Scanning Probe Microscopy Platforms: Morphology and Beyond

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Scanning Probe Microscopy (SPM) is a powerful technique which allow to investigate the morphology and the local properties of a material with high spatial resolution. Born at the beginning of 1980s with the scanning tunneling microscopy (STM), it proved to be particularly versatile and, therefore, it rapidly developed with the design of many other devices. Nowadays, SPM also includes electric force microscopy (ECM), scanning near-field optical microscopy (SNOM) and atomic force microscopy (AFM) [1]. AFM has a vertical resolution of 1 Å and a horizontal resolution which depends on the used tip dimension (typically 1 nm).

At CNIS-Nanolab two different AFM platforms are available, namely Dimension ICON and Multimode (Bruker Inc), which are shown in Figure 1.

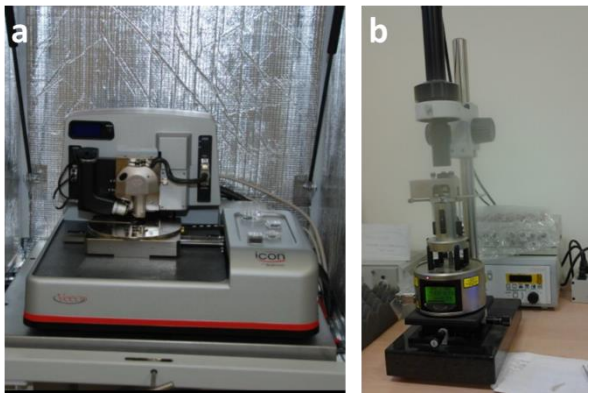

Figure 1. (a) Dimension ICON and (b) Multimode atomic force microscopes available at CNIS-Nanolab.

Both the instruments can work in contact, non-contact, tapping mode, in air or in liquid, according to the material features. As a consequence, it is possible to obtain information on the morphology of a variety of samples, i.e. conductive or not, hard or soft, organic-inorganic hybrids, self-assembled systems, cells and tissues. Moreover, Dimension ICON is equipped with Scan Assyst™ system which, optimizing the applied force, allows to obtain high resolution images even on ultra-soft samples, like hydrogels [2]. Examples of the different samples which can be characterized are reported in Figure 2 [3-4].

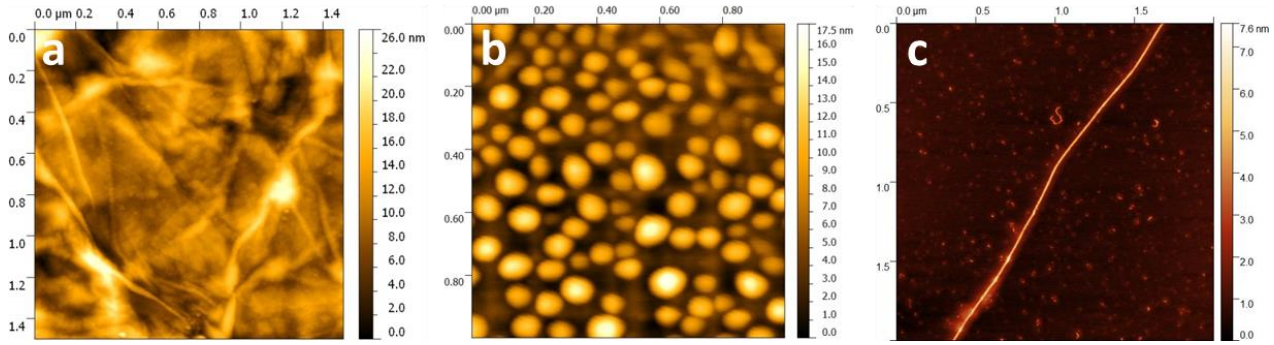

Figure 2. Different kinds of samples, i.e. (a) graphene on silicon, (b) metallic nanoparticles functionalized with thiols, (c) amiloids fibrils, observed using the atomic force microscopes available at CNIS-Nanolab.

Besides topographic information, AFM platforms available at CNIS-Nanolab are equipped with specific modules which can be used to study (i) electric, (ii) magnetic, (iii) piezoelectric, (iv) nanomechanical, (v) electrochemical, (vi) thermoresponsive properties of the samples.

In detail:

- Conductive AFM (C-AFM), Surface potential AFM (SP-AFM), Scanning Capacitance Microscopy (SCM) and Electric Force Microscopy (EFM) can be used to detect respectively electrical conductivity, surface potential, electrical capacity and electrical charge distribution;
- Magnetic Force Microscopy (MFM), by using tips with a magnetic coating, allows to study local magnetic properties visualizing the magnetic domains distribution [5];
- Piezoelectric Force Microscopy (PFM) gives information on piezoelectric properties at the nanometric scale by measuring the local piezoelectric coefficient d_{33} on the sample surface;
- PeakForce QNM™ and Harmonix™ allow to investigate nanomechanical properties of either hard and soft materials, binding events and conformational changes of biological samples [6];
- Electrochemical AFM (EC-AFM) scan a surface which acts as working electrode in an electrochemical cell, thus monitoring electrochemically induced changes in real-time;
- Scanning Thermal Microscopy (SThM) allows local thermal measurements.

References

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