

# Sample preparation methods for Scanning Probe Microscopy

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## Abstract

Scanning Probe Microscopy has been routinely employed as a surface characterization technique for nearly 2 decades. Atomic Force Microscopy and Scanning Tunneling Microscopy are the most widely used from family of SPM, these techniques can be used in ambient conditions with simple sample preparation. AFM and STM are able to measure three-dimensional topography information from the atomic angstrom level to the micron scale with remarkable resolution. In this paper we are reviewing about the simple sample preparation techniques scanning probe microscope techniques like atomic force microscope and scanning tunneling microscopes.

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## 1. Introduction

Materials characterization is very important for studying and analyzing various properties. In the last three decades, drastically changes in semiconductor electronics have increased the use of highly precise instruments for obtaining qualitative information on the composition, surface morphology, and Physical structures of materials at micrometer and nanometer scales [1, 2, 3, 4]. Advantages of SPM are that of that of other techniques it has 3D images of high resolution [5, 6, 7].

With SPM different type of topographies and different types of materials can be imaged[8]. Few of them namely: Quantum dots, Carbon Nanotubes, Nanocomposite coatings, Biological Cells and nanopatterns created using soft lithography.

## 2. Experimental technique

The main focus of this paper is to present simple sample preparation techniques for SPM We used **A.P.E.Research S.r.l** Italy make **TriA-SPM** system for the characterization of various samples. **TriA-SPM** AFM is a versatile atomic force microscope suited to a wide variety of applications including Materials sciences ,biological sciences, semiconductor devices technology, polymer science, optics, chemical science and medical sciences. The

close loop flexure scanning stage guarantees absolute positioning and high planarity. **TriA-SPM** STM is a very powerful Scanning Tunneling Microscope allowing the mapping with atomic resolution in air even for high resistive materials. The STM can be equipped with different scanners with ranges from 3  $\mu\text{m}$  to 25  $\mu\text{m}$ .

By tunneling down to 500 fA the STM is able to measure high resistive materials like the self assembled molecules (SAM).

For the sample preparation various CVD and PVD techniques are used, among them Spin coating, sputtering, and evaporation are few.

### 2.1 AFM Sample Preparation:

Various types of samples can be used for SPM imaging in ambient condition. Different variety of methods are using for sample preparation.

AFM imaging essentially needs:

- a) The Substrate should be clean , flat and very low roughness
- b) The Sample must be properly placed and attached with the substrate
- c) The substrate must be fixed in a stationary position

For SPM sample analysis the substrate must be flatter/smooth than the substrate. In other words, the roughness of the sample should be greater than the topographical features of the substrate. The most commonly used substrates include: Si, Glass, ITO, FTO, Mica and HOPG are used. The adhesives used generally double sided tape, carbon tape and Silver paste.

### 3. Results and Discussion

There are different types of operating modes in Atomic Force Microscopy. Few of them namely: Contact, Non-contact , Semi Contact, Lateral Force, Phase Imaging, Force Modulation , Magnetic Force Imaging, Electric Force Imaging, Electrochemical AFM, Piezo force Imaging and Conductive Imaging [8,9,10].

The advantage of using an AFM for sample characterization is that the scanning may be done in ambient conditions. Thus, most applications for characterizing Nanomaterials are carried in normal room temperature.

For Scanning Tunneling Microscope the substrate must be conductive or semi conductive. The semi conductive must show tunneling property with applied bias. For making conductive contact with substrate is glued with Silver paste or carbon tape.

The STM normally operates in two modes: Namely Constant Current mode and Constant Height mode [8, 11, 12].

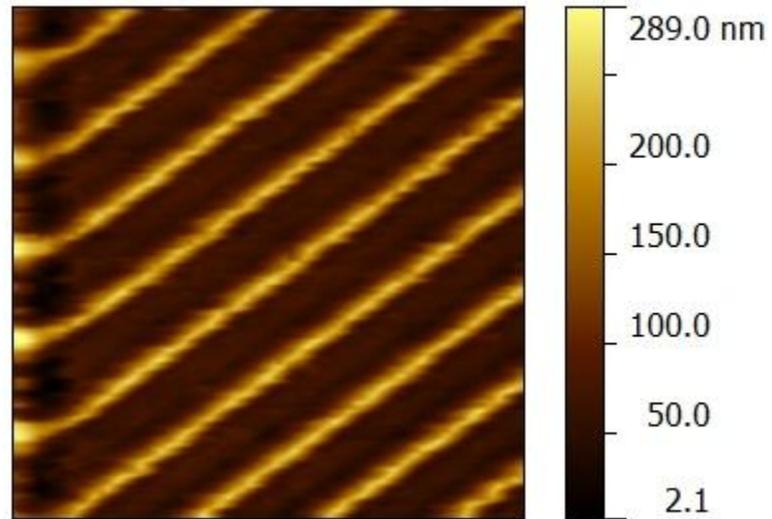


Fig.1 AFM Image of Patterns Using Soft lithography

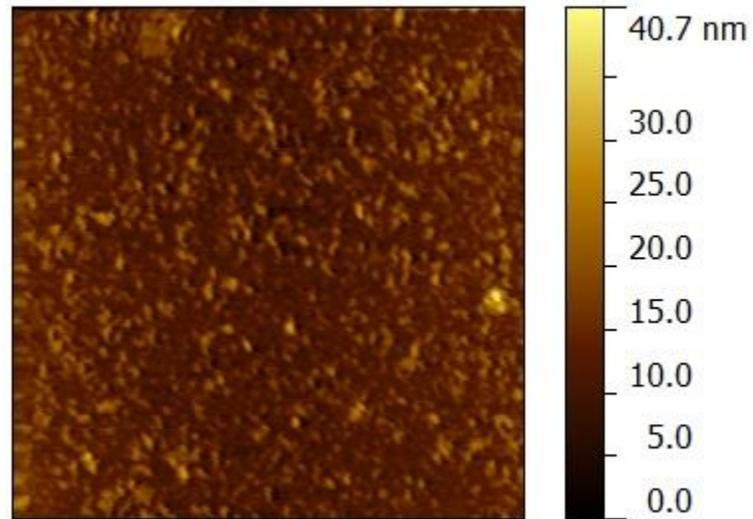


Fig.2 Polymeric materials AFM

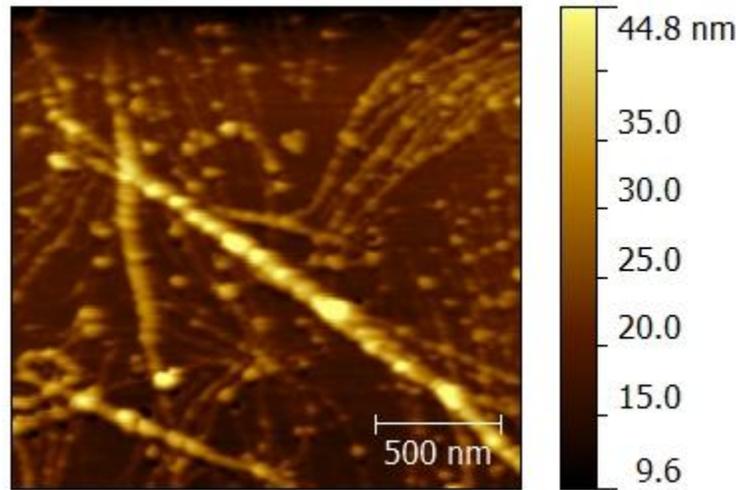


Fig.3 AFM Image Nanowires on Si

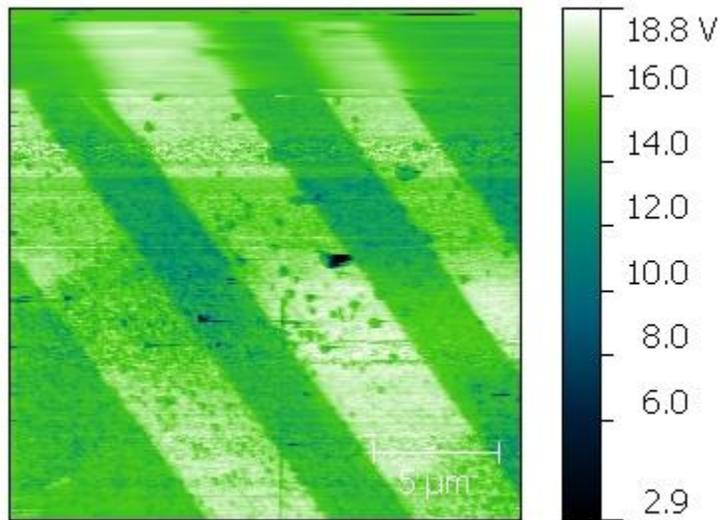


Fig.4 Conductive AFM image of Microchannels

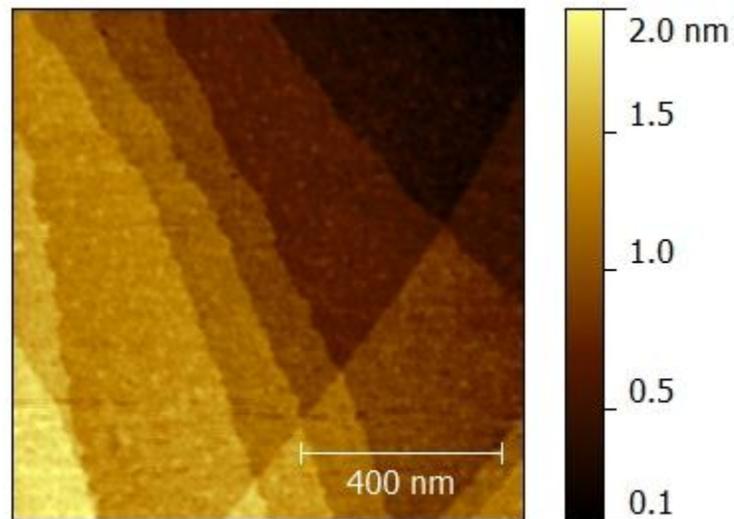


Fig.5 STM Image of Au layers

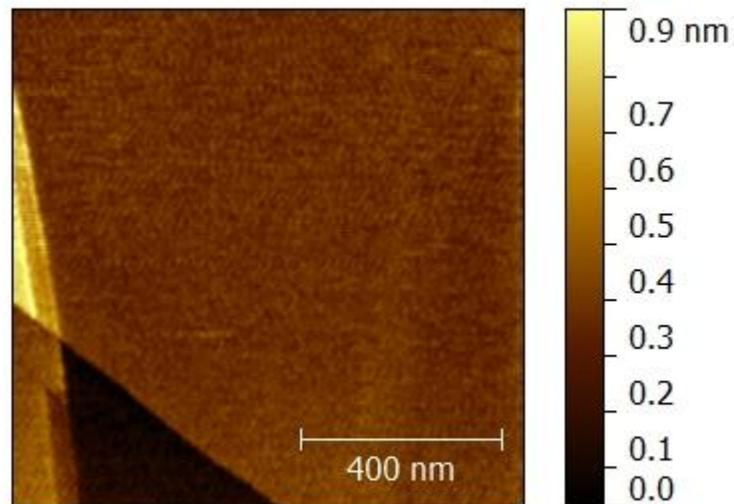


Fig.6 STM Image of HOPG

#### 4. Conclusions:

Sample preparation techniques for Scanning Probe Microscope Techniques AFM and STM are outlined in this paper. Examples of procedures along with AFM images illustrate material science, pharmaceutical or biological applications. AFM sample preparation is quiet same as of other microscopy methods, and is very much simpler and

less time consuming.

. In general, SPM characterization is both cost and time effective .SPM resolution is greater or comparable to traditional techniques. The main advantage of SPM for sample characterization is topography determination along with roughness and 3 dimensional imaging.

Advantages of using a SPM analysis:

- Faster and reliable
- Affordable instrument for small research labs and academic institutions
- 3D Imaging

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