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## Standard Guide for Determining SIMS Relative Sensitivity Factors from Ion Implanted External Standards<sup>1</sup>

This standard is issued under the fixed designation E1505; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 The purpose of this guide is to provide the secondary ion mass spectrometry (SIMS) analyst with two procedures for determining relative sensitivity factors (RSFs) from ion implanted external standards. This guide may be used for obtaining the RSFs of trace elements (<1 atomic %) in homogeneous (chemically and structurally) specimens. This guide is useful for all SIMS instruments.

1.2 This guide does not describe procedures for obtaining RSFs for major elements (>1 atomic %). In addition, this guide does not describe procedures for obtaining RSFs from implants in heterogeneous (either laterally or in-depth) specimens.

1.3 The values stated in SI units are to be regarded as the standard.

1.4 *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:*<sup>2</sup>

**E673 Terminology Relating to Surface Analysis**

### 3. Terminology

3.1 *Definitions*—See Terminology **E673** for definitions of terms used in SIMS.

### 4. Summary of Practice

4.1 This guide will allow calculation of the RSFs of trace elements from plots of SIMS secondary ion intensity (counts/s) versus time (s) that are acquired during the sputtering of ion implanted external standards. Briefly, these plots are obtained in the following manner: an ion beam of a particular ion species, ion energy, and angle of incidence is used to bombard

an ion implanted external standard. The beam is rastered or defocused in order to attempt to produce uniform current density in the analyzed area, which is defined by means of mechanical or electronic gating. The intensities of the secondary ions associated with the implanted element of interest and a reference element (typically, a major element in the specimen matrix, which is distributed homogeneously in the specimen at a known concentration) are monitored with respect to time during the ion sputtering.

4.2 An RSF for a given analyte ion,  $A$ , and a given reference ion,  $R$ , is equal to the ratio of their respective useful ion yields,  $\tau_A \cdot \tau_R^{-1}$ , where  $\tau$  equals the number of ions detected divided by the number of corresponding atoms sputtered (**1-3**).<sup>3</sup> An RSF is determined from the secondary ion intensity versus time data obtained from implanted standards using one of two arithmetic models described in the procedure (Section 7) of this guide. A measure of final crater depth is required for RSF determination. This measurement may be performed by another analytical technique (see Section 7).

### 5. Significance and Use

5.1 The quantification of trace element compositions in homogeneous matrices from first principles requires (1) knowledge of the factors influencing ion and sputtering yields and (2) understanding of how instrumental parameters influence these yields (**1-3**). This information is difficult to obtain. Therefore, SIMS operators commonly use external standards to determine RSFs. These RSFs are then used to quantify the composition of trace elements in the specimen of interest through the application of the following equation to each data point of the depth profile of interest (**1-3**).

$$C_A = I_A \cdot C_R \cdot (I_R \cdot \text{RSF} \cdot N)^{-1} \quad (1)$$

where:

$C_A$  and  $C_R$  = concentrations (atoms-cm<sup>-3</sup>) of the analyte and reference elements, respectively;  
 $I_A$  and  $I_R$  = intensities (counts/s) obtained from the analyte and reference ions, respectively; and  
 $N$  = natural abundance (expressed as a fraction) of the analyte isotope being examined.

<sup>1</sup> This guide is under the jurisdiction of ASTM Committee E42 on Surface Analysis and is the direct responsibility of Subcommittee E42.06 on SIMS.

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<sup>2</sup> 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.

<sup>3</sup> The boldface numbers in parentheses refer to the list of references at the end of this guide.