SEMI C3.40-1011 (Reapproved 0218)
SPECIFICATION FOR CARBON TETRAFLUORIDE (CF_4), 99.997% 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 February 2018; originally published in 1989; previously published October 2011.

1 Purpose

1.1 The purpose of this Document is to provide specification for carbon tetrafluoride (CF_4) that is used in the semiconductor industry.

2 Scope

2.1 This Document covers requirements for carbon tetrafluoride (CF_4) 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 None.

4 Description

4.1 Carbon tetrafluoride is an odorless, colorless, nonflammable gas. It is a simple asphyxiant. It is also known as tetrafluoromethane.

5 Specifications

Table 1 Impurity Limits for Carbon Tetrafluoride

Grade	*99.997%*
Impurities	*Maximum Acceptable Level (ppm)*[#1]
Carbon Dioxide (CO_2)	1
Carbon Monoxide (CO)	1
Nitrogen (N_2)	20
Other Halocarbons (CF_3Cl, CF_2Cl_2,CF_3H)	1
Oxygen (O_2)	5
Sulfur Hexafluoride (SF_6)	1
Water (H_2O) (v/v)	1
TOTAL IMPURITIES	30

#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.

6 Chemical Specification

6.1 *Total Hydrolyzable Fluorides as HF* — 1 ppm max.

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7 Properties of Carbon Tetrafluoride (for information only)

Table 2 Properties of Carbon Tetrafluoride

	Metric Units	*US Units*
Molecular Formula	CF_4	CF_4
CAS Number	75-73-0	75-73-0
Molecular Weight	88.005	88.005
Boiling point at 1 atm	−128.0°C	−198.4°F
Density of gas at 0°C (32°F) and 101 kPa (1 atm)	3.946 kg/m^3	0.246 lb/ft^3
Specific gravity of gas at 0°C and 101 kPa (1 atm)	3.05	3.05
Density of liquid at −80°C	1317 kg/m^3	82.22 lb/ft^3

8 Analytical Procedures (See Figures 1 and 2)

NOTE 1: Introduce the calibration standard as many times as necessary to achieve the desired precision.

NOTE 2: All gases used in the analysis of the sample should not contain more than 10% of the specified value of the component of interest, unless otherwise stated.

8.1 *Carbon Dioxide* — This procedure is for the determination of carbon dioxide in carbon tetrafluoride using a gas chromatograph with an ultrasonic detector.

8.1.1 *Detection Limit* — 0.5 ppm (mole/mole).

8.1.2 *Instrument Parameters*

8.1.2.1 *Columns*

- *Column 1* — Haysep® D, 100/120 mesh, 4.6 m (15 ft.) by 3.2 mm (1/8 in.) OD ss or equivalent.
- *Column 2* — Porapak® QS, 100/120 mesh, 2.1 m (7 ft.) by 3.2 mm (1/8 in.)OD ss or equivalent.

8.1.2.2 *Carrier Flow* — 16 mL/min helium.

8.1.2.3 *Temperatures*

- *Detector* — 120°C.
- *Column* — 50°C.
- *Valve* — 90°C.

8.1.2.4 *Sample Volume* — 1.0 mL.

8.1.2.5 *Time Table* — Determine the times for valve switching and signal changes, and enter into the run table. An example of a run table follows.

Table 3 An Example of a Valve Run

Valve	*On*	*Off*
1	0.01	#1
2	9.20	#1
3	0.01	12.00

#1 Valve left on until end of run.

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8.1.3 *Calibration Standard* — 1 ppm to 5 ppm carbon dioxide and balance helium.

8.1.4 *Operating Procedure*

8.1.4.1 Inject the calibration standard into the column using a gas sampling valve. Record retention times and peak areas. The retention time for carbon dioxide is approximately 16 minutes.

8.1.4.2 Inject the sample to be tested in the same manner as the calibration standard. Record the retention times and peak areas.

8.1.4.3 Repeat ¶ 8.1.4.1.

8.1.4.4 Compare the average peak areas of the calibration standard to those of the carbon tetrafluoride sample being tested. Calculate the concentration of carbon dioxide in the sample, using the formula below. The result may not exceed the specification in § 5 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 *Oxygen, Nitrogen and Carbon Monoxide* — This procedure is for the determination of oxygen, nitrogen, and carbon monoxide in carbon tetrafluoride using a gas chromatograph with an ultrasonic detector.

8.2.1 *Detection Limits* — 0.5 ppm (mole/mole) for each impurity.

8.2.2 *Instrument Parameters*

8.2.2.1 *Columns*

- *Column 3* — Porapak® QS, 100/120 mesh, 3.6 m (12 ft.) by 3.2 mm (1/8 in.) OD ss or equivalent.
- *Column 4* — Haysep® D, 100/120 mesh, 4.6 m (15 ft.) by 3.2 mm (1/8 in.) OD ss or equivalent.
- *Column 5* — Molecular Sieve 13X, 45/60 mesh, 2.1 m (7 ft.) by 3.2 mm (1/8 in.) OD ss or equivalent.

8.2.2.2 *Carrier Flow* — 16 mL/min. helium.

8.2.2.3 *Temperatures*

- *Detector* — 120°C.
- *Column* — 50°C.
- *Valve* — 90°C.

8.2.2.4 *Sample Volume* — 2.0 mL.

8.2.2.5 *Time Table* — Determine the times for valve switching and signal changes, and enter into the run table. An example of a run table follows.

Table 4 An Example of a Valve Run

Valve	*On*	*Off*
1	0.01	#1
2	9.20	#1
3	0.01	12.00

#1 Valve left on until end of run.

8.2.3 *Calibration Standard* — 1 ppm to 5 ppm (mole/mole) each nitrogen, oxygen and carbon monoxide, balance helium.

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