

SEMI C3.57-0312 (Reapproved 0618) SPECIFICATION FOR CARBON DIOXIDE, CO₂, ELECTRONIC GRADE IN CYLINDERS

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 December 13, 2017. Available at www.semiviews.org and www.semi.org in June 2018; originally published June 2000; previously published March 2012.

1 Purpose

1.1 The purpose of this Document is to provide specification for carbon dioxide (CO₂) that is used in the semiconductor industry.

2 Scope

2.1 This Document covers requirements for carbon dioxide (CO₂) that is 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 DIN Standard¹

DIN 50450-1 — Testing of Materials for Semiconductor Technology; Determination of Impurities in Carrier Gases and Doping Gases; Determination of Water Impurity in Hydrogen, Oxygen, Nitrogen, Argon and Helium by Using a Diphosphorus Pentoxide Cell

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

4 Description

4.1 Carbon dioxide is a nonflammable, colorless, odorless, slightly acidic gas which is stable under normal conditions.

5 Specifications

Table 1 Impurity Limits for Carbon Dioxide

<i>Grade</i>	<i>99.999%</i>
<i>Impurities</i>	<i>Maximum Acceptable Level</i>
Nitrogen	4 ppm
Oxygen	1 ppm
Methane	0.5 ppm
Moisture	2 ppm

¹ Deutsches Institut für Normung e.V., Available from Beuth Verlag GmbH, Burggrafenstrasse 4-10, D-10787 Berlin, Germany; <http://www.din.de>

6 Properties of Carbon Dioxide

Table 2 Properties of Carbon Dioxide

Molecular Formula	CO ₂
CAS Number	124-38-9
Molecular Weight	44
Melting Point	-56.6°C
Boiling Point	-78.5(s)°C
Critical Temperature	30°C
Relative Density, Gas	1.52 (air=1)
Relative Density, Liquid	0.82 (water=1)
Vapor Pressure 20°C	57.3 bar
Appearance/Color	Colorless gas
Odor	none

7 Analytical Procedures

7.1 *Nitrogen, Oxygen and Methane* — This procedure is for the determination of nitrogen, oxygen and methane using a gas chromatograph with discharge ionization detector and heartcut column switching.

7.1.1 *Detection Limit* — 100 ppb.

7.1.2 *Instrument Parameters*

7.1.2.1 *Columns*

- *Column 1* — Haysep® Q, 2 m by 3 mm (stainless-steel or nickel rich alloy).
- *Column 2* — Molecular sieve 5A, 3 m by 3 mm (stainless-steel or nickel rich alloy) 80/100 mesh or equivalent.

7.1.2.2 *Carrier Flow* — 25 mL/minute helium.

7.1.2.3 *Sample Volume* — 2 mL.

7.1.2.4 *Temperatures:*

- *Detector* — 110°C.
- *Column Oven* — 50°C.
- *Injector* — Ambient.

7.1.3 *Calibration Standard* — 1 to 10 ppm (mole/mole) nitrogen, oxygen and methane, balance helium.

7.1.4 *Operating Procedure*

7.1.4.1 Inject the calibration standard into the gas chromatograph via the gas sampling valve. Record the retention times and peak areas for the components within the standard. The order of elution is: oxygen, nitrogen, methane.

7.1.4.2 Inject the sample to be tested in the same manner as the calibration standard. Record the retention times and peak areas. The carbon dioxide matrix gas is vented via the heartcut.

7.1.4.3 Repeat ¶ 7.1.4.1.

7.1.4.4 Compare the average peak areas of the calibration standard to that of the unknown carbon dioxide sample being tested. Calculate the concentrations of oxygen, nitrogen and methane using the formula below. The results shall not exceed the values specified in § 5 of this Standard.

$$\frac{\text{Sample Peak Area}}{\text{Standard Peak Area}} \times \frac{\text{Concentration}}{\text{Standard}} = \frac{\text{Concentration}}{\text{Sample}} \quad (1)$$