Designation: E 684 – 95 (Reapproved 2000)

Standard Practice for Approximate Determination of Current Density of Large-Diameter Ion Beams for Sputter Depth Profiling of Solid Surfaces[1]

This standard is issued under the fixed designation E 684; 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 describes a simple and approximate method for determining the shape and current density of ion beams. The practice is limited to ion beams of diameter greater than 0.5 mm of the type used for sputtering of solid surfaces to obtain sputter depth profiles. It is assumed that the ion-beam current density is symmetrical about the beam axis.

1.2 *This standard does not purport to address all of the safety concerns, 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 673 Terminology Relating to Surface Analysis[2]

E 1127 Guide for Depth Profiling in Auger Electron Spectroscopy[2]

E 1577 Guide for Reporting of Ion Beam Parameters Used in Surface Analysis[2]

3. Terminology

3.1 Terms used in Auger electron spectroscopy are defined in Terminology E 673.

4. Significance and Use

4.1 Sputter depth profiling is used in conjunction with Auger electron spectroscopy, x-ray photoelectron spectroscopy, and secondary ion mass spectrometry to determine the chemical composition and atomic concentration as a function of distance from the surface of a specimen. See Guide E 1127.

4.2 The diameter of the ion beam used for sputtering must be specified and this practice is a relatively quick method of measuring the shape (that is, current density distribution) of the ion beam if a suitable Faraday cup is not available.[3]

5. Procedure

5.1 Measure the total ion current in the beam by allowing the total beam to strike the carousel (or other specimen holder). Apply a d-c bias of about 100 V to the carousel to return low-energy secondary electrons created by the ion beam.

5.2 Attach a straight wire to the carousel extending over the edge such that the ion beam will strike the wire but not the carousel. The wire may be tungsten or other suitable material with a diameter of about 25 µm. The wire diameter should be sufficient to intercept measurable ion current but small with respect to the ion beam diameter to minimize distortion. The carousel may then be translated or rotated (with rotation converted to arc length) to determine the ion beam shape. See Guide E 1577.

6. Interpretation of Results

6.1 In general, a Gaussian current distribution will be observed and the full width at half-maximum peak height can be determined. The maximum ion beam current density may then be determined as follows:

$$J_{max} = 0.88 \frac{i^+}{(FWHM)^2} \quad (1)$$

where:

J_{max} = maximum ion beam current density,
i^+ = otal ion current, and
$FWHM$ = full width at half-maximum peak height.

6.2 This method is simple, but it suffers from the collection of stray secondary electrons during biased ion current measurements. This situation can be alleviated somewhat if the ion detection wire is electrically isolated from the carousel and both are biased independently. However, the stray electron problem still exists. Also, the application of a bias can distort the beam profile to be measured. Thus, this practice should be used only as an approximate method for determining the shape and current density of the ion beam. The errors of measurement have not been investigated but can be expected to depend on

[1] This practice is under the jurisdiction of ASTM Committee E-42 on Surface Analysis and is the direct responsibility of Subcommittee E42.08 on Ion Beam Sputtering.

Current edition approved Sept. 10, 1995. Published November 1995. Originally published as E 684 – 79. Last previous edition E 684 – 94.

[2] *Annual Book of ASTM Standards*, Vol 03.06.

[3] For a discussion of errors in the use of a Faraday cup detector, see Ingram, G. D. and Seah, M. P., *Journal of Physics E: Scientific Instruments*, Vol 22, 1989, pp. 242–249.

the wire material, the electric field in the neighborhood of the wire, and the ion species and energy. A Faraday-cup detector should be used to obtain more accurate measurements of ion current.

7. Keywords

7.1 ion beam sputtering