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Standard Practice for Minimizing Dosimetry Errors in Radiation Hardness Testing of Silicon Electronic Devices Using Co-60 Sources[1]

This standard is issued under the fixed designation E 1249; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers recommended procedures for the use of dosimeters, such as thermoluminescent dosimeters (TLD's), to determine the absorbed dose in a region of interest within an electronic device irradiated using a Co-60 source. Co-60 sources are commonly used for the absorbed dose testing of silicon electronic devices.

NOTE 1—This absorbed-dose testing is sometimes called "total dose testing" to distinguish it from "dose rate testing."

NOTE 2—The effects of ionizing radiation on some types of electronic devices may depend on both the absorbed dose and the absorbed dose rate; that is, the effects may be different if the device is irradiated to the same absorbed-dose level at different absorbed-dose rates. Absorbed-dose rate effects are not covered in this practice but should be considered in radiation hardness testing.

1.2 The principal potential error for the measurement of absorbed dose in electronic devices arises from non-equilibrium energy deposition effects in the vicinity of material interfaces.

1.3 Information is given about absorbed-dose enhancement effects in the vicinity of material interfaces. The sensitivity of such effects to low energy components in the Co-60 photon energy spectrum is emphasized.

1.4 A brief description is given of typical Co-60 sources with special emphasis on the presence of low energy components in the photon energy spectrum output from such sources.

1.5 Procedures are given for minimizing the low energy components of the photon energy spectrum from Co-60 sources, using filtration. The use of a filter box to achieve such filtration is recommended.

1.6 Information is given on absorbed-dose enhancement effects that are dependent on the device orientation with respect to the Co-60 source.

1.7 The use of spectrum filtration and appropriate device orientation provides a radiation environment whereby the absorbed dose in the sensitive region of an electronic device can be calculated within defined error limits without detailed knowledge of either the device structure or of the photon energy spectrum of the source, and hence, without knowing the details of the absorbed-dose enhancement effects.

1.8 The recommendations of this practice are primarily applicable to piece-part testing of electronic devices. Electronic circuit board and electronic system testing may introduce problems that are not adequately treated by the methods recommended here.

1.9 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

E 170 Terminology Relating to Radiation Measurements and Dosimetry[2]

E 666 Practice for Calculating Absorbed Dose From Gamma or X-Radiation[2]

E 668 Practice for Application of Thermoluminescence-Dosimetry (TLD) Systems for Determining Absorbed Dose in Radiation-Hardness Testing of Electronic Devices[2]

E 1250 Test Method for Application of Ionization Chambers to Assess the Low Energy Gamma Component of Cobalt-60 Irradiators Used in Radiation-Hardness Testing of Silicon Electronic Devices[2]

2.2 *International Commission on Radiation Units and Measurements Reports:*

ICRU Report 14 Radiation Dosimetry: X-Rays and Gamma Rays With Maximum Photon Energies Between 0.6 and 50 MeV[3]

ICRU Report 18 Specification of High Activity Gamma-Ray Sources[3]

3. Terminology

3.1 *absorber*—material that reduces the photon fluence rate from a Co-60 source by any interaction mechanism.

3.2 *absorbed-dose enhancement*—increase (or decrease) in the absorbed dose (as compared to the equilibrium absorbed dose) at a point in a material of interest. This can be expected to occur near an interface with a material of higher or lower atomic number.

[1] This practice is under the jurisdiction of ASTM Committee E10 on Nuclear Technology and Applications and is the direct responsibility of Subcommittee E10.07 on Radiation Dosimetry for Radiation Effects on Materials and Devices.

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[2] *Annual Book of ASTM Standards*, Vol 12.02.

[3] Available from International Commission on Radiation Units, 7910 Woodmont Ave., Washington, DC 20014.

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