



Standard Guide for Literature Describing Properties of Electrostatic Electron Spectrometers¹

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1. Scope

1.1 The purpose of this guide is to familiarize the analyst with some of the relevant literature describing the physical properties of modern electrostatic electron spectrometers.

1.2 This guide is intended to apply to electron spectrometers generally used in Auger electron spectroscopy (AES) and X-ray photoelectron spectroscopy (XPS).

1.3 *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 902 Practice for Checking the Operating Characteristics of X-Ray Photoelectron Spectrometers²

E 1217 Practice for Determination of the Specimen Area Contributing to the Detected Signal in X-Ray Photoelectron Spectroscopy and Auger Electron Spectroscopy²

3. Terminology

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

4. Summary of Guide

4.1 This guide serves as a resource for relevant literature which describes the properties of electron spectrometers commonly used in surface analysis.

5. Significance and Use

5.1 The analyst may use this document to obtain information on the properties of electron spectrometers and instrumental aspects associated with quantitative surface analysis.

6. General Description of Electron Spectrometers

6.1 An electron spectrometer is typically used to measure the energy and angular distributions of electrons emitted from a specimen, typically for energies in the range 0 to 2500 eV. In surface analysis applications, the analyzed electrons are produced from the bombardment of a sample surface with electrons, photons or ions. The entire spectrometer instrument may include one or more of the following: (1) apertures to define the specimen area and emission solid angle for the electrons accepted for analysis; (2) an electrostatic and/or magnetic lens system; (3) an electrostatic (dispersing) analyzer; and (4) a detector. Methods to check the operating characteristics of X-ray photoelectron spectrometers are reported in Practice E 902.

6.2 *Intensity Scale Calibration and Spectrometer Transmission Function*—Quantitative analysis requires the determination of the ability of the spectrometer to transmit electrons, and the resultant detector signal, throughout the spectrometer instrument. This can be described by an overall electron energy-dependent transmission function $Q(E)$ and is given by the product **(1,2)**,³ as follows:

$$Q(E) = H(E) \cdot T(E) \cdot D(E) \cdot F(E), \quad (1)$$

where:

$H(E)$ = the effect of mechanical imperfections (such as aberrations, fringing fields, etc.),

$T(E)$ = electron-optical transmission function,

$D(E)$ = detector efficiency, and

$F(E)$ = efficiency of the counting systems.

Knowledge of this transmission function permits the calibration of the spectra intensity axis **(3)**. A detailed review of the experimental determination of the transmission function for XPS **(4)** and AES **(5)** measurements has been published.

6.3 *Energy Scale Calibration*—Quantitative analysis also requires the absolute calibration of spectra energy scales in either XPS or AES. Suitable photon energy values for Al and Mg anode X-ray sources often used in XPS measurements are available **(6)** and reference binding energy values for Cu, Au, and Ag have been published **(7)**. Binding energy scale calibration procedures have been described in the literature for XPS

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.

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

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