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Alpha Radiation Measurement in Electronic Materials

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ALPHA RADIATION MEASUREMENT IN ELECTRONIC MATERIALS

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Introduction

Soft error upsets in semiconductor devices are caused by energetic particle interactions with the sensitive nodes in the device. One source of these energetic particles is radioisotope impurities in the materials that comprise the device. Alpha particles are of primary concern, and materials that have low alpha activity have been selected for critical applications to mitigate this effect. Measurement of the alpha flux is important to establish both the usability of these materials and the reliability of the semiconductor devices fabricated from them.

The measurement of alpha flux below 10 $\alpha \cdot khr^{-1} \cdot cm^{-2}$ is complicated by the fact that the sample alpha flux is usually less than or equal to the background alpha flux in the detector. Achieving a reasonable degree of precision requires measurements lasting for many hours or days. The low signal to background ratio also makes measurement results vulnerable to variations in techniques and methods. Elimination of or compensation for these sources of measurement variation allows for scientifically and statistically valid results that are reproducible between different laboratories.

ALPHA RADIATION MEASUREMENT IN ELECTRONIC MATERIALS

(From JEDEC Board Ballot JCB-11-21, formulated under the cognizance of the JC-13.4 Subcommittee on Radiation Hardness and Assurance and the JC-14.1 Subcommittee for Reliability Test Methods for Packaged Devices.)

1 Scope

This standard applies generally to gas proportional instruments and the use thereof in measuring materials with an alpha emissivity of less than 10 $\alpha \cdot khr^{-1} \cdot cm^{-2}$. The primary focus will be on materials used in semiconductor fabrication.

The purpose of this document is to specify the recommended method for measuring alpha emissivity in materials utilized in the manufacturing of semiconductors. The method specifically applies to gas proportional instruments and designates recommended instrument settings. In addition, the method discusses operation of ionization counters. The document also recommends methods for determining sample size and for evaluating instrument background accurately. Treatment of data is also outlined, including identification and elimination of systematic errors. The calculation of results and detection limits is detailed with examples in the annexes. A standard format for reporting results is specified.

2 Terms and Definitions

accuracy: A measure of how close the measured result is to the true value.

bias voltage: Potential applied between the anode and cathode in a gas proportional counter.

detector background: Signal measured by the detector in the absence of a sample.

discriminator: Signal rejection mechanism which eliminates low and high energy events.

efficiency: The ratio between the number of alpha particles detected and the actual number of events occurring. This same value for the detector efficiency is used when measuring the detector background.

emissivity: The rate of emission of alpha radiation measured in counts per unit area per unit time.