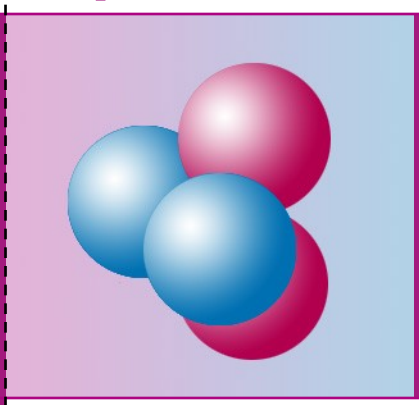
Alpha Particle Emissivity Counting



Determining the Source of Soft Errors to Improve Yield

Alpha Emissivity Testing in the Semiconductor Industry

As semiconductor industry evolves and device geometries shrink and new materials films are being utilized, device sensitivity to contamination becomes more significant. Many contamination sources such as metallics or salts will reveal themselves via in-process testing. One such impurity not so easily determined is alpha particle emissivity. Alpha particles are single He atoms that in semiconductor processing are derived from materials such as H_3PO_4 (phosphate ore), new exotic materials or molding compounds used in packaging. Alpha emissivity generates localized ionization events that temporarily disrupt the state of the device. However, since no permanent physical damage is done to the device, this type of error has been termed a “soft” error.

Moreover, soft errors associated with alpha emissivity are not detected with in-process test or at post-process test. Instead, this failure mode exhibits itself in a more random manner. This mode of failure has cost companies millions of dollars in troubleshooting and further illustrates the need for up front material testing for alpha emissivity.

Analytical Technique

There are several different gas proportion alpha particle counters that can be used for testing the alpha emissions of materials. Balazs™ NanoAnalysis utilizes an ultra-low background counter with highest sensitivity. Solid samples up to 11 inches x 14 inches in size (or two 200 mm wafers) can be tested.

Figure 1. Alpha particle counters at Balazs laboratory

www.balazs.com
Tel. +1 510 624 4000

The ultra-low background model can test up to eight 200 mm wafers at a time to increase surface area for ultra-low alpha testing (Figure 1). Balazs™ can perform alpha emissivity testing for a full range of materials used in semi processing.

Analytical Methodology

Alpha particles emitted from a sample surface travel through a very thin Mylar film within a sample chamber. The particles then collide with a counting gas to form ions that are attracted to electrodes for signal amplification and counting (Figure 2). Because the life of an alpha particle is limited to only a few centimeters, the sample surface must be placed within 2 millimeters of the detector window for reliable and accurate counting.

Alpha particles with energy between 1 and 10 MeV can be detected.

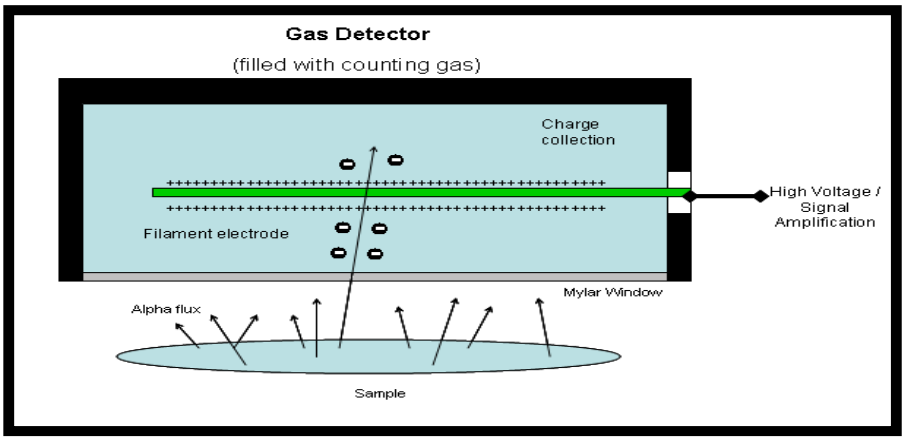


Figure 2. Diagram of typical gas flow proportional configuration for alpha particle counting.

Sample area and counting time are two major factors that can be controlled to increase detection sensitivity. Increasing the sample surface results in higher alpha flux, while increasing acquisition time leads to better precision and better counting statistics.

The JEDEC Standard

Special considerations must be made for measuring the alpha emissivity of materials used in the semiconductor industry because the low alpha flux of the samples being tested can be approximately the same as measured background levels. Longer acquisition times must be used to gain the proper counting statistics in these cases.

In 2009, a JEDEC sub-committee was assembled to develop measurement criteria for ultra-low alpha testing to be used in the semiconductor industry. Balazs™ is committed to following these guidelines for all alpha particle measurements to ensure compliance with these standards.