

WELD GAS PURGE JUMPER PARTICLE FILTERS FOR SEMICONDUCTOR WAFER FAB

OVERVIEW:

The purpose of the weld gas purge jumper particle filter is to remove submicron sized particles from the shield gases used in high purity welds during the build and installation of a semiconductor wafer fab. Contractors and weld operators use shield gas (argon, helium or both) to protect against oxidation when joining high purity tubing. Most fab project managers insist that contractors follow specific welding procedures and will inspect weld quality to SEMI standards.

THE CHALLENGE: SEMI STANDARDS FOR WELDING

Today the Semiconductor industry welders are using welding guidelines established by SEMI International. The standards that apply to orbital GTA welding in semiconductor fluid distribution systems are: SEMI F78-0304 - Practice for Gas Tungsten Arc (GTA) Welding of Fluid Distribution Systems in Semiconductor Manufacturing Applications, which is a guideline for fabrication, and SEMI F81-1103, Specification for Visual Inspection and Acceptance, which details weld acceptance criteria.

The SEMI standards provide guidelines for welders and welding operators while also providing a set of criteria by which quality assurance/quality control inspectors can evaluate welds.

INERT GAS PURGING IS CRITICAL

Purging is an essential part of the GTA welding process in which inert gas protects the tungsten electrode and weld pool from discoloration caused by oxidation. A purge on the ID surface is particularly critical as discoloration is associated with loss of corrosion resistance and particulate detrimental to semiconductor wafer yield and other gas delivery components. The weld assembly must be kept under a continuous purge until all welding is complete. The all 316L SS purge gas apparatus must use face seal fittings for ultra-high purity applications. This purge gas apparatus sometimes called a purge jumper often includes a particle filter.

The ID purge gas must be certified to less than 3 parts per million (ppm) total moisture, oxygen and other contaminants. Filtering this gas is critical to weld quality as often cylinders used for compressed argon and helium gases can contain substantial levels of particles that could impact the quality of the weld or leave behind particle contaminants after the weld closure.



Welding Process

SOLUTION: OPTIMAL FILTER MEDIA

Weld gas filters should be of sufficient filtration efficiency as to remove particle contamination from the gas stream without contributing additional contamination from outgassing of Oxygen or Hydrocarbons. In addition, the weld purge gas filters should have a rapid moisture recovery time as they will often be exposed to atmosphere as the contractors are welding new systems.

In terms of moisture recovery and particle efficiency levels, not all filters are of equal performance. The most popular filter media for purge gas jumpers is a sintered metal element, either 316L SS or Nickel powder or a 316L SS fiber media. These metal media have exceptional filtration efficiency performance and very good moisture recovery as the subsequent data below illustrates. Occasionally filters with plastic or Teflon® filter media are used, but this can greatly increase the time to welding due to long moisture recovery. Since today's metal filters are often comparable in cost to Teflon® or plastic filters, there is little reason to accept long moisture recovery cycles.

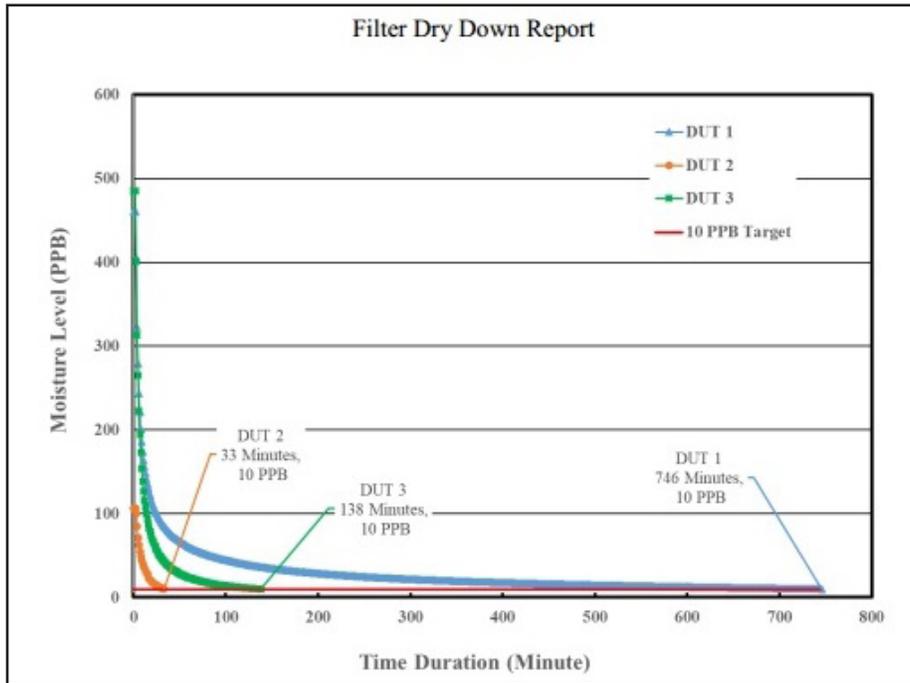
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Data has proven that metal filters can recover from a significant moisture exposure to dry down to less than 10 ppb in under 60 minutes at the rated gas flow. Teflon® and other polymer filters can have an affinity for water and take upward of 24-48 hours to meet that required moisture level. Given the thousands of welds made in the building of a semiconductor facility, this time savings and weld quality assurance of an all-metal filter provides significant cost benefit to the wafer fab owner.

COMPARISON OF WELD PURGE GAS FILTERS

Below is a comparison of various filter types and their effectiveness as a purge gas filter in terms of particle efficiency and moisture recovery. This data was gathered using Continuous Wave Cavity Ring-Down Spectroscopy with parts per trillion detection limits for moisture.



Filter Media Type	DUT 2 Mott POU-05-FSV1	DUT 3 Mott FXP331FF11	DUT 1 Standard Polymeric Filter
Materials of Construction	316L SS Housing and Filter Media	316L SS Housing and Filter Media	316L SS Housing and Teflon® Filter Media, PFA Molded Structure
Moisture Recovery After 24 Hours Exposure at Ambient ATM Conditions	<10 ppb after 33 Minutes at 10 slpm	<10 ppb after 138 Minutes (2 hrs, 18 min) at 10 slpm	<10 ppb after 750 Minutes (>12 hrs, 26 min) at 10 slpm
Filtration Efficiency	99.9999999% at 0.0015 µm	99.9999999% at 0.003 µm	99.9999999% at 0.003 µm

CONCLUSION:

The flexibility to be able to start and stop shield gas systems up to 8 times per 8-hour day provides significant savings in time and shield gas costs. Using a fiber metal filter provides the fastest and most cost-effective filtration of shield gases needed for ultra-high purity and high purity weldments. Given the thousands of welds required for installation of a semiconductor wafer fab, this filter could save several weeks to months in installation time, allowing commissioning of wafer fabs in a relatively shorter time. The recouping of capital investment for the fab can be significant as expensive equipment and facilities can begin producing product that much sooner.