Designation: F 1438 – 93 (Reapproved 1999)

Standard Test Method for Determination of Surface Roughness by Scanning Tunneling Microscopy for Gas Distribution System Components[1]

This standard is issued under the fixed designation F 1438; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

INTRODUCTION

Semiconductor clean rooms are serviced by high-purity gas distribution systems. This test method presents a procedure that may be applied for the evaluation of one or more components considered for use in such systems.

1. Scope

1.1 The purpose of this test method is to define a method for analyzing the surface texture of the above-mentioned components using a scanning tunneling microscope (STM). STM is a noncontact method of surface profiling that can measure three-dimensional surface features in the nanometer size range, which can then be used to represent the surface texture or to provide figures of merit. Application of this test method, where surface texture is used as a selection criterion, is expected to yield comparable data among different components tested.

1.2 *Limitations*:

1.2.1 This test method is limited to characterization of stainless steel surfaces that are smoother than R_a = 0.25 µm, as determined by a contact-stylus profilometer and defined by ANSI B46.1. The magnifications and height scales used in this test method were chosen with this smoothness in mind.

1.2.2 Intentional etching or conductive coating of the surface are considered modifications of the gas-wetted surface and are not covered by this test method.

1.2.3 This test method does not cover steels that have an oxide layer too thick to permit tunneling under the test conditions outlined in 11.3.

1.3 This technique is written with the assumption that the STM operator understands the use of the instrument, its governing principles, and any artifacts that can arise. Discussion of these points is beyond the scope of this test method.

1.4 The values stated in SI units are to be regarded as the standard.

1.5 *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:*

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method[2]

2.2 *ANSI Standard:*

ANSI B.46.1-85, "Surface Texture (Surface Roughness, Waviness, and Lay)," ANSI/ASME, 1985[3]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *artifact*—any contribution to an image from other than true surface morphology. This could include such examples as vibration, electronic noise, thermal drift, or tip imperfections.

3.1.2 *center line (graphical center line)*—line parallel to the direction of profile measurement, such that the sum of the areas contained between it and the profile contained on either side are equal (see Calculation Section).

3.1.3 *cutoff length (l_c)—for profiles in this context*, the sampling length, that is, the length of a single scan, in nanometers (see Calculation Section).

3.1.4 *current*— in this context, the tunneling current (expressed in nanoamperes) that flows in either direction between the tip and surface, under the conditions specified.

3.1.5 *feature height*—datum (height in the z-direction) of any point in the scan area, relative to the lowest point in the scan area, as derived from tunneling current during tip rastering.

[1] This test method is under the jurisdiction of ASTM Committee F-1 on Electronicsand is the direct responsibility of Subcommittee F01.10 on Contamination Control.

Current edition approved Feb. 15, 1993. Published April 1993.

[2] *Annual Book of ASTM Standards*, Vol 14.02.

[3] Available from American National Standards Institute, 13th Floor, 11 W. 42nd St., New York, NY 10036.

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