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Surface chemical analysis — Scanning-probe microscopy — Determination of cantilever normal spring constants

Analyse chimique des surfaces — Microscopie à sonde à balayage — Détermination de constantes normales en porte-à-faux de ressort

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Foreword

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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 ISO/TC 201, *Surface chemical analysis*, Subcommittee SC 9, *Scanning probe microscopy*.

Introduction

Atomic force microscopy (AFM) is a mode of scanning probe microscopy (SPM) used to image surfaces by mechanically scanning a probe over the surface in which the deflection of a sharp tip sensing the surface forces mounted on a compliant cantilever is monitored. It can provide amongst other data, topographic, mechanical, chemical, and electro-magnetic information about a surface depending on the mode of operation and the property of the tip. Accurate force measurements are needed for a wide variety of applications, from measuring the unbinding force of protein and other molecules to determining the elastic modulus of materials, such as organics and polymers at surfaces. For such force measurements, the value of the AFM cantilever normal spring constant, k_z, is required. The manufacturers' nominal values of k_z have been found to be up to a factor of three in error, therefore practical methods to calibrate k_z are required.

This International Standard describes five of the simplest methods in three categories for the determination of normal spring constants for atomic force microscope cantilevers. The methods are in one of the three categories of dimensional, static experimental, and dynamic experimental methods. The method chosen depends on the purpose and convenience to the analyst. Many other methods may also be found in the literature.

Surface chemical analysis — Scanning-probe microscopy — Determination of cantilever normal spring constants

1 Scope

This International Standard describes five of the methods for the determination of normal spring constants for atomic force microscope cantilevers to an accuracy of 5 % to 10 %. Each method is in one of the three categories of dimensional, static experimental, and dynamic experimental methods. The method chosen depends on the purpose, convenience, and instrumentation available to the analyst. For accuracies better than 5 % to 10 %, more sophisticated methods not described here are required.

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, *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.

3.1
normal spring constant
spring constant
force constant
DEPRECATED: cantilever stiffness
k_z
<AFM> quotient of the applied normal force at the *probe tip* (3.2) by the deflection of the cantilever in that direction at the probe tip position

Note 1 to entry: See lateral spring constant, torsional spring constant.

Note 2 to entry: The normal spring constant is usually referred to as the spring constant. The full term is used when it is necessary to distinguish it from the lateral spring constant.

Note 3 to entry: The force is applied normal to the plane of the cantilever to compute or measure the normal force constant, k_z. In application, the cantilever in an AFM may be tilted at an angle, θ, to the plane of the sample surface and the plane normal to the direction of approach of the tip to the sample. This angle is important in applying the normal spring constant in AFM studies.

3.2
probe tip
tip
probe apex
structure at the extremity of a probe, the apex of which senses the surface

Note 1 to entry: See *cantilever apex* (3.3).

3.3
cantilever apex
end of the cantilever furthest from the cantilever support structure

Note 1 to entry: See *probe apex* (3.2), *tip apex* (3.2).