Designation: E 1813 – 96 (Reapproved 2002)

Standard Practice for Measuring and Reporting Probe Tip Shape in Scanning Probe Microscopy[1]

This standard is issued under the fixed designation E 1813; 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

An image produced by a stylus scanning in close proximity to a surface is usually not an exact replica of the surface. The data are subject to a type of distortion called dilation. The amount of dilation depends on the shape and the orientation of the probe as well as the surface topography **(1)**.[2] Analysis of the scanned probe images thus requires knowledge of the probe shape and orientation.

1. Scope

1.1 This practice covers scanning probe microscopy and describes the parameters needed for probe shape and orientation.

1.2 This practice also describes a method for measuring the shape and size of a probe tip to be used in scanning probe microscopy. The method employs special sample shapes, known as probe characterizers, which can be scanned with a probe microscope to determine the dimensions of the probe. Mathematical techniques to extract the probe shape from the scans of the characterizers have been published **(2-5).**

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:*

F 1438 Test Method for Determination of Surface Roughness by Scanning Tunneling Microscopy for Gas Distribution System Components[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *active length*—length of the region of the probe tip that could come into contact with the sample during a scan, and is set by the height of the tallest feature encountered, and it should be less than the probe length (see Fig. 1).

3.1.2 *characterized length*—the region of the probe whose shape has been measured with a probe characterizer (see Fig. 1).

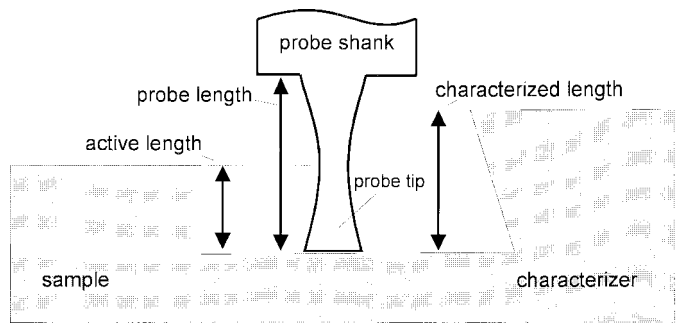

FIG. 1 Probe Tip Characterization

3.1.3 *concave probe*—a probe that is not convex.

3.1.4 *convex probe*—the probe is convex if for any two points in the probe, the straight line between the points lies in the probe.

3.1.4.1 *Discussion*—Conical and cylindrical probes are convex, while flared probes are not. Minor imperfections in the probe, caused for instance by roughness of the probe surface, should not be considered in determining whether a probe is convex.

3.1.5 *dilation*—the dilation of a set A by a set B is defined as follows:

$$A + B = \bigcup_{b \in B} (A + b) \tag{1}$$

The image I produced by a probe tip T scanning a surface S is $I = S + (-T)$ **(6)**. This is the surface obtained if an inverted image of the tip is placed at all points on the surface. The envelope produced by these inverted tip images is the image of the surface **(3)**.

3.1.6 *erosion*—the erosion of a set A by a set B is defined as follows:

$$A - B = \bigcap_{b \in B} (A - b). \tag{2}$$

[1] This practice is under the jurisdiction of ASTM Committee E42 on Surface Analysis and is the direct responsibility of Subcommittee E42.14 on STM/ATM.

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[2] The boldface numbers in parentheses refer to the list of references at the end of this document.

[3] *Annual Book of ASTM Standards,* Vol 10.05.

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