



Standard Guide to Charge Control and Charge Referencing Techniques in X-Ray Photoelectron Spectroscopy¹

This standard is issued under the fixed designation E 1523; 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 acquaints the XPS user with the various charge control and charge shift referencing techniques that are and have been used in the acquisition and interpretation of X-ray photoelectron spectroscopy (XPS) data from surfaces of insulating specimens and provides information needed for reporting the methods used to customers or in the literature.

1.2 This guide is intended to apply to charge control and charge referencing techniques in XPS and is not necessarily applicable to electron-excited systems.

1.3 SI units are standard unless otherwise noted.

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:

E 673 Terminology Relating to Surface Analysis²

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

E 1078 Guide for Specimen Handling in Auger Electron Spectroscopy, X-Ray Photoelectron Spectroscopy, and Secondary Ion Mass Spectrometry²

E 1829 Guide for Specimen Preparation and Mounting in Surface Analysis²

3. Terminology

3.1 Definitions:

3.1.1 See Terminology E 673 for definitions of terms used in X-ray photoelectron spectroscopy.

3.1.2 Symbols

BE	Binding energy, in eV
BE _{corr}	Corrected binding energy, in eV
BE _{meas}	Measured binding energy, in eV

BE _{ref}	Reference binding energy, in eV
BE _{meas, ref}	Measured Binding energy, in eV, of a reference line
FWHM	Full width at half maximum amplitude of a peak in the photoelectron spectrum above the background, in eV
XPS	X-ray photoelectron spectroscopy
Δ_{corr}	Correction energy, to be added to measured binding energies for charge correction, in eV

4. Overview of Charging Effects

4.1 For insulating specimen surfaces, the emission of photoelectrons following X-ray excitation may result in a buildup of a positive surface charge. This positive surface charge changes the surface potential thereby shifting the measured energies of the photoelectron peaks to higher binding energy. This binding energy shift may reach a nearly steady-state value of between 2 and 5 eV for spectrometers equipped with nonmonochromatic X-ray sources. The surface potential charge and the resulting binding energy shift is, generally, larger for spectrometers equipped with monochromatic X-ray sources because of the, generally, lower flux of low-energy electrons impinging on the specimen surface. This lower flux arises because focused, monochromatic X-ray beams irradiate only a portion of the specimen and not other nearby surfaces (for example, the specimen holder) that are sources of low-energy electrons. The absence of an X-ray window in many monochromatic X-ray sources (or a greater distance of the specimen from the X-ray window) also eliminates another source of low-energy electrons.

4.2 The amount of induced surface charge, its distribution across the specimen surface, and its dependence on experimental conditions are determined by several factors including specimen composition, homogeneity, magnitude of surface conductivity, total photoionization cross-section, surface topography, spacial distribution of the exciting X-rays, and availability of neutralizing electrons. Charge buildup is a well-studied (1, 2)³, three dimensional phenomenon that occurs

¹ This guide 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 May 10, 2003. Published July 2003. Originally approved in 1993. Last previous edition approved in 1997 as E 1523 – 97.

² Annual Book of ASTM Standards, Vol 03.06.

³ The boldface numbers given in parentheses refer to a list of references at the end of the text.