SEMI F67-1101 (Reapproved 1108)
TEST METHOD FOR DETERMINING INERT GAS PURIFIER CAPACITY

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1 Purpose

1.1 The purpose of this document is to define a test method to quantify impurity removal capacity of inert gas purifiers.

2 Scope

2.1 To determine the impurity capacity of a gas purifier at the point of breakthrough. Capacity tests are done by adding ppm levels of a given gaseous impurity to a pure zero gas and monitoring the effluent of the test purifier for active impurity species.

NOTE 1: Mixtures of two or more impurities for multi-impurity removal purifiers are a more representative method for determining capacity.

2.2 This document is intended for point of use (POU) inert gas purifiers where inlet purity is 99.9995% or higher.

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 The inherent limitation to this method is the limit of detection (LOD) of the analytical instrument employed by the user.

3.2 This test method can only be used to compare purifier capacity results if the user application for flow rate, pressure, and temperature are the same as the test conditions. Different users and/or different operating conditions may result in different purifier performance results.

3.3 In testing mixtures of impurities, some impurities may influence the capacity results. Discussion with the manufacturer is highly recommended prior to testing.

3.4 The test method does not apply to particulates.

3.5 This test method can only be used to compare the capacity of different purifiers, when the purifiers are sized for the appropriate flow rate. Comparing purifiers of different maximum flow ratings will result in misleading information.

3.6 This test method will provide capacity information only for impurities that are used in the challenge gas.

4 Referenced Standards and Documents

4.1 *SEMI Standards*

SEMI E29 — Standard Terminology for the Calibration of Mass Flow Controllers and Mass Flow Meters

SEMI F6 — Guide for Secondary Containment of Hazardous Gas Piping Systems

SEMI F22 — Guide for Gas Distribution Systems

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

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4.2 *ANSI Standards*[1]

ANSI B46.1 — Surface Texture (Surface Roughness, Waviness, and Lay)

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

5 Terminology

5.1 *Abbreviations and Acronyms*

5.1.1 *APIMS* — atmospheric pressure ionization mass spectrometer

5.1.2 *°C* — degrees Celsius

5.1.3 *DUT* — device under test

5.1.4 *°F* — degrees Fahrenheit

5.1.5 *in* — inch

5.1.6 *kPa* — kiloPascal

5.1.7 *LOD* — limit of detection

5.1.8 *m* — meter

5.1.9 *MFC* — mass flow controller

5.1.10 *NMHC* — non methane hydrocarbons

5.1.11 *POU* — point of use

5.1.12 *ppb* — parts per billion, volume basis

5.1.13 *ppm* — parts per million, volume basis

5.1.14 *psi* — pounds per square inch

5.1.15 *psia* — pounds per square inch absolute

5.1.16 *psig* — pounds per square inch gauge

5.1.17 R_a — surface roughness average (as defined in ANSI B46.1)

5.1.18 $R_{a,max}$ — surface roughness maximum (as defined in ANSI B46.1)

5.1.19 *s* — second

5.1.20 *sccm* — standard cubic centimeters per minute

5.1.21 *slpm* — standard liter per minute

5.2 *Definitions*

5.2.1 *activation* — the process of initially preparing the purifier media to be chemically reactive with gas impurities.

5.2.2 *activation temperature* — temperature at which DUT was initially prepared.

5.2.3 *atmospheric pressure ionization mass spectrometer (APIMS)* — an instrument consisting of an atmospheric pressure ion source where gas phase impurities are ionized via charge exchange reactions with the bulk gas. These ions are directed into a vacuum chamber where they are then separated by a mass analyzer and detected by an electron multiplier.

5.2.3.1 *ion source* — the section of a mass spectrometer used to generate sample ions by electron impact, chemical ionization, or charge exchange.

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5.2.3.2 *mass analyzer* — a device that utilizes electric and/or magnetic fields to separate charged particles or ions according to their mass-to-charge (m/e) ratios. Examples of mass analyzers include quadrupole, magnetic and/or electric sector, time of flight, and ion traps.

5.2.3.3 *electron multiplier* — a device that detects and amplifies electro-magnetic phenomena such as positive/negative ions.

5.2.4 *back pressure regulator* — a self-contained device, consisting of a mechanical or electrical sensor and control device, commonly used in the semiconductor industry to maintain a constant pressure upstream of the regulator.

5.2.5 *breakthrough* — the point in time when an individual impurity level in the purifier effluent exceeds the level specified by the manufacturer. Typically in the range of 1–100 ppb.

5.2.6 *challenge gas* — a gas mixture containing high levels of gas impurities. Typically, a challenge gas has impurities of between 500 ppm to 1% which is used to shorten the test duration; however, challenges in the range of 1–10 ppm for the impurities is more representative.

5.2.7 *gaseous impurities* — gas phase elements and compounds in the gas stream other than the process or base gas.

5.2.8 *impurity analyzer* — an appropriate analyzer to measure the concentration of desired impurities in a gas stream from the ppm to the percent (%) concentration range.

5.2.9 *inert gas* — a gas, which at ambient conditions, does not react chemically with other materials or chemicals.

5.2.10 *limit of detection (LOD)* — lowest concentration that can be detected by an instrument. LOD is typically defined as three times the standard deviation of the mean noise level (see SEMI F6, lower detectable limit of instrument).

5.2.11 *mass flow controller (MFC)* — a self-contained device, consisting of a mass flow transducer, control valve, and control and signal-processing electronics, commonly used in the semiconductor industry to measure and regulate the mass flow of gas (as defined in SEMI E29).

5.2.12 *pure gas* — an inert gas, minimum purity of 99.9995%, and less than 1 ppb of each impurity that is specified to be removed by the DUT.

5.2.13 *purifier* — generally a catalytic (getter, reactive), resinous, or diatomaceous material within a pressure vessel which removes particulate and/or trace gas impurities from a gas stream (as defined in SEMI F22).

5.2.14 *purifier capacity* — the total quantity of each trace gas impurity that may be sorbed by the purifier media. Defined as liters impurity/liter purifier media.

5.2.15 *regeneration* — the process of reactivating the purifier media.

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

5.2.17 *test flow rate* — flow rate through DUT (slpm).

5.2.18 *test pressure* — pressure immediately upstream of the DUT.

5.2.19 *test temperature* — operating temperature of DUT.

5.2.20 *ultratrace analytical instrumentation* — instrumentation that has sufficient sensitivity to measure all impurities of interest at the specified level of the customer, the ppb or sub-ppb level.

5.2.21 *zero gas* — nitrogen, argon, helium or hydrogen with an estimated level an order of magnitude, or more, lower than the lowest calibration point for each impurity of interest (as defined in SEMI F33).

6 Summary of Method

6.1 This method will allow a user to quantify the impurity removal capacity of a given inert gas purifier for that impurity.

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