



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

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1. Scope

1.1 This guide acquaints the X-ray photoelectron spectroscopy (XPS) user with the various charge control and charge shift referencing techniques that are and have been used in the acquisition and interpretation of 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 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E673 Terminology Relating to Surface Analysis (Withdrawn 2012)³

E902 Practice for Checking the Operating Characteristics of X-Ray Photoelectron Spectrometers (Withdrawn 2011)³

E1078 Guide for Specimen Preparation and Mounting in Surface Analysis

E1829 Guide for Handling Specimens Prior to Surface Analysis

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.

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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.

³ The last approved version of this historical standard is referenced on www.astm.org.

3. Terminology

3.1 *Definitions*—See Terminology **E673** for definitions of terms used in XPS.

3.2 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 temporary (or sometimes persistent) buildup of a positive surface charge caused by the photoelectric effect. Its insulating nature prevents the compensation of the charge buildup by means of electron conduction from the sample holder. 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, spatial distribution of the exciting X-rays, and