



Standard Guide for Quantitative Analysis by Energy-Dispersive Spectroscopy¹

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1. Scope

1.1 This guide is intended to assist those using energy-dispersive spectroscopy (EDS) for quantitative analysis of materials with a scanning electron microscope (SEM) or electron probe microanalyzer (EPMA). It is not intended to substitute for a formal course of instruction, but rather to provide a guide to the capabilities and limitations of the technique and to its use. For a more detailed treatment of the subject, see Goldstein, et al. (1) This guide does not cover EDS with a transmission electron microscope (TEM).

1.2 *Units*—The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

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:²

E3 Guide for Preparation of Metallographic Specimens

E7 Terminology Relating to Metallography

E673 Terminology Relating to Surface Analysis (Withdrawn 2012)³

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Terminology

3.1 *Definitions*—For definitions of terms used in this guide, see Terminologies E7 and E673.

¹ This guide is under the jurisdiction of ASTM Committee E04 on Metallography and is the direct responsibility of Subcommittee E04.11 on X-Ray and Electron Metallography.

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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.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *accelerating voltage*—the high voltage between the cathode and the anode in the electron gun of an electron beam instrument, such as an SEM or EPMA.

3.2.2 *beam current*—the current of the electron beam measured with a Faraday cup positioned near the specimen.

3.2.3 *Bremsstrahlung*—background X rays produced by inelastic scattering (loss of energy) of the primary electron beam in the specimen. It covers a range of energies up to the energy of the electron beam.

3.2.4 *critical excitation voltage*—the minimum voltage required to ionize an atom by ejecting an electron from a specific electron shell.

3.2.5 *dead time*—the time during which the system will not process incoming X rays (real time less live time).

3.2.6 *k-ratio*—the ratio of background-subtracted X-ray intensity in the unknown specimen to that of the standard.

3.2.7 *live time*—the time that the system is available to detect incoming X rays.

3.2.8 *overvoltage*—the ratio of accelerating voltage to the critical excitation voltage for a particular X-ray line.

3.2.9 *SDD (silicon drift detector)*—An x-ray detector characterized by a pattern in the biasing electrodes which induces generated electrons to move laterally (drift) to a small-area anode for collection, resulting in greatly reduced capacitance which to a first approximation does not depend on the active area, in contrast to conventional detectors using flat-plate electrodes. (2)

3.2.10 *shaping time*—a measure of the time it takes the amplifier to integrate the incoming charge; it depends on the time constant of the circuitry.

3.2.11 *spectrum*—the energy range of electromagnetic radiation produced by the method and, when graphically displayed, is the relationship of X-ray counts detected to X-ray energy.

4. Summary of Practice

4.1 As high-energy electrons produced with an SEM or EPMA interact with the atoms within the top few micrometres of a specimen surface, X rays are generated with an energy characteristic of the atom that produced them. The intensity of