

SEMI F28-1103

TEST METHOD FOR MEASURING PARTICLE GENERATION FROM PROCESS PANELS

This test method 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 September 25, 2003. Initially available at www.semi.org October 2003; to be published November 2003. Originally published September 1997.

1 Purpose

1.1 The purpose of this document is to define a method for testing process panels intended for installation in high-purity gas distribution systems. Application of this test method is expected to yield comparable data among process panels tested for the purposes of qualification for this installation.

1.2 This document describes a test method designed to draw comparisons of particulate generation performance of process panels. This test method evaluates the cleanliness of process panels in the “as received” condition as well as under normal operating conditions. The “as received” test is intended to enable the user to evaluate the fabrication, cleaning, and packaging techniques of the manufacturer of the process panel. The test under actual operating conditions is intended to allow the user to evaluate the manufacturer’s component selection as well as the quality of the panel design. The specific flow rates described in both test methods are representative of relatively high flow conditions for a typical process panel.

2 Scope

2.1 This test method addresses total particle counts greater than the minimum detection limit (MDL) of the particle counter and does not consider classifying data into various size ranges.

2.2 This procedure utilizes a particle counter applied to process panels typically used in semiconductor applications. It applies to process gas supply systems (e.g., gas cabinets) which include a process panel, an inert purge panel, and a system vent. Both automatic and manual process panels are within the scope of this test procedure. Panels, as defined in this test method, are considered to consist of 6.35 mm O. D. × 0.89 mm wall (1/4" O.D. × 0.035" wall) tubing and components.

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 determine the applicability of regulatory or other limitations prior to use.

3 Limitations

3.1 This test method specifies flow and mechanical stress conditions considered typical of conditions which would be expected under moderately aggressive operating conditions. These conditions should not exceed those recommended by the manufacturer. Actual performance under operating conditions at lower flow rates or less aggressive conditions may differ. This test method does not address particle generation under vibrating conditions.

3.2 The test medium is limited to nitrogen, argon, or clean dry air (CDA). Performance with other gases may differ.

3.3 The accuracy of the data generated by this method is limited to the accuracy of the particle measuring instruments utilized.

3.4 This method is written with the assumption that the operator understands the use of the apparatus at a level equivalent to six months of experience.

3.5 This document is not intended as a methodology for monitoring on-going particulate performance once a particular process panel has been tested. Also, this method does not include extended dynamic particle count testing (particle generation after thousands of cycles).

3.6 Auto-crossover systems are not within the scope of this test procedure.

NOTE 1: It should be mentioned that test results from panels equipped with final outlet filters can differ significantly from test results from panels without filters.

4 Referenced Standards

4.1 ISO Standards¹

ISO 14644-1 — Cleanrooms and associated controlled environments Part 1: Classification of air cleanliness.

¹ International Organization for Standardization, ISO Central Secretariat, 1, rue de Varembé, Case postale 56, CH-1211 Geneva 20, Switzerland. Telephone: 41.22.749.01.11; Fax: 41.22.733.34.30, Website: www.iso.ch

ISO 14644-2 — Cleanrooms and associated controlled environments Part 2: Specifications for testing and monitoring to prove continued compliance with ISO 14644-1.

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

5 Terminology

5.1 Abbreviations and Acronyms

5.1.1 *CDA* — Clean, dry air

5.1.2 *EP* — Electropolished

5.1.3 *LPC* — Laser particle counter

5.1.4 *psi* — Pounds per square inch

5.1.5 *psia* — Pounds per square inch absolute

5.1.6 *psid* — Pounds per square inch differential

5.1.7 *psig* — Pounds per square inch gauge

5.1.8 *scfm* — Standard cubic feet per minute

5.1.9 *slpm* — Standard liters per minute

5.1.10 *SL* — Standard liters

5.2 Definitions

5.2.1 *background counts* — counts contributed by the test apparatus (including counter electrical noise) with a spool piece in place of the test object.

5.2.2 *Compressed Gas Association (CGA)* — also frequently used to refer to a fitting, as defined and specified by the Compressed Gas Association, which is used to connect a gas source cylinder to a panel inlet.

5.2.3 *condensation nucleus counter (CNC)* — a discrete particle counting instrument that detects particles, in a gaseous stream, by measuring light scattered from droplets grown to measurable size by condensation of supersaturated vapor upon the particles.

5.2.4 *dynamic test* — a test performed to determine particle contribution as a result of valve actuation or regulator adjustment in a process panel during normal operation.

5.2.5 *process panels* — a gas source control piping system for delivering process gases as defined in SEMI F13.

5.2.6 *sample flow rate* — the volumetric flow rate drawn by the particle counter for particle detection.

5.2.7 *sampling time* — the time increment over which counts are recorded.

5.2.8 *source pressure* — pressure of the source gas applied to the cylinder connection at the panel inlet.

5.2.9 *spool piece* — a null component consisting of a straight piece of electropolished tubing and appropriate fittings used in place of the test component to establish the baseline.

5.2.10 *standard conditions* — 101.3 kPa, 0.0°C (14.73 psia, 32°F).

5.2.11 *static test* — a test performed on an as-received process panel with all valves in the fully-open position.

5.2.12 *test duration* — total time required to complete the test procedure.

5.2.13 *test flow rate* — volumetric flow rate of the test gas at standard conditions as defined in Section 5.2.10.

5.2.14 *test pressure* — pressure immediately downstream of the test panel.

6 Test Procedure

6.1 Test Conditions

6.1.1 *Precautions* — This test method may involve hazardous materials, operations, and equipment. This test method does not purport to address the safety considerations associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and determine the applicability of regulatory limitations before using this method.

6.1.1.1 Exhaust from the CNC may contain hazardous and/or flammable vapors and should be properly treated before being released to atmosphere.

6.1.2 The test is to be conducted at a normal indoor temperature of between 18°C (64°F) and 26°C (78°F).

6.1.3 Test apparatus must be enclosed in a Class 100 environment (per ISO 14644). Use procedures necessary to maintain Class 100 when handling test apparatus and test components.

6.1.4 Care should be taken to protect the test apparatus from excessive vibration. For example, vacuum pumps and compressors should be isolated from the system.

6.2 Apparatus and Materials

6.2.1 *Test Gas* — Clean, dry nitrogen or air is to be used [minimum dryness –60°C dew point at 790 kPa (100 psig) and < 10 ppm total hydrocarbons]

6.2.2 *Filters* — Filters are required to provide “particle-free” test gas. Each filter must be nine-log retentive, per manufacturer’s specifications, to 0.02 µm particles and have a pressure drop of less than 6.9 kPa (1 psid) at the specified test pressure and flow rate. The filter must be capable of achieving less than 1 particle³

($\geq 0.02 \mu\text{m}$) per cubic foot of test gas under test conditions.

6.2.3 Pressure Regulator — Pressure regulators are required to maintain system test pressures.

6.2.4 Pressure Gauge — Pressure transducers or gauges are required to monitor system test pressures.

6.2.5 Flow Control Device — A 0–100 slpm flow control device is required for controlling the test flow rate.

6.2.6 Tubing — A 6.35 mm O.D. $\times$ 0.89 mm wall (1/4" O.D. $\times$ 0.035" wall) tubing is required. The tubing shall have an average surface roughness of 0.25 micrometer (10 microinch) Ra or less. Electropolished tubing (as defined in SEMI F16) is recommended.

6.2.7 Sampler — The sampling system consists of a diffuser equipped with a pressure reducing device (e.g., critical orifice) and a sample probe. All parts of the sampling system are to be electropolished with a surface roughness of 0.25 micrometer (10 microinch) Ra or less. If a critical orifice is to be used for pressure reduction, it is not required to be electropolished. The diffuser and sample probe must be sized to obtain isokinetic sampling at the specified test conditions. The critical orifice must be sized to obtain the specified panel pressure at the specified test flow rate.

6.2.8 Spool Piece — Spool pieces shall be electropolished 316L stainless steel tubing with a surface

finish of 0.25 micrometer (10 microinch) Ra or better. The spool piece is to be installed in the system in place of the test device while obtaining background counts for the system.

6.2.9 Fittings — Use face seal connectors or compression fittings depending on test panel end connections.

6.2.10 Gaskets — Use non-plated metal gaskets where required.

6.2.11 A CNC capable of detecting particles at least as small as $0.02 \mu\text{m}$ at a 50% efficiency envelope as defined by ISO 14644, with a sampling flow rate of 1.23 SLPM (0.05 scfm) or greater, is to be used for particle counting. A laser particle counter, capable of detecting particles at least as small as 0.1 micrometers, may be used in addition to, or in place of, the CNC. Test durations in this test method have been established based on a sampling flow rate of 1.23 SLPM (0.05 scfm).

6.2.11.1 Instruments should be calibrated regularly, according to manufacturer's recommendations. For the CNC, this includes routine checks of sample flow rate, working fluid level, and zero.

6.2.11.2 The CNC and data collection equipment should have power surge suppression.

6.2.11.3 Setup and Schematic — See Figure 1.