

SEMI F112-0820

TEST METHOD FOR DETERMINATION OF MOISTURE DRY-DOWN CHARACTERISTICS OF SURFACE-MOUNTED AND CONVENTIONAL GAS DELIVERY SYSTEMS BY CAVITY RING DOWN SPECTROSCOPY (CRDS)

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1 Purpose

1.1 This Document describes the procedure for determination of the moisture dry-down characteristics (quantity of removable moisture) of surface mount (integrated gas delivery systems) and conventional gas delivery systems using cavity ring down spectroscopy (CRDS) analyzers.

1.2 The results of this test can be used for qualitative ranking of gas delivery system based on the design. It can also be used by a sufficiently sophisticated user as input for numerical simulation of a gas distribution system behavior.

2 Scope

2.1 This Test Method applies to all types of surface mount and conventional gas delivery systems used in semiconductor processing.

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 Test Method allows the determination of moisture interactions which can be used, for example, to rank systems in order of decreasing moisture interaction. Because different degrees of moisture interaction are permissible in different situations, selecting the 'best' system requires consideration of how they will be used, either qualitatively or through a numerical simulation of distribution system behavior.

3.2 The results of this test can only be used for qualification for gas delivery systems based on different designs. It cannot be used for production purposes and/or certification/testing.

4 Referenced Standards and Documents

4.1 *SEMI Standards and Safety Guidelines*

SEMI C15 — Test Method for ppm and ppb Humidity Standards

SEMI F1 — Specification for Leak Integrity of High-Purity Gas Piping Systems and Components

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

5 Terminology

5.1 *Abbreviations and Acronyms*

5.1.1 *CRDS* — cavity ring down spectroscopy

5.1.2 *EPSS* — electropolished stainless steel

5.1.3 *ppb* — molar parts per billion (nmole/mole). The same as ppbv.

5.1.4 *ppt* — molar parts per trillion (pmole/mole). The same as pptv.

5.1.5 *slpm* — standard liters per minute, the gas volumetric flow rate measured in liters per minute at 0°C and 1 atm.

5.2 Definitions

5.2.1 *baseline* — an instrument response under steady state conditions.

5.2.2 *induction time* — the elapsed time between when humidified gas is introduced to the test system and when moisture is detected at the moisture analyzer. For a test system which is perfectly transparent to moisture, the induction time is equal to the residence time of the gas in the system.

5.2.3 *peak height* — the maximum moisture concentration recorded when a moisture input of predefined length and concentration is introduced to a test system.

5.2.4 *response time* — the time required for the test system to reach steady state after a change in concentration.

5.2.5 *test system* — the gas delivery system under test.

6 Summary of Test Method

6.1 This Test Method consists of initial dry-down and moisture input tests for both surface-mount and conventional gas delivery systems.

6.2 *Operating Situations* — Moisture contribution from a gas delivery system may be the result of contamination arising in its manufacture, or from subsequent exposure to ambient air or non-dry gas. Thus, it is necessary to consider two main situations:

6.2.1 The ‘initial dry-down’ situation, which is determined by the moisture content of the components in the system (as received) with the effects of manufacturing process and design, surface quality, pretreatment and packaging convoluted together.

6.2.2 The ‘response to upset’ situation, which is determined by the amount of moisture taken up by the system and subsequently released in any exposure after receipt.

7 Required Equipment and Medium

7.1 *CRDS* — The CRDS analyzer used for moisture detection can be of any type. The CRDS analyzer should be installed following the manufacturer’s guidelines.

7.2 *Dry Gas and Moisture Generator* — A source of extremely dry nitrogen (less than 200 ppt moisture) and a moisture generator capable of delivering up to 13 slpm nitrogen doped with 200 ppb moisture is required. The output of the generator shall be verified according to SEMI C15.

7.2.1 Most ultra-high purity gas panels are currently fitted with metal gasket type connectors. The same type of connector should, therefore, be incorporated into the test bench for connection to the test system.

7.3 *Test Blank* — Any series of tests shall include the results of testing a blank. The blank shall be the shortest convenient length (no more than 1 m) of 0.63 cm (1/4 in.) electropolished stainless steel (EPSS) tubing with suitable fittings and/or adapters at either end to enable it to be inserted in place of the test system.

7.4 *Moisture Pulse Generator* — A valve arrangement capable of switching instantaneously between dry and humidified nitrogen is also required. An example of such a design is shown in Figure 1. In this design, flow is maintained in both the humidified and dry gas lines at all times. By simultaneously switching valves V_{1a} , V_{1b} or V_{2a} , V_{2b} , either humidified or dry gas is directed through the test system while the other gas stream is directed to vent. Note that there is a bypass loop so that flow can be maintained to the CRDS analyzer when the test system is removed. In this design, all gas lines should be constructed of EPSS tubing of high quality and kept as short as possible, with valve porting as shown in Figure 1, to minimize dead legs.

7.5 *Test Medium* — The test medium shall be nitrogen. Other ‘inert’ gases will have different purging characteristics and may dry a system more quickly or slowly. Reactive gases shall not be used as they may react chemically with moisture. Considerations relating to corrosion resistance are outside the scope of the present document, although the test procedure may prove useful in corrosion studies. The results will provide a ranking with respect to moisture contribution arising as a result of differences in design, which may be applied with due caution to systems intended for use in other gas applications.