

SEMI M40-0200

GUIDE FOR MEASUREMENT OF SURFACE ROUGHNESS OF PLANAR SURFACES ON SILICON WAFER

This guide was technically approved by the Global Silicon Wafer Committee and is the direct responsibility of the North American Silicon Wafer Committee. Current edition approved by the North American Regional Standards Committee on December 15, 1999. Initially available at www.semi.org February 2000; to be published February 2000.

1 Purpose

1.1 This guide provides procedures for specifying the measurements to be used in characterizing and reporting roughness of the planar surfaces of silicon wafers. It may also be applicable to other types of planar wafer materials.

1.2 This guide provides nomenclature and procedures for roughness determination that employ three key methodologies:

1.2.1 Standardized scan site patterns,

1.2.2 Roughness abbreviations, and

1.2.3 Reference test methodologies with respect to identifying specific roughness measurements.

2 Scope

2.1 This guide incorporates the following methodologies:

2.1.1 Standardized scan patterns for both local and full-area surface characterization,

2.1.2 A set of roughness abbreviations that describe measurement conditions in a short-hand code, and

2.1.3 Reference test methodologies for three generic types of roughness measuring instruments. These general categories may include, but are not limited to:

- Profilometers — AFM and other scanning probe microscopes; optical profilometers; high-resolution mechanical stylus systems,
- Interferometers — interference microscopes, and
- Scatterometers — Total integrating scatterometers (TIS), angle-resolved light scatterometers (ARLS), scanning surface inspection systems (SSIS).

2.2 Procedures to obtain a representative value of roughness for a surface are specified.

2.3 Roughness nomenclature is intended to remove ambiguities with respect to identifying the roughness measurements used and the results achieved.

2.4 This guide does not purport to address safety issues, if any, associated with its use. It is the

responsibility of the users of this guide to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

3 Limitations

3.1 This guide does not apply to measurements in the edge region of wafers.

3.2 This guide does not apply to spatial wavelengths ≤ 10 nm.

3.3 This guide is not intended to define specific roughness parameters; these can be found in other documents.

3.4 The bandwidth of the measurement tool and the bandwidth used can severely influence the result of roughness measurements.

3.4.1 Differences in either long or short bandwidths used between two instruments can produce significantly different results.

3.4.2 The codes listed in Table 1 of this guide do not identify instrument transfer functions.

3.5 The presence of films may affect light scattering measurements.

4 Discussion

4.1 Roughness of silicon wafer surfaces is becoming frequently specified for bare silicon wafers (cf. the SIA International Technology Roadmap for Semiconductors). These specifications refer to the roughness of both the final polished front and the back surfaces of a wafer. Various techniques are currently used to measure the surface roughness of silicon wafers. These techniques include AFM scanning probes, mechanical and optical profiling, interferometric microscopes, and light (electromagnetic radiation) scattering. Mechanical profiling techniques are widely used in other industries and are well standardized. Profiling techniques are generally limited to line scans and therefore provide information of only a very small part of a surface. Interferometric techniques for roughness measurements are similarly limited, whereas light scattering techniques can scan the entire wafer surface.

4.2 Historically a variety of roughness parameters for profiling techniques have evolved and have been standardized, including rms roughness (R_q) and average roughness (R_a). Profiling instruments measure the surface topography and derive roughness statistics, such as R_q , from a series of height data. Light scattering techniques measure R_q from the angular dependence of scattering; some light scattering systems derive other parameters through interpretation and estimation.

4.3 A roughness value representative of an entire wafer surface, or a large portion of the surface, cannot be based on data obtained at a single point. Yet, specifications often describe a single value for a wafer. Therefore, this guideline suggests and defines standardized patterns of scan sites that can be described and used unambiguously. A model describing the relationship between several types of roughness variation, scan patterns, and reported results is included in the attached Related Information to assist users in specifying and interpreting these variables.

4.4 A common feature of all roughness measurements is their dependence on the bandwidth and transfer function of the tool used. In addition, high or low spatial frequency software filters are common and affect reported results. Widely different numbers can be reported for the same surface by two measurement instruments. This guideline includes suggestions on specifying and reporting the instrument bandwidth and transfer function.

5 Referenced Standards

5.1 SEMI Standards

SEMI M1 — Specifications for Polished Monocrystalline Silicon Wafers

SEMI M20 — Specification for Establishing a Wafer Coordinate System

5.2 ASME Standard¹

ASME B46.1 — Surface Texture (Surface Roughness, Waviness, and Lay)

5.3 ASTM Standards²

E 1392 — Practice for Angle Resolved Optical Scatter Measurements on Specular or Diffuse Surfaces

F 1048 — Test Method for Measuring the Effective Surface Roughness of Optical Components by Total Integrated Scattering

F 1620 — Practice for Calibrating a Scanning Surface Inspection System Using Monodisperse Polystyrene Latex Spheres Deposited on Polished or Epitaxial Surfaces

F 1811 — Estimating the Power Spectral Density Function and Related Finish Parameters from Surface Profile Data

5.4 DIN Standards³

DIN 4760 — Form Deviation, Waviness, Surface Roughness; System of Order, Terms and Definitions

DIN 4768 — Determination of Values of Surface Roughness Parameters R_a , R_z , R_{max} by Means of Electrical Contact (Stylus) Instruments; Terminology, Measuring Conditions

DIN 4777 — Metrology of Surfaces; Profile Filters for Electrical Contact Stylus Instruments; Phase-Corrected Filters

5.5 ISO Standards⁴

ISO 468 — Surface Roughness – Parameters, Their Values and General Rules for Specifying Requirements

ISO 1879 — Instrument for the Measurement of Surface Roughness by the Profile Method - Vocabulary

ISO 1880 — Instruments for the Measurement of Surface Roughness by the Profile Method - Contact (Stylus) Instruments of Progressive Profile Transformation - Profile Recording Instruments

ISO 3274 — Instruments for the Measurement of Surface Roughness by the Profile Method – Contact (Stylus) Instrument of Consecutive Profile Transformation – Contact Profile Meters, System M

ISO 4287/1 — Surface roughness – Terminology – Part 1: surface and its parameters

ISO 4288 — Rules and Procedures for the Measurement of Surface Roughness Using Stylus Instruments

5.6 JIS Standards⁵

JIS B 0601 — Surface Roughness - Definitions And Designation

JIS B 0652 — Instruments For The Measurement Of Surface Roughness By The Interferometric Method

JIS B 0659 — Roughness Comparison Specimens

³ Deutsches Institut für Normung e.V., Beuth Verlag GmbH, Burggrafenstrasse 4-10, D-10787 Berlin, Germany

⁴ ISO Central Secretariat, 1, rue de Varembe, Case postale 56, CH-1211 Genève 20, Switzerland

⁵ Japanese Standards Association, 1-24, Akasaka, 4-Chome, Minato-ku, Tokyo 107 Japan

¹ American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, NY 10017

² American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959

5.7 Other Documents

International Technology Roadmap for Semiconductors⁶

Optical Scattering in the Optics, Semiconductor, and Computer Disk Industries, Second Edition 1995, J C Stover, Editor⁷

NOTE 1: As listed or revised, all documents cited shall be the latest publications of adopted standards.

6 Terminology

6.1 *autocorrelation function* — the Fourier transform of the Power Spectral Density function. It expresses the similarity between a surface profile and the same profile that is slipped, or moved laterally, with respect to itself.

6.2 *autocorrelation length* — the lateral slip required to reduce the Autocorrelation function to a value equal to e-1 times its zero slip value. Sometimes 10% or even 0 value definitions are used instead of e-1.

6.3 *average roughness (R_a)* — the average of the surface profile height deviations $Z(x)$ from the mean line taken within the evaluation length (ASME B46.1).

6.4 *bi-directional reflectance distribution function, BRDF* — a description of the distribution of light scattered by a surface, it is the differential radiance normalized by the differential irradiance, and is approximated by the scattered power per unit projected solid angle divided by the incident power (Stover).

6.5 *fixed quality area (FQA)* — the central area of a wafer surface, defined by a nominal edge exclusion, X , over which the specified values of a parameter apply (SEMI M1). See also the discussion immediately following this definition in SEMI M1.

6.6 *haze* — non-localized light scattering resulting from surface topography (microroughness) or from dense concentrations of surface or near-surface imperfections (SEMI M1).

DISCUSSION — Haze due to the existence of a collection of imperfections is a mass effect; individual imperfections of the type which result in haze cannot be readily distinguished by the eye or other optical detection systems without magnification. In a particle counter (SSIS), haze results in a background signal and laser light-scattering events together comprise the signal due to light-scattering from a wafer surface. (SEMI M1). It is the total scattered optical flux

collected by an optical system normalized by the incident flux.

NOTE 2: Different SSIS instrument types may give significantly different haze values on a given sample.

6.7 *illumination source incidence angle* — the angle of the incoming beam, measured from surface normal.

6.8 *kurtosis (Rku)* — a measure of the sharpness of the histogram of surface profile height deviations $Z(x)$ from the mean line within the evaluation length. A complete random surface will have a Gaussian histogram and $Rku = 3$ (ASME B46.1).

6.9 *laser light-scattering event* — a signal pulse that exceeds a preset threshold, generated by the interaction of a laser beam with a discrete scatterer at a wafer surface as sensed by a detector; see also *haze* (SEMI M1). See also the discussion that follows this definition in SEMI M1.

6.10 *lay* — the predominant direction of the surface pattern, ordinarily determined by the production method used (ASME B46.1).

6.11 *microroughness* — surface roughness components with spacing between irregularities (spatial wavelength) less than about 100 μm (SEMI M1).

6.12 *Nyquist Criterion* — the shortest spatial wavelength detected. It is twice the sample spacing.

6.13 *one-dimensional grating equation* — in its most common form, it is an expression that gives the positions of diffracted orders from a one-dimensional sinusoidal grating (Stover).

6.14 *peak to valley (R_v)* — the highest to lowest value of the surface profile height deviations $Z(x)$ from the mean line taken within the evaluation Length L (ASME B46.1).

6.15 *power spectral density (PSD) function* — a surface characterization function that is proportional to the square of the modulus of the Fourier transform of the surface and may be considered as a roughness power per unit of spatial frequency (ASTM F 1811).

6.16 *Rayleigh Criterion (of resolving power)* — a condition for distinguishing a pair of diffraction patterns whereby the maximum of one pattern overlaps with the minimum of the other.

DISCUSSION — When a lens is free from aberrations, the images of point objects appear as diffraction patterns. When the principle maximum of one pattern strikes the first minimum of another, the images are described as being resolved. With respect to circular optics, this criterion applies when the distance between resolvable point objects, viewed from the objective lens of the instrument, is

⁶ Semiconductor Industry Association (SIA), 181 Metro Drive, Suite 450, San Jose, CA

⁷ SPIE, P.O. Box 10, Bellingham, WA 98227-0010

$$\frac{0.61\lambda}{NA}$$

where NA is the numerical aperture of the objective lens and λ is the illumination wavelength.⁸

6.17 *rms area microroughness* (R_qA) — the root mean square of the topographic deviations of a surface $Z(x,y)$ from the mean surface taken within the evaluation Area ($=L_xL_y$) (SEMI M1). See also the extended discussion that follows this definition in SEMI M1.

6.18 *rms microroughness* (R_q) — the root mean square of the surface profile height deviations $Z(x)$ from the mean line taken within the evaluation Length L (SEMI M1). See also the extended discussion that follows this definition in SEMI M1.

6.19 *rms slope* (mq) — the root-mean-square value of the rate of change of profile departures within the evaluation length (Adapted from ISO 4271/1).

6.20 *roughness* — the more narrowly spaced components of surface texture (SEMI M1). Compare with *waviness*.

6.21 *skewness* (R_{sk}) — a measure of the asymmetry of the surface topographic deviations of a surface $Z(x,y)$ about the mean line. A perfect random surface will have $R_{sk} = 0$ (ASME B46.1).

6.22 *spatial bandwidth* — the range of wavelengths in which a given instrument operates (Stover).

6.23 *spatial frequency* — spatial frequency ($F_{spatial}$) is the inverse of spatial wavelength ($\lambda_{spatial}$).

6.24 *spatial wavelength* — the spacing between adjacent peaks of a purely sinusoidal profile (ASME B46.1).

6.25 *ten point roughness height* (R_z) — the average value of the absolute values of the heights of the five highest profile peaks and the depths of the five lowest profile valleys from the mean line taken within the evaluation length. (Adapted from ISO 4281/1.)

6.26 *transfer function* — the response of an instrument over all measured spatial wavelengths.

DISCUSSION — A perfect instrument would have a 100% response over all spatial wavelengths. Every measuring instrument will have some deviation from a perfect response especially at the low spatial frequency limit (the traversing length) and at the high spatial frequency limit. The power spectrum can be used to examine this limit near the high spatial frequency

response. Contact the instrument supplier for this information.

6.27 *traversing length* — the maximum distance sampled in a given direction. The maximum measurable spatial wavelength is always less than the traversing length.

6.28 *wavelength scaling* — a surface is said to wavelength scale if the scatter measurements at one wavelength may be used to predict scatter measurements at another wavelength (Stover).

6.29 *waviness* — the more widely spaced (spatial wavelength) components of surface texture (SEMI M1). Compare with *roughness*.

7 Instruments and Capabilities

7.1 Profilometers

7.1.1 The high spatial frequency limit of AFM, mechanical and optical profilers can be approximated by the radius of the mechanical tip or by the diameter and intensity profile of the laser spot, respectively. Their response functions are complicated, and in some cases are a combined effect of the probe and the measured surface. The high spatial frequency limit of such tools has to be set or selected reasonably removed from that limit in order to achieve reasonable, comparable, and repeatable measurements.

7.2 Interference Microscope

7.2.1 The high spatial frequency limit of these instruments is defined by the focusing optics or in some cases by the pixel spacing of the detector array. The high spatial frequency limit of such tools has to be set or selected reasonably removed from that limit in order to achieve reasonable, comparable, and repeatable measurements.

7.3 Scattering Instruments

7.3.1 A straightforward relation between scattered light intensity and roughness exists only for sufficiently smooth surfaces. The Rayleigh smooth-surface criterion, given below, is frequently used for estimating the smooth-surface limit (Stover).

$$\frac{1}{2} \left(\frac{4\pi a \cos \theta_i}{\lambda} \right)^2 \ll 1 \quad (1)$$

$$m \ll 1 \quad (2)$$

where: m = profile slope,

λ = wavelength of incident light,

a = amplitude of sample profile (half of the peak-to-valley height), and

⁸ Optics, Eugene Hecht, et al; 3rd edition (August 1997); Addison-Wesley Publishing Co; ISBN: 0201838877

θ_i = incidence angle of light.

7.3.2 Corresponding amplitude examples assuming a limit of 0.1 result in

$a \leq 23 \text{ nm}$ for $\lambda = 633 \text{ nm}$, $\theta_i = 0^\circ$ and

$a \leq 51 \text{ nm}$ for $\lambda = 488 \text{ nm}$, $\theta_i = 70^\circ$

7.3.3 The equivalent rms-roughness values for a sinusoidal profile and for a limit of 0.1 are

$R_q \leq 16 \text{ nm}$ for $\lambda = 633 \text{ nm}$, $\theta_i = 0^\circ$ and

$R_q \leq 36 \text{ nm}$ for $\lambda = 488 \text{ nm}$, $\theta_i = 70^\circ$

7.3.4 Light scattering tools can be applied to rougher surfaces than those surfaces identified in equations 1 and 2, but then other mathematical approaches as compared to PSD curves have to be applied to calculate roughness or slope values. Also, the slope of the PSD curve can be important in certain situations (Stover).

7.3.5 There is a basic high spatial frequency (short spatial wavelength) limit for light scattering tools which cannot be exceeded. This limit is:

a) twice the inverse wavelength, $\frac{2}{\lambda}$, of the light used in case of grazing incidence ($\theta_i = 90^\circ$), and

b) one inverse wavelength, $\frac{1}{\lambda}$, in the case of normal incidence ($\theta_i = 0^\circ$).

These conditions follow directly from the one-dimensional grating equation

$$f_x = \frac{\sin \theta_s \cos \phi_s - \cos \theta_i}{\lambda}$$

where: θ_s = scattering angle in the incident plane, and

ϕ_s = scattering angle out of the plane-of-incidence.

NOTE 3: f_x becomes -1 when the light is scattered back in the direction of the incoming light in the incident plane ($\phi_s = 180^\circ$).

7.4 Total Integrating Scatterometers (TIS)

7.4.1 These instruments most often use an incidence angle close to zero. The low and high frequency limits of the accessible spatial bandwidth are defined by the design of the optical system. An appropriately designed system may be able to access a spatial bandwidth from about $0.8 \mu\text{m}$ to about $40 \mu\text{m}$. These systems may also be designed so that the scattered signal can be broken into low spatial frequency (near specular) and high spatial frequency (large scatter

angle) bands.

7.5 Angle-resolved Light Scatterometers (ARLS)

7.5.1 The high spatial frequency limit of this technique is defined by incident and scattering angles and the illumination wavelength used.

7.5.2 The low spatial frequency limit is given by

- the above equations (for incidence angle),
- the diameter of the incident illumination spot at the wafer surface,
- the solid collection angle of the optical system, and
- the smallest angular distance allowed by the instrument between specular reflected light and the detector.

7.5.3 The roughness may be measured by using a fixed incidence angle and by recording the intensity of scattered light at various scattering angles in the plane of incidence. The two-dimensional PSD curve of the surface can then be calculated from the angular spectrum of the scattered light (BRDF). R_q as well as m_q may be calculated from a one-dimensional or isotropic PSD curve for a given spatial bandwidth as long as the above mentioned limits are accommodated.

7.5.4 Such tools may be able to access a spatial bandwidth range of about one-half the wavelength of the illuminating light up to several hundred μm .

7.6 Scanning Surface Inspection Systems (SSIS)

7.6.1 SSIS measurements are integrated scatter measurements similar to those made by TIS systems, in that they gather light over large solid angles; however, there are some significant differences. In general, most SSIS avoid light collection within five to ten degrees of the specular beam, because in this region the scatter tends to be dominated by surface roughness scatter (which becomes background noise) competing with the signal from laser light scattering events. The early (older) scanners generally had one detector measuring light from a very large solid angle collector. Later systems tend to use several smaller collection angles, each with their own detector. Whatever the arrangement, each collection angle can be defined in terms of its spatial frequency band pass region, and each detector will have some background haze component (or threshold) that is caused by surface roughness. Thus, in the absence of laser light scattering events, measured haze may be converted to an rms roughness for the defined spatial frequencies. This conversion assumes that the surface meets the necessary (smooth, clean, front surface reflective) conditions required for roughness calculations, and that

other noise sources, such as background electronic noise and Rayleigh air scatter, are not issues.

8 Roughness Measurements

8.1 Parameters

8.1.1 R_q and R_a are generally used for silicon wafer surfaces. Other roughness measurement parameters may also prove useful. This guideline does not suggest which parameters to use, rather it suggests how to incorporate any parameter into a standardized measurement specification.

8.2 Measurement Sites

8.2.1 Roughness can vary considerably across a wafer surface. It may also have a preferential direction or anisotropy, often called “lay” (ASME B46.1). Many measurement techniques are limited to a very small measurement area and to one or two scan directions. Therefore specific measurement patterns must be defined to obtain representative and reproducible results. These patterns should correspond to effects observed on wafers in different manufacturing steps. These processing steps can generate features on a wafer surface with rotational symmetries ranging from mirror to infinite. The wafer slicing process may produce low symmetry, while single-wafer polishing can produce high symmetry.

8.2.2 In cases where only a small number of spots is measured, the spot pattern and the scan orientation have to be identified. See Figure 1 for some patterns and orientations; others may be agreed upon between interested parties.

8.3 Site Patterns

8.3.1 One-point — This can be useful for rapidly reviewing results of a quantity of wafers. This is often at the wafer centerpoint.

8.3.2 In applications where only a small number of locations are to be measured, the pattern and orientation of the local scans have to be identified. Measurements are performed at locations as outlined in Figure 1. For each local scan, a representative roughness is calculated. The wafer’s representative roughness is then a function of the n individual representative scan values. The roughness variation can be calculated by the average, the standard deviation, the maximum or the range (Max-Min) of the individual scan values. Other statistical approaches may be employed.

8.3.3 Standard patterns include:

- a. 1-point Wafer center,
- b. 5-point Wafer Center plus four points at $2r/3$ from the wafer center, and

- c. 9-point Wafer Center plus four points at $2r/5$ and four at $4r/5$ from the wafer center.

NOTE 4: These patterns have been shown to be useful with a range of symmetries and values. See Related Information.

8.3.4 Standard measurement orientation patterns include:

- a. Type A - linear scans parallel and perpendicular to the fiducial bisector, and
- b. Type B - linear scans at 45° relative to the fiducial bisector.

NOTE 5: Type A is generally used for all surfaces. Type B has been reported to be useful for some surface conditions on (111) wafers.

8.4 Bandwidth

8.4.1 Two issues affect the bandwidth of the roughness results. The first is the bandwidth of the roughness measuring tool, which is discussed in Section 7. The second bandwidth effect is from the analysis software, which is user selected to emphasize certain spatial frequencies. Both long and short spatial wavelength (or frequency) limits must be defined in μm (or μm^{-1}). When entering this information into a measurement, specification wavelength units shall be used. Profiling instruments should have scan length and bandwidth adjusted according to DIN 4768 and 4777 or ASME B46.1.

8.5 Precision

8.5.1 The precision of the roughness measuring instrument (P) is important. The relationship between P and the tolerance of the parts to be characterized (T) is often called the P/T Ratio. SEMI M27 describes how to determine and interpret the factors: “A test instrument is usually deemed to be suitable for the purpose if P/T lies below 10%. If P/T is greater than 30%, the test instrument is not likely to be suitable for the purpose. Cases for which P/T lies between 10% and 30% must be judged on an individual basis, depending on the requirements being placed on the measurement system.”

9 Roughness Measurement Specifications

9.1 The process of defining the measurements to be taken involves several distinct steps. The definition sequence below represents one logical sequence; others may be equally useful. See Table 1 for measurement abbreviations.

9.2 First, select the type of instrument to be used, including ALL of the following:

9.2.1 Generic instrument type

9.2.1.1 Interferometer

- a. Interference microscope

9.2.1.2 Profilometer

- a. AFM
- b. Other scanning probe microscopes
- c. Optical profilometer
- d. Mechanical stylus

9.2.1.3 Scatterometer

- a. Total Integrating (TIS)
- b. Angle-resolved light (ARLS)
- c. Scanning Surface Inspection System (SSIS)

9.3 Next, select the roughness parameter to be calculated.

9.4 Select the measurement pattern (Figure 1):

- a. Center point
- b. 5-point
- c. 9-point
- d. Full-FQA raster scan
- e. Full-FQA R-theta scan

9.5 Select the pattern orientation (Figure 1)

- a. Type A

- b. Type B

9.6 Select the local measuring condition

- a. Point
- b. Line
- c. Area

9.7 Specify the measurement calculations to be reported

- a. Average (A)
- b. Range (R)
- c. Maximum (M)
- d. Standard Deviation, 1 sigma (S_{n-1})

9.8 Specify the bandwidth and scan length limits within which data is to be gathered.

9.9 Lastly, record the abbreviations describing these selections (see Appendix 1 for examples), separating adjacent abbreviations with a comma and using periods for decimal notation. This creates a seven-field abbreviation. The field sequence described above follows the order of elements in Table 1.

10 Measurement Reporting Sequence

10.1 In general, one value is reported for a wafer. Where more than one pattern is specified the calculated values are reported in the order in which they are listed in Table 1.

Table 1 Roughness Measurement Codes

<i>Element</i>	<i>Abbreviation Item</i>					
Instrument	A	1	2	3	4	
	Profilometer	AFM	SPM	OPR	MPR	
	B	1				
	Interferometer	IM				
	C	1	2	3		
	Scatterometer	TIS	ARLS	SSIS		
Pattern (See NOTE 1.)	1	5	9	R	C	S
	Center	5-point	9-point	FQA/Raster scan	FQA/Concentric R-theta scan	FQA/Spiral R-theta scan
Pattern Orientation	A	B				
	A	B				
Local Measurement Condition	P	L	A			
	Point	Line	Area			
Parameter (See NOTE 1.)	Q	A	Z	T	K	S
	Rq	Ra	Rz	Rt	Kurtosis	Skewness
Calculation (See NOTE 1.)	A	R	M	D		
	Average	Range	Maximum	Std. Deviation (1 sigma _{n-1})		
Bandwidth, μm	[_]/[_] (fill in blanks to two significant figures) Long wavelength (μm)/Short wavelength (μm)					

NOTE 1: If more than 1 element is specified, the representative letters are concatenated in the relevant field, in the order specified. See Appendix 1 for examples.