



Designation: ~~E996-04~~ Designation: E996 – 10

Standard Practice for Reporting Data in Auger Electron Spectroscopy and X-ray Photoelectron Spectroscopy¹

This standard is issued under the fixed designation E996; 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 Auger and ~~x-ray~~X-ray photoelectron spectra are obtained using a variety of excitation methods, analyzers, signal processing, and digitizing techniques.

1.2 This practice lists the desirable information that shall be reported to fully describe the experimental conditions, specimen conditions, data recording procedures, and data transformation processes.

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1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this 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:*²

E673 [Terminology Relating to Surface Analysis](#)

E902 [Practice for Checking the Operating Characteristics of X-Ray Photoelectron Spectrometers](#)

E983 [Guide for Minimizing Unwanted Electron Beam Effects in Auger Electron Spectroscopy](#)

E995 [Guide for Background Subtraction Techniques in Auger Electron Spectroscopy and X-ray Photoelectron Spectroscopy](#)

E1078 [Guide for Specimen Preparation and Mounting in Surface Analysis](#)

E1127 [Guide for Depth Profiling in Auger Electron Spectroscopy](#)

3. Terminology

3.1 *Definitions*—For definitions of terms used in this guide, refer to Terminology E673.

4. Summary of Practice

4.1 Report all experimental conditions that affect Auger and ~~x-ray~~X-ray photoelectron spectra so spectra can be reproduced in other laboratories or be compared with other spectra.

5. Significance and Use

5.1 Include the experimental conditions under which spectra are taken in the “Experiment” section of all reports and publications.

5.2 Identify any parameters that are changed between different spectra in the “Experiment” section of publications and reports, and include the specific parameters applicable to each spectrum in the figure caption.

6. Information To Be Reported

6.1 *Equipment Used:*

6.1.1 If a commercial electron spectroscopy system is used, specify the manufacturer and model. Indicate the type of electron excitation source and electron analyzer as well as the model designation of other equipment used for generating the experimental data, such as a sputter ion source.

¹ This practice is under the jurisdiction of ASTM Committee E42 on Surface Analysis and is the direct responsibility of Subcommittee E42.03 on Auger Electron Spectroscopy and X-Ray Photoelectron Spectroscopy.

Current edition approved Nov. 1, 2004, 2010. Published December 2004, 2010. Originally approved in 1984. Last previous edition approved in 1999, 2004 as E996-04 (1999)-E996-04. DOI: 10.1520/E0996-104.

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.

6.1.2 If a spectrometer system has been assembled from several components specify the manufacturers and model numbers of excitation source, analyzer, and auxiliary equipment.

6.1.3 Identify the model name, version number, and manufacturer of software packages used to acquire or process the data.

6.2 *Specimen Analyzed:*

6.2.1 Describe the specimen as completely as possible, for example, its bulk composition, history, any methods of cleaning or sectioning, pre-analysis treatments, and dimensions.

6.2.2 Describe the method of mounting and positioning the specimen for analysis, for example, mounted on a carousel, or mounted between strips of a particular metal. If the specimen is heated, cooled or treated in the spectrometer system, describe the method used (for example, heated by electron bombardment on the back of the specimen, or resistively heated). See Guide E1078 for more detail.

6.2.3 State the operating pressure of the vacuum system during data acquisition and the position of the vacuum gage relative to the specimen being analyzed. State if the system was backfilled with a sputter gas. Indicate the presence of active gases if they are appropriate to the measurement. If the system (and specimen) was baked-out before analysis, the time, temperature and final pressure should also be stated.

6.3 *Parameters Used for Analysis:*

6.3.1 *Excitation Source*—For electron beam excitation, state the beam energy, beam size, incident current, whether the beam is stationary or ~~scanning~~scanned (if ~~scanning~~scanned, state the area), and angle of incidence. State the method used to determine the electron beam diameter. (See Note 1.) For radiation-sensitive specimens, give the pre-analysis and analysis beam exposure times. See Guide E983 to minimize unwanted electron beam effects. For ~~x-ray~~X-ray excitation, specify the anode material, characteristic radiation energy, beam size at the specimen, whether the beam is stationary or scanned (if scanned, state the area), source strength, electron emission current, acceleration voltage, window material, and whether the source ~~x-ray~~X-ray was monochromatic.

NOTE 1—The common method of measuring incident electron beam current by applying a low (approximately + 100 volt) specimen bias does not account for emission of backscattered electrons. The preferred method is to use a Faraday cup bearing a small entrance aperture to limit the number of electrons escaping.

6.3.2 *Charge Correction*—For insulating specimens, it is often necessary to correct for the charging of the specimen under irradiation. When energies of lines from such specimens are quoted, the method of charge correction must also be described as well as the standard value assumed. If an electron beam or ion beam is used, its beam current, energy, and diameter or current density should also be given.

6.3.3 *Analyzer*—State the type of analyzer (and lens) used for electron collection (cylindrical mirror (single or double-pass), hemispherical, spherical, and the like). State the spectrometer's energy resolution, retardation ratio, pass energy (if pertinent), emission angle, source-to-analyzer angle, acceptance angle width, and specimen acceptance area. Describe how any of these analyzer properties vary with electron energy.

6.3.4 *Modulation*—If phase-sensitive detection is used to obtain the Auger spectrum in derivative form the peak-to-peak energy modulation should be stated. If electron beam modulation is used, the electron beam chopping frequency and duty cycle should be stated.

6.3.5 *Time Constant*—Give the system time constant if analog detection is used. The limiting time constant could be determined by that of the phase-sensitive detector, ratemeter, recorder, or digitizing system.

6.3.6 *Scan Rate*—If an analog scan is used, give the sweep rate in eV/s (electronvolt/second). If a stepped scan is used, give the step size in eV and the dwell time per step.

6.3.7 *Energy Scale Calibration*—The method for calibration of the binding energy scale shall be specified. It is recommended that the procedure described in Practice E902 be used to ensure that the spectrometer is operating in a reproducible manner.

6.3.8 *Detector Description*—Describe the detector used. If an electron multiplier is used and the front is biased, state the bias voltage. Indicate whether the output of the analyzer is measured directly, or by a voltage isolation method, by pulse counting, or by voltage-to-frequency conversion. For a multichannel detector, give the number of channels in the spectrum covered by the width of the detector.

6.3.9 *Signal Averaging*—If the spectrum is signal averaged, state the number of scans.

6.3.10 *Sputtering*—If ion sputtering was used for cleaning or sputter depth profiling, describe the ion species, ion energy, energy filtering, neutral rejection (if employed), the beam current, diameter, or maximum current density, and angle of incidence. If ion beam scanning is used, state the area and rate. State the total pressure in the vicinity of the specimen (if known) and if the sputtering source was differentially pumped. If a depth scale is given on a sputter depth profile, state the method of depth calibration. If the sputter rate is not known, it is recommended that relative sputter rates be determined using a known thickness of tantalum pentoxide or silicon dioxide. State the specimen rotation rate if rotational depth profiling was used.

6.4 *Data Handling:*

6.4.1 *Data Processing*—Describe any smoothing, differentiation, background subtraction (see Guide E995), deconvolutions, curve resolution, intensity scale correction, satellite subtraction, or other processing of the data. Specify any assumptions and approximations required for the processing, together with the data reduction algorithm. In the case of multiple processing methods, the step-by-step effect of each method should be explained.