Designation: E 1635 – 95 (Reapproved 2000)

# Standard Practice for Reporting Imaging Data in Secondary Ion Mass Spectrometry (SIMS)[1]

This standard is issued under the fixed designation E 1635; 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 lists the minimum information necessary to describe the instrumental, experimental, and data reduction procedures used in acquiring and reporting images generated by secondary ion mass spectrometry (SIMS).

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 1504 Practice for Reporting Mass Spectral Data in Secondary Ion Mass Spectrometry (SIMS)[2]

## 3. Terminology

3.1 *Definitions*—For definitions of terms used in this guide, refer to Terminology E 673.

## 4. Summary of Practice

4.1 Experimental conditions and reporting procedures that affect SIMS imaging data are presented in order to standardize the reporting of such data and to facilitate comparisons with other laboratories and analytical techniques.

## 5. Significance and Use

5.1 This practice is to be used for reporting the experimental and data reduction procedures to be described with the publication of the data.

## 6. Information to be Reported

6.1 Standard information to be reported may be found in Practice E 1504. This information pertains to the type of SIMS instrumentation used, the mounting of the specimen, and the experimental conditions. For imaging SIMS analysis, additional information is required on the acquisition and display parameters for each image. The information reported will depend primarily on the type of SIMS instrumentation used. Two distinct instrumental configurations are used for ion imaging: the ion microscope and the ion microprobe.

6.2 *Experimental Conditions for Acquisition of Ion Microscope Images*:

6.2.1 *Camera Based Systems*—In the ion microscope, the secondary ion optics project a mass resolved secondary ion image onto the plane of an imaging detector. In the simplest case, the secondary ion image is visualized via ion-to-electron conversion at a channel plate array placed in front of a fluorescent screen.[3] The image resolution depends on the setup of the ion optics and the energy and angular distribution of the sputtered ion flux and is typically 0.5 to 1 μm. The ion image is visualized on the fluorescent screen using a variety of camera systems, including but not limited to vidicon cameras, intensified cameras such as the SIT camera, charge-coupled device (CCD) cameras and slow-scan scientific grade CCD cameras. The type of camera system used will define the sensitivity and dynamic range of the acquired images. Minimum parameters to be specified should include the integration time for each mass, number of pixels in the image, field-of-view, and the level of digitization (one byte or two). Also, the type of channel plate used for ion-to-electron conversion should be stated (single, double, curved, or high-output-technology (HOT) plates). The setup of the secondary ion optics should be reported, including the use and settings of contrast apertures, energy resolving slits, and high mass resolution. Any information pertinent to the specific operation of a given type of camera or image acquisition system should also be included. This could include manufacturer and model number and the use of any accessory or auxiliary equipment that would affect the acquisition or display of an image. If long integration times are used, a dark-current image (or detail about the maximum intensity/pixel in dark-current mode) should be included. Any nonstandard modifications made to the equipment should be described in detail.

6.2.2 *Resistive Anode Encoder Systems*— The resistive anode encoder (RAE) is a position-sensitive, pulse-counting detector that replaces the standard channel plate/fluorescent screen assembly.[4] The RAE assembly consists of a double

[1] This practice is under the jurisdiction of ASTM Committee E-42 on Surface Analysis and is the direct responsibility of Subcommittee E42.06 on SIMS.

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

[3] Lapareur, M., *Rev. Tech. Thomson-CSF 12(1)*, p. 225, 1980.

[4] Odom, R. W., Furman, B. K., Evans, C. A., Bryson, C. E., Peterson, W. A., Kelly, M. A., and Wayne, D. H., *Analytical Chemistry*, Vol 55, p. 574, 1983.

channel plate array followed by a resistive anode. Secondary ions arriving at the front of the microchannel plate are converted into an electron pulse that strikes the resistive anode; the position of the centroid of each electron pulse is calculated from the ratio of electron charge collected at each of four electrodes placed at the corners of the anode. Reporting of RAE acquired images should be the same as that listed above for camera based systems. Because the RAE detector is more sensitive to count-rate saturation, the dead-time of the RAE should be specified. It is also important to report whether a static or rastered primary beam was used. If a rastered beam was used, the size of the beam relative to the raster size will affect the count rate at which saturation occurs.

6.3 *Experimental Conditions for Acquisition of Microprobe Images*—In the microprobe mode of operation, the spatial resolution of the image depends only on the spot size of the primary beam. Two modes of microprobe imaging are possible, depending on the type of mass spectrometer used. Continuous primary beams are used with quadrupole and magnetic sector instruments, and pulsed primary beams are used with time-of-flight SIMS instruments. Experimental parameters to be reported are similar to those used for camera-based systems. In addition, the approximate primary beam size, the method by which it was determined, the scan frequency (or dwell time per pixel), the nature of the scan (that is, interlaced), the type of secondary ion detector, and the degree of electronic gating used shall also be reported.

6.4 *Display of Ion Image Data*:

6.4.1 *Image Display*—Secondary ion images are usually displayed using a look-up table (LUT) that codes the pixel intensity with a given color or gray level. This LUT should be visible in the image (particularly with the use of pseudo color displays) and the numerical values (secondary ion counts or pixel intensities) for the different colors should be specified. The field-of-view of the image, the mass of the analyzed species, and the image acquisition time should be visible in the image or stated in the image caption.

6.4.2 *Image Processing*—Any general enhancement procedures (altered contrast, rescaling, image convolution) should be reported. Any detector-specific image artifacts and any image processing techniques used to remove them shall be reported. For example, when using camera-based systems, it is common practice to divide the analytical image by a uniformly illuminated reference to remove the influence of spatial variation in channel plate response.

6.4.3 *Quantitative Imaging*—If a concentration scale is generated for the image, the full quantitative imaging procedure should be specified. This includes the preparation of imaging standards and the calibration/characterization of the detector system response.

## 7. Keywords

7.1 imaging; secondary ion mass spectrometry