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Surface chemical analysis — Atomic force microscopy — Guideline for restoration procedure for atomic force microscopy images dilated by finite probe size

Analyse chimique des surfaces — Microscopie à force atomique — Lignes directrices relatives au mode opératoire de restauration des images de microscopie à force atomique dilatées par la taille finie de la sonde

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Foreword

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This document was prepared by Technical Committee ISO/TC 201, *Surface chemical analysis*, Subcommittee SC 9, *Scanning probe microscopy*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Atomic force microscope (AFM) is a method for imaging surfaces by mechanically scanning their surface contours, in which the deflection of a sharp probe tip sensing the surface forces, mounted on a compliant cantilever, is monitored. AFM belongs to a family of scanning probe microscope (SPM) and is of increasing importance for the characterization of materials surfaces at the nanoscale. Therefore, precise and quantitative measurement of three-dimensional (3D) surface topography at the nanoscale by AFM is highly demanded by researchers and engineers in the various fields of academia and industry. One of the imaging artefacts of AFM topography measurements is caused by the finite size and shape at the apex of an AFM probe used for the scanning. Such a dilation effect due to the probe shape can cause a significant error in the precise analysis of 3D surface morphology. Especially for the critical dimension (CD) analysis of fine devices at the nanoscale, there is a need for probe-shape artefact to be corrected in a reproducible and quantitative way. Thus, the demand for the establishment of an international standard on the guideline for a reliable restoration procedure of dilated AFM images is high.

This document describes a quantitative procedure for the restoration of AFM height images dilated by finite probe size and shape. It includes the quantitative characterization of AFM probe apex in use and the restoration of AFM topography images using the actual probe shape.

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1 Scope

This document describes a procedure for the quantitative characterization of the probe tip of an atomic force microscope (AFM) probe and a restoration of AFM topography images dilated by finite probe size. The three-dimensional shape of the probe apex is extracted by image reconstruction using suitable reference materials. This document is applicable to the reconstruction of AFM topography images of solid material surfaces.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 11775, *Surface chemical analysis — Scanning-probe microscopy — Determination of cantilever normal spring constants*

ISO 11952, *Surface chemical analysis — Scanning-probe microscopy — Determination of geometric quantities using SPM: Calibration of measuring systems*

ISO 18115-2, *Surface chemical analysis — Vocabulary — Part 2: Terms used in scanning-probe microscopy*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 18115-2 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
dilation
one of the two basic operators of mathematical morphology, whose basic effect on a binary image is to gradually enlarge the boundaries of regions of foreground pixels

Note 1 to entry: The dilation ($\oplus$) of a set A by a set B is defined as follows:

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

Note 2 to entry: By dilation, areas of foreground pixels grow in size while holes within those regions become smaller.