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# Surface Chemical Analysis — Atomic force microscopy — Procedure for in situ characterization of AFM probe shank profile used for nanostructure measurement

*Analyse chimique des surfaces — Microscopie à balayage de sonde — Procédure pour la caractérisation in situ des sondes AFM utilisées pour mesurer la nanostructure*

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# Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is Technical Committee ISO/TC 201, *Surface chemical analysis*, Subcommittee SC 9, *Scanning probe microscopy*.


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# Introduction

Atomic force microscopes (AFMs) are of increasing importance for imaging surfaces at the nanoscale. The imaging mechanism involves a dilation of the surface form by the AFM probe shape. In practice, the radii of probe tips are in the range of 1 nm to 200 nm, which is the same order of magnitude as that of many important surface features. AFM images may, therefore, be strongly affected by the shape and size of the AFM probe used for imaging. In addition, the mechanism used to control the distance between the AFM probe and the sample surface can create artefacts in AFM images, because the effective probe shape characteristic depends on the control parameters. The probe radius and its half-cone angle are often used for the specification of AFM probes. However, practical probes are often not described so simply. Therefore, a quantitative expression for probe shank shape is required. This International Standard describes two methods for the detailed determination of probe shank shape: a projection of the probe profile (PPP) and the effective probe shape characteristic (EPSC), both of which are projected onto a defined plane and which, in turn, include the effect of the probe controlling mechanism. The PPP provides a continuous profile, whereas the EPSC provides a few discrete characteristic points. PPP, used in conjunction with a probe shape characteristic (PSC) measurement, gives the quality of the probe for general applications, whereas EPSC indicates the usefulness of the probe for depth measurements in narrow trenches and similar profiles. The true surface shape can be recovered and estimated from the measured surface with an accurate model of the true probe shape. This International Standard provides methods for the quantitative determination of aspects of AFM probe shank shape, to ensure that the probe is adequate to measure surfaces with narrow trenches and similar profiles and to ensure reproducible AFM imaging.

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# Surface Chemical Analysis — Atomic force microscopy — Procedure for in situ characterization of AFM probe shank profile used for nanostructure measurement

## 1 Scope

This International Standard specifies two methods for characterizing the shape of an AFM probe tip, specifically the shank and approximate tip profiles. These methods project the profile of an AFM probe tip onto a given plane, and the characteristics of the probe shank are also projected onto that plane under defined operating conditions. The latter indicates the usefulness of a given probe for depth measurements in narrow trenches and similar profiles. This International Standard is applicable to the probes with radii greater than $5u_0$, where $u_0$ is the uncertainty of the width of the ridge structure in the reference sample used to characterize the probe.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 18115-2:2010, *Surface chemical analysis — Vocabulary — Part 2: Terms used in scanning-probe microscopy*

ISO/TS 80004-4:2011, *Nanotechnologies — Vocabulary — Part 4: Nanostructured materials*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 18115-2, ISO/TS 80004-4 and the following apply.

NOTE Some of the terms and definitions are reprinted here for convenience.

**3.1**
**aspect ratio of the probe**
ratio of the probe profile length at a certain position to the probe profile width at that position

**3.2**
**deflection sensitivity**
sensitivity factor converting the output of an AFM optical displacement detection system for a cantilever in the contact mode to the displacement of the tip

**3.3**
**error signal**
feedback control system signal whose amplitude and sign are used to correct the position and/or alignment between the controlling and the controlled elements

**3.4**
**effective probe shape characteristic**
**EPSC**
relationship between the probe profile width and probe profile length for a given probe, including the effects of the true probe shape, artefacts due to the feedback controlling mechanism in the AFM modes employed, and other imaging mechanisms of AFM projected onto a defined plane

Note 1 to entry: The defined plane is usually the *x*-*z* plane.

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