

SEMI C55-1104

SPECIFICATION FOR LIQUID CARBON DIOXIDE (CO₂) USED IN NEAR CRITICAL, CRITICAL AND SUPERCRITICAL APPLICATIONS, ≥ 99.99% QUALITY

This specification was technically approved by the Global Gases Committee and is the direct responsibility of the North American Gases Committee. Current edition approved by the North American Regional Standards Committee on July 11, 2004. Initially available at www.semi.org September 2004; to be published November 2004.

1 Purpose

1.1 The purpose of this document is to provide a specification for liquid carbon dioxide (CO₂) that is used in near critical, critical and supercritical applications in the semiconductor industry.

2 Scope

2.1 This document provides purity requirements for all grades of liquid carbon dioxide that are used in near critical, critical and supercritical applications in the semiconductor industry.

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

NOTE 1: Minimum purity requirements. Some applications may require higher purity.

NOTICE: This standard does not purport to address safety issues, if any, associated with its use. It is the responsibility of the users of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory or other limitations prior to use.

3 Description/Definition

3.1 Carbon dioxide is a non-flammable, colorless, odorless compound that is stable at ambient conditions (25°C, 1 bar). Supercritical carbon dioxide exists at a temperature and pressure that exceeds the critical point of carbon dioxide. Near critical carbon dioxide exists in the liquid phase at a pressure that meets or exceeds the critical pressure and a temperature that is below its critical temperature but above a reduced temperature (absolute temperature divided by absolute critical temperature) of approximately 0.75.

4 Terminology

4.1 None.

5 Specifications

Table 1 Quality: ≥99.99%

<i>Impurities</i>	<i>Maximum Acceptable Level</i>
Water	20 ppmv
Total Hydrocarbons expressed as Methane (THC)	50 ppmv
Particles	#1
Soluble and Insoluble Compounds Containing Metals (Na, Fe, Ni, Cu, Cr, Co, Ca, Mn, W, Mo) (each)	0.1 ppmw

#1: To be determined between supplier and user.

6 Referenced Standards

6.1 SEMI Standards

SEMI C10 — Guide for Determination of Method Detection Limits

SEMI C15 — Test Method for ppm and ppb Humidity Standards

SEMI F33 — Method for Calibration of Atmospheric Pressure Ionization Mass Spectrometer (APIMS)

6.2 ASTM Standard¹

E 1747-95(2000) — Guide for Purity of Carbon Dioxide Used in Supercritical Fluid Applications

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

¹ American Society for Testing and Materials International, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428-2959, USA. Telephone: 610.832.9585, Fax: 610.832.9555, Website: www.astm.org.

7 Physical Constants

7.1 The physical constants of carbon dioxide are given in Table 2 (for information only).

Table 2 Physical Constants (for information only)

	<i>Metric Units</i>	<i>US Units</i>
Molecular Weight	44.01	44.01
Sublimation Point at 1 atm (14.7 psia)	-78.5°C	-109.3°F
Triple Point Temperature	-56.6°C	-69.9°F
Triple Point Pressure	5.1 atm	75.1 psia
Critical Temperature	31°C	87.8°F
Minimum Near Critical Temperature	-45.0°C	-49.1°F
Critical Pressure	73 atm	1070 psia
Density of gas at 21.1°C (70°F) and 1 atm	1.823 kg/m ³	0.1138 lb/ft ³
Density of Saturated Liquid at 25°C	713 kg/m ³	44.5 lb/ft ³

8 Analytical Procedures

8.1 *Water* — This procedure is for the determination of trace moisture (water) in carbon dioxide using an analyzer, such as a continuous flowing phosphorus pentoxide hygrometer.

8.1.1 *Detection Limit* — 100 ppbv or better

8.1.2 *Instrument Parameters*

8.1.2.1 *Flow Requirements* — Use appropriate flow, as recommended by manufacturer.

8.1.3 *Calibration Standard* — The analyzer shall be calibrated by reference to a standard gas calibration mixture containing a moisture content close to the expected value of the gas under test, in accordance with the instrument manufacturer's instructions. This calibration standard may be prepared using the procedure described in SEMI F33, Sections 13.2.2 and 13.2.3 and tested using the procedure described in SEMI C15.

8.1.4 Sample System

8.1.4.1 The sample line and associated valves must be clean and moisture free. They must be constructed from high cleanliness materials, such as electropolished stainless steel. The sample line should be purged dry if exposed to ambient moisture. The baseline moisture level should be less than 0.1 ppm.

8.1.4.2 Draw a continuous liquid sample from the source. The sample line should be insulated so that the sample does not boil due to heat infiltration. The distance between the sample point and the analyzer should be as small as possible to minimize boil-off.

8.1.4.3 Heat the sample so that it is completely vaporized, leaving absolutely no liquid or solid carbon dioxide or water residue.

8.1.4.4 Maintain the sample temperature at the analyzer inlet above its condensation point. A sample temperature of 40°C is recommended.

8.1.4.5 Figure 1 illustrates one potential sampling configuration.

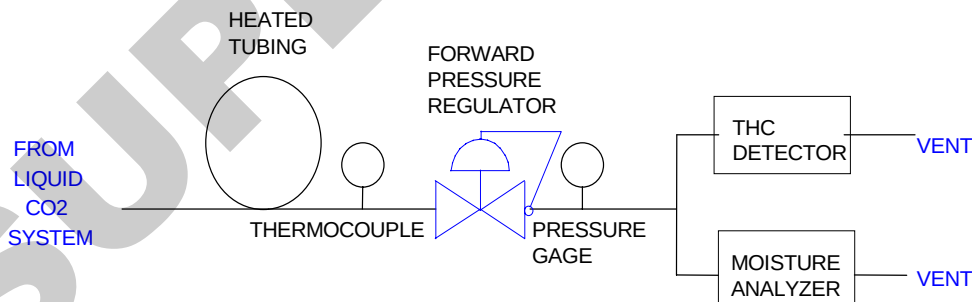


Figure 1
Potential Hydrocarbon and Water Sampling System