The American Society of
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AN AMERICAN NATIONAL STANDARD

SURFACE TEXTURE (SURFACE ROUGHNESS, WAVINESS, AND LAY)

ASME B46.1-2002
(Revision of ASME B46.1-1995)

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The 2002 edition of this Standard is being issued with an automatic addenda subscription service. The use of addenda allows revisions made in response to public review comments or committee actions to be published as necessary. This Standard will be revised when the Society approves the issuance of a new edition.

ASME issues written replies to inquiries concerning interpretations of technical aspects of this Standard. Interpretations are published on the ASME Web site under the Committee Pages at http://www.asme.org/codes/ as they are issued.

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FOREWORD

The first standard on surface texture was issued in March 1940. The dates for the subsequent changes are as follows:

Revision — February 1947
Revision — January 1955
Revision — September 1962
Revision — August 1971
Revision — March 1978
Revision — March 1985
Revision — June 1995

The current revision is the culimination of a major effort by the ASME Committee B46 on the Classification and Designation of Surface Qualities. A considerable amount of new material has been added, particulary to reflect the increasing number of surface measurement techniques and surface parameters in practical use. Overall, our vision for the ASME B46.1 Standard is twofold:

(a) to keep it abreast of the latest developments in the regime of contact profiling techniques where the degree of measurement control is highly advanced, and

(b) to encompass a large range of other techniques that present valid and useful descriptions of surface texture.

The present Standard includes twelve sections:

Section 1, Terms Related to Surface Texture, contains a number of definitions that are used in other sections of the Standard. Furthermore, a large number of surface parameters are defined in addition to roughness average, *Ra*. These include rms roughness *Rq*, waviness height *Wt*, the mean spacing of profile irregularities *RSm*, and several statistical functions, as well as surface parameters for area profiling techniques.

Section 2, Classification of Instruments for Surface Texture Measurement, defines six types of surface-texture measuring instruments including several types of profiling instruments, scanned probe microscopy, and area averaging instruments. With this classification scheme, it is possible that future sections may then provide for the specification on drawings of the type of instrument to be used for a particular surface texture measurement.

Section 3, Terminology and Measurement Procedures for Profiling, Contact, Skidless Instruments, is based on proposals in ISO Technical Committee 57 to define the characteristics of instruments that directly measure surface profiles, which then can serve as input data to the calculations of surface texture parameters.

Section 4, Measurement Procedures for Contact, Skidded Instruments, contains much of the information that was previously contained in ASME B46.1-1985 for specification of instruments primarily intended for measurement of averaging parameters such as the roughness average *Ra*.

Section 5, Measurement Techniques for Area Profiling, lists a number of techniques, many of them developed since the mid 1980's, for three-dimensional surface mapping. Because of the diversity of techniques, very few recommendations can be given in Section 5 at this time to facilitate uniformity of results between different techniques. However, this section does allow for the measurement of the area profiling parameters, *Sa* and *Sq*, as alternatives to the traditional profiling parameters.

Section 6, Measurement Techniques for Area Averaging, discusses the use of area averaging techniques as comparators to distinguish the surface texture of parts manufactured by similar processes. In future sections, surface parameters based directly on these techniques may be defined or surface specifications may be proposed that call for measurements by these types of instruments.

Section 7, Nanometer Surface Texture and Step Height Measurements by Stylus Profiling Instruments, addresses the use of contacting profilometry in the measurement of surface texture features whose height dimensions are typically measured within the scale of nanometers. Section

7 may be applicable to such industries as the semiconductor, data storage, and micro electro-mechanical systems (MEMS) manufacturers.

Section 8, Nanometer Surface Roughness as Measured with Phase Measuring Interferometric Microscopy, addresses the use of optical non-contact techniques for measuring highly polished surfaces. Section 8 may be applied to the measurement of such items as polished silicon wafers, optical components and precision mechanical components.

Section 9, Filtering of Surface Profiles, carries on with the traditional specifications of the 2RC cutoff filter and introduces the phase corrected Gaussian filter as well as band-pass roughness concepts.

Section 10, Terminology and Procedures for Evaluation of Surface Textures Using Fractal Geometry, introduces the field of fractal analysis as applied to measuring surface texture. Introductions of various techniques and terms are included to allow for lateral scale specific interpretation of surface texture.

Section 11, Specifications and Procedures for Precision Reference Specimens, describes different types of specimens useful in the calibration and testing of surface profiling instruments. It is based on ISO 5436, Part 1, Calibration Specimens-Stylus Instruments-Types, Calibration, and Use of Specimens, and contains new information as well.

Section 12, Specifications and Procedures for Roughness Comparison Specimens, describes specimens that are useful for the testing and characterization of area averaging instruments.

This Standard was approved as an American National Standard on January 16, 2002, and October 7, 2002.

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Classification and Designation of Surface Qualities

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The Committee welcomes proposals for revisions to this Standard. Such proposals should be as specific as possible, citing the paragraph number(s), the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent documentation.

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Subject:	Cite the applicable paragraph number(s) and the topic of the inquiry.
Edition:	Cite the applicable edition of the Standard for which the interpretation is being requested.
Question:	Phrase the question as a request for an interpretation of a specific requirement suitable for general understanding and use, not as a request for an approval of a proprietary design or situation. The inquirer may also include any plans or drawings, which are necessary to explain the question; however, they should not contain proprietary names or information.

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SURFACE TEXTURE (SURFACE ROUGHNESS, WAVINESS, AND LAY)

Section 1
Terms Related to Surface Texture

1.1 General

1.1.1 Scope. This Standard is concerned with the geometric irregularities of surfaces. It defines surface texture and its constituents: roughness, waviness, and lay. It also defines parameters for specifying surface texture.

The terms and ratings in this Standard relate to surfaces produced by such means as abrading, casting, coating, cutting, etching, plastic deformation, sintering, wear, erosion, etc.

1.1.2 Limitations. This Standard is not concerned with error of form and flaws, but discusses these two factors to distinguish them from surface texture.

This Standard is not concerned with luster, appearance, color, corrosion resistance, wear resistance, hardness, subsurface microstructure, surface integrity, and many other characteristics which may govern functional considerations in specific applications.

This Section does not recommend specific surface roughness, waviness, or type of lay suitable for specific purposes, nor does it specify the means by which these irregularities may be obtained or produced. Criteria for selection of surface qualities and information on instrument techniques and methods of producing, controlling, and inspecting surfaces are included in the other sections and in the appendices.

Surface texture designations as delineated in this Standard may not provide a sufficient set of indexes for describing performance. Other characteristics of engineering components such as dimensional and geometrical characteristics, material, metallurgy, and stress must also be controlled.

1.1.3 SI Values. Values of quantities stated in the SI[1] (metric) system are to be regarded as standard. Approximate nonmetric equivalents are shown for reference.

1.1.4 References. This Standard is to be used in conjunction with ASME Y14.36M-1996, Surface Texture Symbols, which prescribes engineering drawing and related documentation practices for specifying surface texture. Other relevant standards, which should be used in design and measurement, are:

ASME B89.6.2-1973 (R1995), Temperature and Humidity Environment for Dimensional Measurement

ASME Y14.5M-1994 (R1999), Dimensioning and Tolerancing, Engineering Drawings and Related Documentation Practices

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References to other useful works are included as footnotes.

1.1.5 Cleanliness. Normally, surfaces to be measured should be free of any foreign material that would interfere with the measurement.

1.2 Definitions Related to Surfaces

1.2.1 Surfaces

measured surface: a representation of the real surface obtained by the use of a measuring instrument

nominal surface: the intended surface boundary (exclusive of any intended surface roughness), the shape and extent of which is usually shown and dimensioned on a drawing or descriptive specification (See Fig. 1-1.)

real surface: the actual boundary of an object. Its deviations from the nominal surface stem from the processes that produce the surface.

surface: the boundary that separates an object from another object, substance, or space

1.2.2 Components of the Real Surface. The real surface differs from the nominal surface to the extent that it exhibits surface texture, flaws, and errors of form. It is considered as the linear superposition of roughness, waviness, and form with the addition of flaws.

error of form: widely spaced deviations of the real surface from the nominal surface, which are not included in

[1] Le Système International d'Unités.