Designation: E684 – 04

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

1. Scope

1.1 This practice describes a simple and approximate method for determining the current density distribution 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:*[2]

E673 Terminology Relating to Surface Analysis (Withdrawn 2012)[3]

E1127 Guide for Depth Profiling in Auger Electron Spectroscopy

E1577 Guide for Reporting of Ion Beam Parameters Used in Surface Analysis

3. Terminology

3.1 Terms used in Auger electron spectroscopy are defined in Terminology E673.

4. Significance and Use

4.1 Sputter depth profiling is used in conjunction with Auger electron spectroscopy, x-ray photoelectron spectroscopy, ion scattering 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 E1127.

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.[4]

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 E1577.

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^{+} = total ion current, and
$FWHM$ = full width at half-maximum peak height.

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

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

[4] 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.