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Physics Abstracts

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Scanning probe microscopy: applications in biology and physics

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Abstract. — Scanning probe microscopes can probe a variety of quantities characterizing surfaces. This overview paper describes techniques applicable in an ambient environment and having the power to distinguish different materials: the scanning force and friction microscope and the scanning near-field optical microscope combined with a spectrometer. The basic operating principles of these two microscopes are described. Selected experiments point to possible future applications: we discuss scanning force and friction microscopy of ZnSe on GaAs and of Na, K-ATPase and near-field optical microscopy of a grating and of micropores.

1. Introduction.

Scanning probe microscopy techniques [1] are powerful tools to investigate atomic and molecular scale objects in biology and physics. Various kinds of interactions are employed, such as electron tunneling [2], attractive [3], repulsive [4] and frictional forces [5], and optical effects [6]. Due to the inherent nonlinear interaction characteristics scanning probe microscopes can be used to trigger events or modify surfaces or objects [7]. Unique to the scanning probe microscopy techniques is the wide range of operating environments [1], comparable only to classical optical microscopy. Experiments are now routinely performed in air, liquids and in ultra high vacuum.

Many samples should be investigated under ambient conditions, especially in biology or in application relevant fields. It is desirable that a microscope measures not only the topography of a sample, but also additional quantities giving a detailed view of the composition of the sample. At length scales larger than a micrometer, optical spectroscopy is well suited for this task [8]. For operation in vacuum conditions many techniques with this capability exist, such as Auger electron spectroscopy, photo electron spectroscopy and others [9].

Conductive samples can be investigated down to the atomic scale at ambient conditions or in electrochemical environments by scanning tunneling microscopy and spectroscopy [10]. However, the vast majority of surfaces is isolating: therefore scanning tunneling microscopy is of only limited use for real sample surfaces, such as biological samples or samples of technological relevance.

Scanning force microscopy is a well proven technique which allows the measurement of the topography of isolating and conductive samples down to the atomic scale [1]. By measuring not

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