

SEMI P36-0308

GUIDE FOR MAGNIFICATION REFERENCE FOR CRITICAL DIMENSION MEASUREMENT SCANNING ELECTRON MICROSCOPES (CD-SEMS)

This standard was technically approved by the global Micropatterning Committee. This edition was approved for publication by the global Audits and Reviews Subcommittee on January 18, 2008. It was available at www.semi.org in February 2008 and on CD-ROM in March 2008. Originally published June 2000.

1 Purpose

1.1 The purpose of this guide is (1) to define common and important specifications of magnification references which are used for calibrating magnifications of critical dimension measurement scanning electron microscopes (CD-SEMs), and as the result (2) to provide magnification references which are easy for anyone to use.

2 Scope

2.1 It is preferable that design, manufacture and purchase specifications for CD-SEM magnification references conform to this guideline.

NOTICE: This standard does not purport to address safety issues, if any, associated with its use. It is the responsibility of the users of this standard to establish appropriate safety and health practices and determine the applicability of regulatory or other limitations prior to use.

3 Referenced Standards and Documents

3.1 None.

4 Terminology

4.1 Definitions

4.1.1 *CD-SEM magnification reference* — a CD-SEM magnification reference is defined as a standard for calibrating magnifications of a said CD-SEM through mounting the standard on the specimen stage, measuring the dimensions of reference patterns formed on the standard, determining the difference between the measurement value and the true or reference value of the reference patterns, and adjusting the CD-SEM parameters to bring the difference zero.

4.1.1.1 There are two types of CD-SEM magnification references: one is a wafer on which reference patterns are formed; another is a chip on which reference patterns are formed. Hereinafter, the former will be referred to as “wafer-type magnification reference,” and the latter will be referred to as “chip-type magnification reference.”

4.1.2 *edge roughness* — edge roughness refers to edge variations seen in the SEM images, and is defined as the distance, within a field of view, between the peak line and the valley line, where the peak line means the line which runs through the highest peak and is parallel to the pattern-edge mean line, the valley line means the line which runs through the lowest valley and is parallel to the pattern-edge mean line, and the pattern-edge mean line conforms to the expected pattern-edge line. Here, a peak is the tip of a convex section, and a valley is the deepest part of a concave section.

5 Ordering Information

5.1 None.

6 Requirements

6.1 CD-SEM Magnification References and Their Structure

6.1.1 CD-SEM magnification references are either wafer type or chip type. Chip types are composed of a chip (or chips) and a stub to hold the chip (or chips). Wafer type include a 'drop-in' wafer which is a wafer with a thinned section where a die with the reference calibration pattern can be dropped in.

6.2 Shape, Size and Mounting Method of CD-SEM Magnification References

6.2.1 Shape and size of wafer-type magnification references, and method of mounting them on the specimen stages in CD-SEMs must follow the shape, size and mounting method of product wafers.

6.2.2 Shape and size of chip-type magnification references, and method of mounting them on the specimen stages of CD-SEMs are defined as follows:

6.2.2.1 Size and shape of chip-type magnification references (see Figure 1).

6.2.2.2 Mounting method of chip-type magnification references:

6.2.2.2.1 A magnification reference should be mounted on a specimen stage as markers made on the stub fit in markers made on the specimen stage, and be fixed by using a screw. The markers made on the stub should show the direction of reference patterns at an accuracy of within $\pm 1^\circ$.

6.2.2.2.2 The markers made on the specimen stage should show the X- and Y-direction of specimen-stage movement, and the angle between the two markers should be $90^\circ \pm 0.1^\circ$ (see Figures 1 and 2).

6.2.2.3 Chip surface height for chip-type magnification references:

6.2.2.3.1 The height of chip surface (or reference pattern surface) from the specimen stage surface should be 1.7 ± 0.05 mm as the magnification reference is mounted on the specimen stage.

6.3 *Materials for Magnification References* — Materials for magnification references must be non-magnetic.

6.3.1 Wafers for wafer-type magnification references and chips for chip-type magnification references are preferable to be silicon.

6.3.2 Materials of the stub for chip-type magnification references are preferable to be aluminum, copper, or carbon.

6.4 Properties of Magnification Reference Pattern

6.4.1 Reference patterns do not change or degrade in use.

6.4.2 The block area of reference patterns (or every block area, in the case where there are some reference pattern blocks) must be larger than $100 \times 100 \mu\text{m}$, and the block should be placed so that it is easily recognizable.

6.4.3 The pattern-edge roughness must be within the calibration uncertainty described in ¶ 6.5.5.

6.5 Report

6.5.1 Suppliers of CD-SEM magnification references must report the following to the purchaser.

6.5.2 Wafer material for wafer-type magnification references, or chip and stub materials for chip-type magnification references (e.g., silicon chip, aluminum stub, etc).

6.5.3 Type of reference patterns (e.g., dense lines, etc).

6.5.4 Figures and/or pictures of the reference patterns with pattern dimensions which show top and/or cross sectional view.

6.5.5 Calibration uncertainty of reference patterns (e.g., line pitch 180 ± 1 nm at 95% confidence level, etc).

6.5.6 Traceability and its certification organization, and measurement method used for deciding the calibration uncertainty of reference patterns (e.g., the uncertainty was decided in terms of mean value and variation obtained by means of a precise diffraction angle measurement using a He-Cd laser beam of a 2 mm spot diameter, and was certified by NMI (National Metrology Institute), etc).

NOTE 1: Traceability is the property of the result of a measurement or the value of a standard whereby it can be related to stated references, usually national or international standards, through an unbroken chain of comparison of all having stated uncertainties. Refer to the international vocabulary of basic and general terms in metrology, ISO, 1993, 47 p., ISEN 92-67 01075-1.

6.5.7 Applicable magnification range.

6.5.8 Notices of caution for cleaning and maintenance (e.g., whether cleaning is possible or not, and if possible, the process of cleaning, procedures for storage, etc).