, capable of weighing to 0.01 g.

8.1.1.2 Polyethylene bottles (wide mouth, 1-L capacity) with caps.

8.1.1.3 Tygon® tubing, 6 mm (¼ in.).

8.1.1.4 PTFE tubing, 6 mm (¼ in.).

8.1.1.5 Valve assembly consisting of a needle valve with a stainless steel needle, a steel bushing and steel coupling with a steel gas cylinder connection; a gas take-off consisting of a steel sleeve from the valve with steel pipe leading to a 61 cm Tygon delivery tube. The delivery tube is a temporary connection and is replaced as needed (see Figure 1).

8.1.1.6 *Trap* — 1-liter polyethylene bottle fitted with a 2-hole Neoprene stopper and two 4-inch pieces of ¼ in. PTFE tubing which do not extend below the stopper by more than 1 inch. The Tygon delivery tube is attached to one of the PTFE tubes in the stopper (Inlet to Trap). A 61 cm length of Tygon tubing is attached to the second piece of PTFE tubing in the stopper (Outlet from Trap). The trap is supported with a clamp and ring stand.

8.1.1.7 Modified gas collecting tube (see Figure 2); 250-mL Pyrex sampling tube (modified with a graduated scale on one end).

8.1.2 *Reagents*

8.1.2.1 Distilled-water ice, cracked.

8.1.2.2 Nitrogen, dry; 35 ppm water, or less.

8.1.3 *Operating Procedure — Water-Insoluble Components*

CAUTION: Perform all work in a hood.

8.1.3.1 Prepare the gas-collecting tube by washing with distilled water, rinsing with acetone, then drying in an air oven at 100°C to 125°C. Flush with dry nitrogen for about one minute. Leave filled with dry nitrogen; close the stopcocks.

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8.1.3.2 Connect the needle valve assembly apparatus to the cylinder to be tested.

8.1.3.3 Attach the gas-collecting tube to the valve nipple with a short piece of dry Tygon tubing.

8.1.3.4 Open the cylinder valve, open the gas collecting tube stopcocks, and very carefully crack open the needle valve.

8.1.3.5 Purge the tube for 5 minutes with a slow stream of BF_3 gas.

8.1.3.6 Close the needle valve, close the gas-collecting tube stopcocks, and then close the cylinder valve.

8.1.3.7 Proceed with the analysis, after removing the gas-collecting tube from the valve nipple.

8.1.4 *Operating Procedure — Water Soluble Components*

CAUTION: Perform all work in a hood.

8.1.4.1 Before attaching the Tygon delivery tube, purge the sampling valve system for 1 minute with a slow stream of boron trifluoride from the cylinder. Use a separate piece of tubing when purging.

8.1.4.2 Weigh an empty 1-L polyethylene bottle with cap to the nearest 0.01 g. Record this weight as A.

8.1.4.3 Fill the bottle with about 400 g of cracked, distilled-water ice. Re-weigh the bottle with cap to the nearest 0.01 g; record as weight B.

8.1.4.4 A sampling line is used to transfer BF_3 gas from the cylinder to the sample bottle.

8.1.4.5 Connect the Tygon delivery tube from the sampling valve apparatus to the trap. Support the Tygon tubing from the trap outlet; then open the needle valve and adjust until a steady flow of BF_3 is obtained. Insert this Tygon tubing (from the trap outlet) into the polyethylene sample bottle, extending down to the bottom of the bottle. Carefully introduce the BF_3 into the ice until most of the ice is melted, then close the needle valve and remove the Tygon tubing. Remove the sample bottle and cap it. Re-weigh the bottle, cap and contents to the nearest 0.01 g. Record this weight as C.

8.1.4.6 Mix thoroughly by careful inversion until all of the ice melts, being certain to keep the plastic bottle tightly capped so that none of the liquid is lost.

8.1.4.7 Proceed with the determination of water-soluble components, being sure to do the sulfur dioxide first, since opening the bottle repeatedly may result in a considerable loss of sulfur dioxide.

8.1.4.8 Calculations for sample size:

- B − A = Grams of Ice (H_2O)
- C − A = Weight of Solution (BF_3 Solution)
- C − B = Weight of Water-soluble Material (grams of BF_3 gas)

$$\frac{\text{Grams of } BF_3\ Gas}{\text{Grams of Solution}} = \frac{\text{C} - \text{B}}{\text{C} - \text{A}} = \text{F}$$

$$\frac{\text{Grams BF}_3\text{ needed for method}}{\text{F}} = \text{Grams Solution Needed for Method} \quad (1)$$

8.2 *Air* — This procedure describes the determination of insoluble gases in boron trifluoride gas. A known volume of boron trifluoride gas is absorbed in sodium chloride solution, then any undissolved gases remaining are measured and calculated as % air.

8.2.1 *Method Capabilities* — The range of this method is 0.05% to 2.3%.

8.2.2 *Apparatus*

8.2.2.1 The modified gas collecting tube shown in ¶ 8.1.1.7, Figure 2.

8.2.2.2 Separatory funnel, 2000-mL Pyrex (with 61-cm Tygon tubing and pinch clamp attached to stopcock end).

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