

CRDS becomes method of choice for SEMI F112

Test Method for Determining Moisture Dry-down Characteristics of Gas Delivery Systems by Cavity Ring-Down Spectroscopy (CRDS)

Introduction

Cavity Ring-Down Spectroscopy is a well-known and utilized technique for monitoring moisture in high purity process gases within the semiconductor and LED manufacturing industries, as well as in industrial gas and chemical production, transport, and distribution. The benefits of CRDS are attracting the attention of industry standards publishers, such as SEMI, who are aggressively moving to incorporate this accurate and cost-effective moisture monitoring technique into relevant standards that are instrumental in their industries.

What is the SEMI F112 Standard?

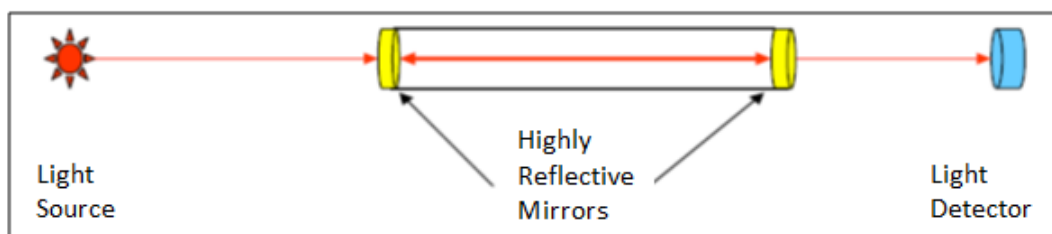
SEMI standards are voluntary technical agreements between suppliers and customers, aimed at improving product quality and reliability at a reasonable price and steady supply. These standards ensure global compatibility and inter-operability of goods and services to meet the challenges of increasing productivity while enabling business opportunities around the globe. The documents are published in the 16 volume set¹ of SEMI International Standards, which cover every aspect of photovoltaic and semiconductor manufacturing. More information on SEMI standards can be found here: http://www.semi.org/en/Standards/P_000787

SEMI Standard F112 is a test method for determining moisture dry-down characteristics of gas delivery systems by Cavity Ring-Down Spectroscopy (CRDS). This procedure allows users to qualitatively assess and rank gas delivery systems based on their design, and is applied to:

- Surface mounted gas delivery systems (“gas sticks”)
- Conventional gas delivery systems
- Qualification of new piping installations
- Qualification of new gas distribution designs

How does CRDS work?

CRDS works by utilizing a Continuous Wave (CW) diode laser to emit a directed beam of light energy through an ultra-high reflective mirror into the absorption cell (cavity). The light reflects back and forth between two ultra-high reflective mirrors multiple times; on each successive pass, a small amount of light or ring-down signal emits through the second mirror and is sensed by the light detector. When the photodiode detector “sees” a preset level of light energy, the light source is shuttered, or diverted from the cavity.



¹ As of August, 2013

Once the light decays, or “rings down”, the detector achieves a point of zero light energy in a matter of microseconds and the measurement is complete. The computer within the CRDS analyzer controls the laser to measure ring-down times both on the major absorption wavelength for the species of interest, as well as off-peak where the wavelength is such that no absorption occurs (which is equivalent to a zero baseline). The concentration within the cell cavity can then be calculated by comparing the ring-down times, based on first principles which follow the Beer-Lambert law.

How does CRDS improve the standard?

Prior to SEMI F112, the standard that supported this moisture dry-down characterization procedure (SEMI F58) required the use of an Atmospheric Pressure Ionization Mass Spectrometer (APIMS) to monitor the moisture levels in a gas stick. While the APIMS system can achieve part-per-trillion (ppt) levels of moisture detection, these systems are expensive, require a highly-trained operator, need calibration as well as consumable calibration gases, and require periodic maintenance.

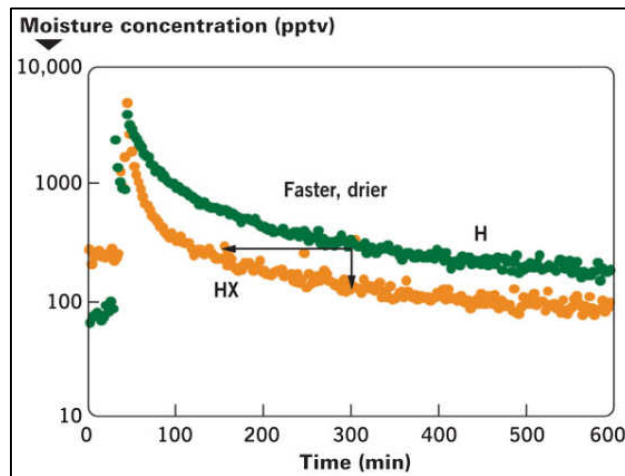
The benefits of CRDS compelled the SEMI technical committee to replace APIMS with CRDS as part of the new SEMI F112 standard. CRDS analyzers provide the user with an accurate and absolute measurement (no calibration gases required) down to ppt level detection limits. In addition to having a low cost of ownership, CRDS analyzers are simple to install and do not require a skilled technician to operate. The analyzers do not have any moving parts and the only “maintenance” required is a software routine that can be pre-programmed and automated. With the adoption of SEMI F112, the SEMI F58 APIMS-based standard is now considered obsolete.

How is SEMI F112 used in practice (practical applications)?

SEMI F112 as described above is used to test moisture dry-down characteristics. This standard can apply to many different stakeholders, including the manufacturers of gas delivery systems, valve manifold boxes, gas purifiers, as well as gas validation firms. In practice, this standard is applied for many reasons, such as evaluating how quickly a particular system dries down to a specified moisture value, or whether or not a system is capable of achieving a set moisture level that may be required by a particular customer. Two practical examples are noted below.

Entegris, a manufacturer of critical products and materials used in advanced high-technology manufacturing recently used the SEMI standard to evaluate gas purification performance of an Entegris gas purifier filled with two different gas purification adsorbent media (H and HX media). The system was allowed to drydown to < 300 ppt before replacement of the test blank with each filter. A spike in moisture, to approximately 5 ppbv is seen upon re-establishment of the gas flow. Entegris concluded that while both purifiers exhibited similar dry-down rates, the new HX media achieved an overall 2X drier level than the H media.²

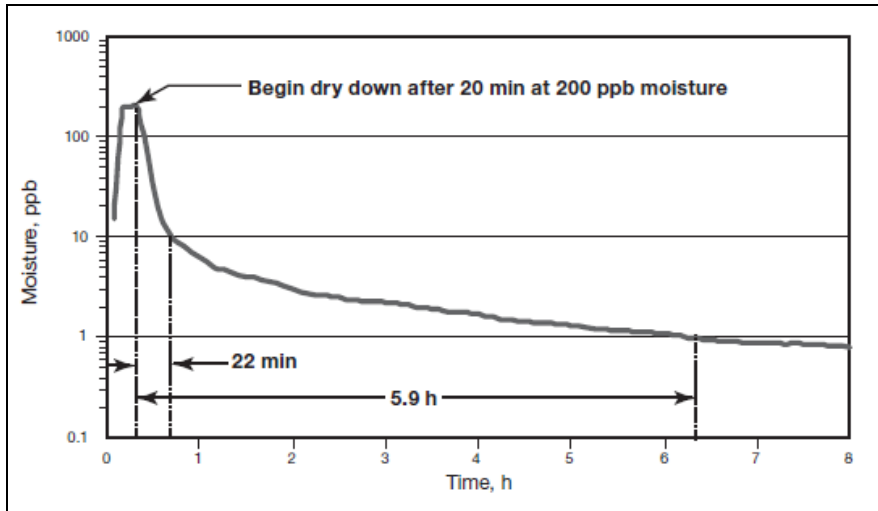
As a second example, Swagelok reported³ their findings when testing the moisture dry-down characteristics of their “ICG II” test panel, which consisted of 3 “stick lines” and 2 “manifold lines” each containing various components. After an initial pulse of 200 ppb of moisture for a



² <http://www.electroiq.com/articles/sst/print/volume-55/issue-2/features/metrology/metrology-aided-gas.html>

³ <http://www.swagelok.com/downloads/webcatalogs/EN/MS-06-17-E.pdf>

duration of 20 minutes, the test panel was characterized to dry-down to 10 ppb within 22 minutes, and a value a 1 ppb in just under 6 hours.



Summary

CRDS has now been adopted and integrated into SEMI Standard F112 for the determination of moisture dry-down characteristics of gas delivery systems. The replacement of APIMS technology with CRDS allows users to utilize an extremely accurate, sensitive, and simple moisture monitor without sacrificing significant budget for analyzer costs or the users needed to operate it. The compelling benefits of CRDS and its incorporation into the SEMI F112 standard will continue to allow electronic manufacturers and gas suppliers to meet the demanding and exacting requirements of ultra-high purity gas delivery.