

SEMI F43-0308 (Reapproved 0613) TEST METHOD FOR DETERMINATION OF PARTICLE CONTRIBUTION BY POINT-OF-USE GAS PURIFIERS AND GAS FILTERS

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1 Purpose

1.1 The purpose of this Document is to define a method for testing POU purifiers and filters intended for installation into a high-purity gas distribution system and semiconductor manufacturing process equipment. Application of this test method is expected to yield comparable data among POU purifiers and filters tested for the purposes of qualification for its installation.

2 Scope

2.1 This Document describes a test method designed to draw comparisons of particulate generation performance of POU purifiers and filters tested under standard conditions. The procedure utilizes a condensation nucleus counter (CNC) applied to in-line gas filters and purifiers typically used in semiconductor applications. This test method applies to devices of various media and for room temperature operation. The purifier's rated flow should be in the range of 0–50 standard liter per minute (slm). The flow rate for filters should be in the range 0–100 slm. If this method is to be used for higher flow rate devices, the testing parameters should be agreed upon by the manufacturer and the user.

2.2 The experimental set up described in this method can be used for testing POU purifiers and stand-alone POU filters.

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 Limitations

3.1 This procedure addresses total particle count greater than the minimum detection limit (MDL) of the condensation nucleus particle counter and does not consider classifying data into various size ranges.

3.2 This methodology specifies flow and mechanical stress conditions in excess of those considered typical. These conditions shall not exceed those recommended by the manufacturer. Actual performance under normal operating conditions may differ.

3.3 The test medium is limited to nitrogen and argon for purifiers. Nitrogen, argon, and clean dry air may be used for filters. Performance with other gases may vary.

3.4 This method does not include extended particle count testing or testing under challenging conditions.

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

3.6 This method is written with the assumption that the operator is proficient in the use of the apparatus.

4 Referenced Standards and Documents

4.1 SEMI Standards and Safety Guidelines

SEMI E49.8 — Guide for High Purity and Ultrahigh Purity Gas Distribution Systems in Semiconductor Manufacturing Equipment

SEMI F19 — Specification for the Surface Condition of the Wetted Surfaces of Stainless Steel Components

SEMI F70 — Test Method for Determination of Particle Contribution of Gas Delivery System

4.2 ISO Standards¹

ISO 14644-1 — Cleanrooms and Associated Controlled Environments – Part 1: Classification of Air Cleanliness

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 *CNC* — condensation nucleus counter

5.1.2 *DUT* — device under test

5.1.3 *EP* — electropolished

5.1.4 *kPa* — kiloPascal

5.1.5 *POU* — point of use

5.1.6 *ppm_v* — parts per million by volume

5.1.7 *psi* — pounds per square inch

5.1.8 *psia* — pounds per square inch absolute

5.1.9 *psid* — pounds per square inch differential

5.1.10 *psig* — pounds per square inch gauge

5.1.11 *Ra* — roughness average

5.1.12 *Rmax* — roughness maximum

5.1.13 *scfm* — standard cubic feet per minute

5.1.14 *sl* — standard liters

5.1.15 *slm* — standard liters per minute

5.2 Definitions

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

5.2.2 *condensation nucleus counter (CNC)* — a light scattering instrument that detects particles in a gaseous stream by condensing supersaturated vapor on the particles.

5.2.3 *control product* — a sample component that gives consistent, stabilized counts at or below the expected counts from the test components. The product is run periodically in accordance with the test protocol to assure that the system is not contributing particles significantly different from expected levels. In the absence of a control product, a spool piece can be used as a control product of low particle emission rate.

NOTE 1: The control product may have to be changed periodically if its performance degrades with testing. Between tests, the control product must be bagged in accordance with the original manufacturer's packaging and stored in a clean manner. The control product is used to allow the system to consider the disruption caused by changes in flow due to the actuation of any valve, such as significant fluctuations in flow, pressure, turbulence, and vibration.

5.2.4 *dynamic test* — a test performed to determine particle contribution as a result of pulsing flow through the DUT.

5.2.5 *impact test* — a test performed to determine particle contribution as a result of mechanical shock applied to the DUT.

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5.2.6 *nine-log retention* — number of particles upstream of the purifier or filter are 1,000,000,000; number of particles down-stream of the purifier or filter is 1.

5.2.7 *sample flow rate* — the volumetric flow rate drawn by the counter for particle detection. The counter may draw higher flow for other purposes (e.g., sheath gas).

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

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

5.2.10 *static test* — a test performed to determine particle contribution under steady flow condition through the DUT.

5.2.11 *test duration* — total time required to complete the test procedure (see § 7.3).

5.2.12 *test flow rate* — mass flow through device under test.

5.2.13 *test pressure* — pressure immediately downstream of the test component (see Figure 1).

5.2.14 *test temperature* — ambient temperature at which the experiment is being conducted.

6 Safety Precautions

6.1 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.

6.2 Exhaust from the CNC may contain hazardous and/or flammable vapors and should be properly vented.

6.2.1 Only inert gases like nitrogen and argon are to be used for purifier testing. No air is allowed in the purifier testing procedure described in this document; an exothermic reaction may result if air is used. Air is allowed for filter testing.

6.3 Care should be taken to minimize the purifier's exposure to room air during and after testing.

7 Test Protocol

7.1 Test Conditions

7.1.1 The test is to be conducted at a normal indoor temperature of between 18°C (64°F) and 26°C (78°F). Environmental temperature within this range is not expected to have any measurable effect on particle detection. Follow manufacturer's recommended handling procedures.

7.1.2 Test apparatus must be enclosed in a ISO Class 5 or better environment (per ISO 14644). If a clean hood is used, the hood should be located within a clean environment. Use procedures necessary to maintain ISO Class 5 or better when handling test apparatus and test component.

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

7.2 Apparatus

7.2.1 Materials

7.2.1.1 *Test Gas* — Test gas of minimum dryness of <10 ppm_v moisture at 790.8 kPa (114.7psia) with <10 ppm_v of total hydrocarbons. See ¶ 6.2.1 for appropriate test gases.

7.2.1.2 *Apparatus Filters* — Filters are required to meet guidelines of SEMI E49.8, High Purity or Ultra High Purity application. The filters must have a differential pressure of 6.9 kPa (1 psid) or less at 790.8 kPa (114.7 psia) and 280 slm.

7.2.1.3 *Pressure Regulator* — To maintain system pressure. Must meet guidelines of SEMI E49.8 High Purity or Ultra High Purity application.

7.2.1.4 *Pressure Gauge* — to monitor system test pressure. Must meet guidelines of SEMI E49.8 High Purity or Ultra High Purity application.

7.2.1.5 *Standard Testing Flow Meter* — Use flow meters with ranges appropriate for testing from 0–100 slm.

7.2.1.6 *Tubing* — Compliant with SEMI F19-UHP Class.

7.2.1.7 *Sampler* — The sampler is to be constructed according to the drawing and sampler design criteria given in Appendix 1 Sampler Design Criteria. The sampler collects gas from the stream exiting the test device, where the sample is near-isokinetic in design.

7.2.1.8 *Upstream Adapter* — The upstream adapter piece connects 12.7 mm (1/2 in.) tubing to the test device. For 12.7 mm (1/2 in.) test devices, the adapter is a simple face-seal connector. For 6.35 mm (1/4 in.) test devices, the adapter is a tapered cone between 6.35 mm and 12.7 mm (1/4 and 1/2 in.) face-seal connections.

7.2.1.9 *Downstream Adapter* — The downstream adapter piece connects 12.7 mm (1/2 inch) tubing of the sampler to the test device. For 12.7 mm (1/2 in.) test devices, the adapter is a simple face seal connector. For 6.35 mm (1/4 in.) test devices, the adapter is a tapered cone between 6.35 mm (1/4 in.) and 12.7 mm (1/2 in.) face-seal connections.

7.2.1.10 *Spool Pieces* — Spool pieces shall be the same diameter as the fittings on the test piece and be 15 cm (6 in.) in length. The spool piece is to be installed in the system in place of the DUT while obtaining background counts for the system.

7.2.1.11 *Fittings* — Face seal connectors or compression fittings dependent on test component end connections. The end connection fittings of each DUT being compared must be of the same type.

7.2.1.12 *Gaskets* — Use metal gaskets for attaching the test device and adapter pieces. New gaskets should be used for each new connection. The use of metal gaskets is recommended in order to minimize the particles that may be generated by installation of the test piece. The use of silver plated metal gaskets should be avoided because they shed particles after installation.

7.2.1.13 *Mechanical Shock Device* — To provide mechanical shock by impact to the test device (see Figure 2). The shock may be applied as drawn in Figure 2 or by using an automated shock device that supplies an equivalent shock at the specified angle. The impact area must be dimensionally equivalent to the ball used in Figure 2.

7.2.1.14 *Actuator* — A gas (compressed air or nitrogen) operated device connected to the valve stem to open and close the valve.

7.2.1.15 *Actuator Pressure* — Minimum actuator gas line pressure required to fully open and close the valve during the dynamic test.

7.2.2 Instrumentation

7.2.2.1 A CNC whose counting efficiency characteristics fall within the range defined in the table below, adapted from SEMI F70. The standard minimum particle equivalent diameter for this test is 0.02 micrometers. Test durations in this test method have been established based on a sampling flow rate of 1.4 slm (0.05 scfm). However, other flow rates may be used provided the sampling volume is constant.

<i>Diameter of Standard Particle</i>	<i>Counting Efficiency</i>
Minimum countable particle diameter of the counter (See #1)	50 ± 20%
1.5–2.0 X Minimum countable particle diameter of the counter	100 ± 10%

#1 For a CNC, the minimum countable diameter shall be defined as the diameter having counting efficiency of 50 ± 20%.

7.2.2.2 Instruments should be calibrated regularly, according to manufacturer's recommendations. For the CNC, this includes routine checks of instrument operation as specified by the manufacturer.

7.2.2.3 The CNC and data collection equipment must have power surge suppression.