



Standard Guide for Minimizing Unwanted Electron Beam Effects in Auger Electron Spectroscopy¹

This standard is issued under the fixed designation E 983; 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 guide outlines the origins and manifestations of unwanted electron beam effects in Auger electron spectroscopy (AES).

1.2 Some general guidelines are provided concerning the electron beam parameters which are most likely to produce these effects.

1.3 General classes of materials are identified which are most likely to exhibit unwanted electron beam effects. In addition, a tabulation of some specific materials which have been observed to undergo electron damage effects is provided.

1.4 A simple method is outlined for establishing the existence and extent of these effects during routine AES analysis.

1.5 *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 Analysis²

E 996 Practice for Reporting Data in Auger Electron Spectroscopy and X-Ray Photoelectron Spectroscopy²

3. Terminology

3.1 See Terminology E 673 for terms used in Auger electron spectroscopy.

NOTE 1—Electron beam effects and their consequences are widely referred to in the literature using any one or more of the following terms: electron beam damage, sample damage, specimen damage, beam effects, electron beam induced processes, and electron irradiation effects.

4. Significance and Use

4.1 When electron beam excitation is used in AES, the incident electron beam can interact with the specimen material causing physical and chemical changes. In general, these

effects are a hindrance to AES analysis because they cause localized specimen modification **(1, 2, 3)**.³

4.2 With specimens that have poor electrical conductivity the electron beam can stimulate the development of localized charge on the specimen surface. This effect is a hindrance to AES analysis because the potentials associated with the charge can either adversely affect the integrity of Auger data or make Auger data collection difficult.

5. Origins of Electron Beam Effects

5.1 Electron beam effects in AES may originate from one or more distinct processes.

5.1.1 Charge accumulation in materials with poor electrical conductivity leading to potentials that cause distortion of Auger data or make AES data collection difficult by virtue of:

5.1.1.1 Auger peak shift on energy scale.

5.1.1.2 Auger peak shape and size distortion.

5.1.1.3 Auger signal strength instability.

5.1.2 Electronic excitation of surface, subsurface, and bulk atoms and molecules leading to specimen changes **(4, 5, 6)** which include:

5.1.2.1 Dissociation.

5.1.2.2 Electron stimulated desorption (ESD) **(7)**.

5.1.2.3 Electron stimulated adsorption (ESA) **(8)**.

5.1.2.4 Polymerization **(9, 10)**.

5.1.2.5 Carburation **(11, 12, 13)**.

5.1.2.6 Oxidation **(14, 15)**.

5.1.2.7 Reduction **(16)**.

5.1.2.8 Decomposition **(17, 18)**.

5.1.2.9 Erosion.

5.1.2.10 Diffusion.

5.1.3 Charge accumulation in materials of poor electrical conductivity leading to specimen changes which include **(19, 20)**:

5.1.3.1 Electric field enhanced diffusion.

5.1.3.2 Electromigration.

5.1.4 Heating which may cause:

5.1.4.1 Annealing.

5.1.4.2 Segregation.

5.1.4.3 Volatilization.

¹ This guide is under the jurisdiction of ASTM Committee E-42 on Surface Analysis and is the direct responsibility of Subcommittee E42.03 on Auger Electron Spectroscopy and XPS.

Current edition approved Sept. 15, 1994. Published November 1994. Originally published as E 983 – 84. Last previous edition E 983 – 89.

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

³ The boldface numbers in parentheses refer to the references listed at the end of this standard.