

The Nanotechnology Platform at Parc Científic Barcelona: Opportunities for your Research and Development

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<http://www.pcb.ub.es/plataforma/nanotecnologia>



Abstract

Nanotechnology is increasingly being applied to areas like medicine, biology, renewable energy, novel materials, cosmetics, agriculture, and the aerospace and automotive industry. Its use within R & D departments is emerging as a key competitive advantage for both the private and public sector. Nonetheless, the incorporation and functional application of this technology requires a sophisticated combination of high level of infrastructure, know-how, and qualified personnel.

The Nanotechnology Platform at Parc Científic Barcelona offers the opportunity to incorporate this technology within any company, laboratory, or research centre. Our platform consists of three working groups comprising: 1) Service & Consulting, 2) Technology Development, and 3) Research. The interaction of these three lines represents a unique and accessible offer that includes micro/nano-fabrication techniques; different surface functionalization processes; numerous techniques for physical, chemical, or biological characterization; and highly qualified personnel with expertise in a wide range of state-of-the-art applications.

Our experience ranges from the development of new materials and processes such as micro/nanoporous membranes or multi-level lithographies to the manufacture of photolithographic masks, components for solar cells, microfluidic systems, lab-on-a-chip devices, biosensors for the diagnosis of cancer or other diseases, and scaffolds for tissue engineering and regenerative medicine. We also have experience with modification of surfaces including topographical and biochemical patterns; physical analysis of biological materials such as cells and bacteria; molecular characterization of human tissues or geological samples, morphological characterization of implants, and the study of molecular interactions. In conclusion, the Nanotechnology Platform provides a unique and accessible set of tools and experience that represents a distinctive advantage of any research, development, and innovation strategy.



RESEARCH

Our Research group is developing projects in the areas of biomaterials, BioMEMS, tissue engineering and regenerative medicine, and nanomedicine integrating "top-down" and "bottom-up" nanotechnologies.

TECHNOLOGY DEVELOPMENT

Our Technology Development group is focused on identifying, implementing, and developing materials, processes, or devices that can benefit current and potential users of our Platform.

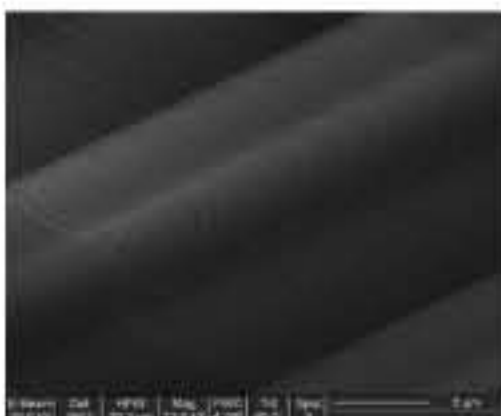
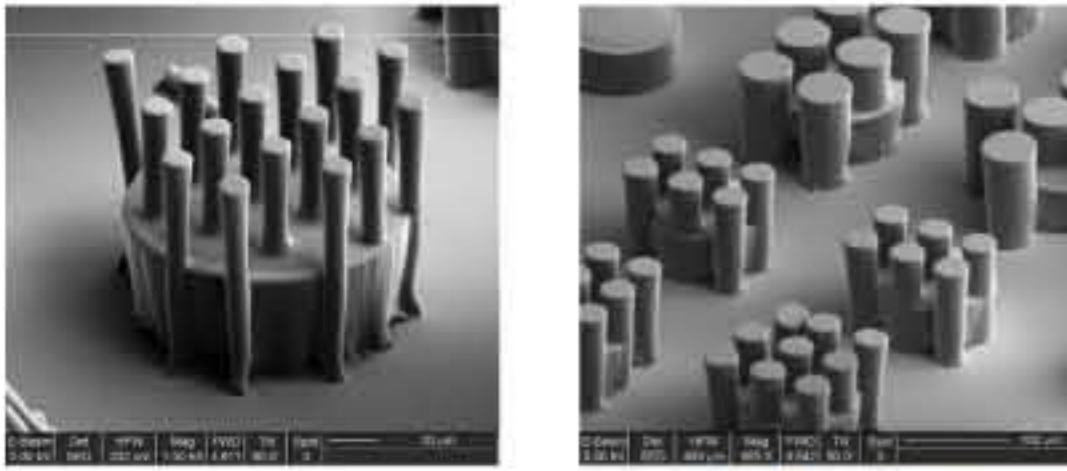
SERVICE AND CONSULTING

Our Service and Consulting group is dedicated to offer a unique combination of highly qualified personnel, state-of-the-art tools and equipment, interdisciplinary know-how, and expertise to provide researchers with a competitive edge on their research. We strive to work in close-contact with our users to propose innovative ideas, identify their needs, and offer personalized solutions for many different fields and applications.

Applications

Lithography capabilities

Multi-level **Photolithography** with SU8 resist. Imaged by **Scanning Electron Microscopy (SEM)**.



Cr photomasks fabrication by Direct Write Laser Lithography.



Micro-nano hierarchical topographies fabricated by combining Photolithography and Focused Ion Beam (FIB).

Material surface modification through topographical or molecular patterns

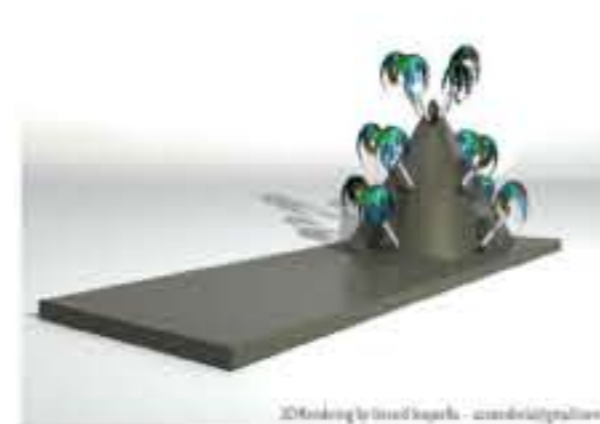
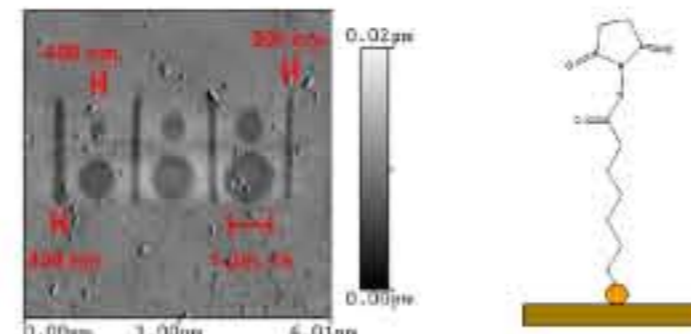


Illustration of functionalized Atomic Force Microscope (AFM) tip with proteins.



Illustration of polynucleotides immobilised on a substrate.



AFM image of N-Hydroxysuccinimide derived thiol nanopatterns on gold.

Characterization of biological samples



Image of bacteria by SEM in HV mode.
Courtesy of Xavier Vila, UB.

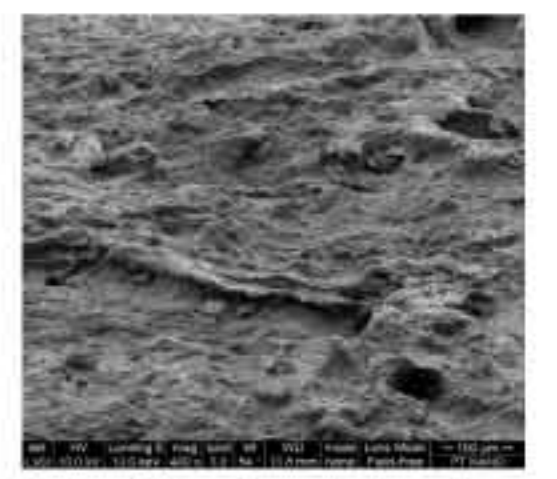
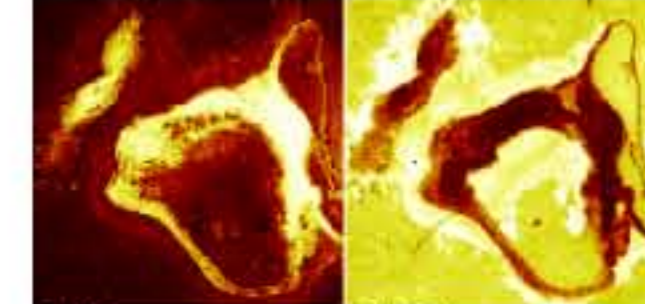


Image of human skull by SEM in HV mode.
Courtesy of Neos Surgery S.L.

Field of view: 2200.0 x 2200.0 μm²

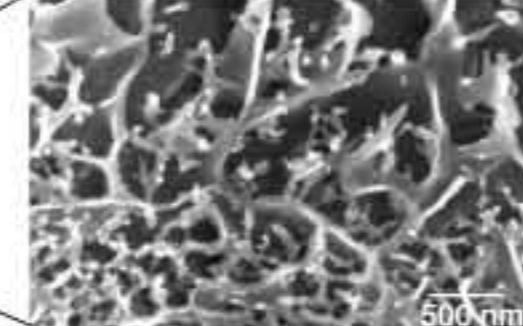
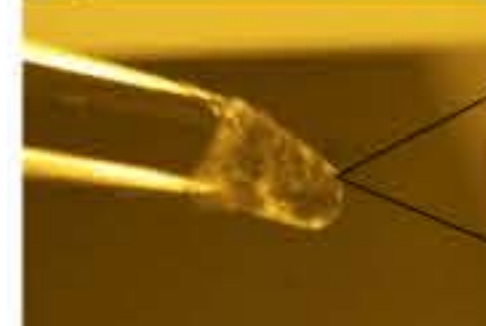


Cross-section image of a human aorta vessel by Time-of-Flight Secondary Ion Mass Spectroscopy (TOF-SIMS).
Courtesy of Sebastián Mas, Universidad Complutense de Madrid.

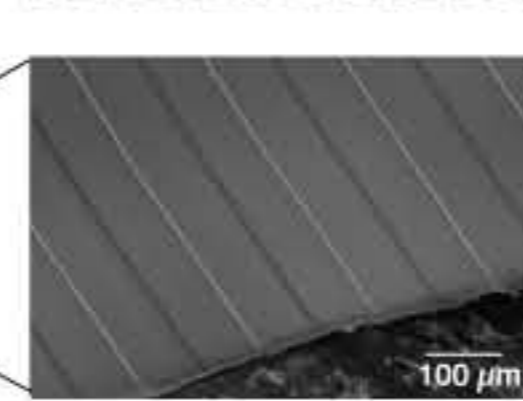
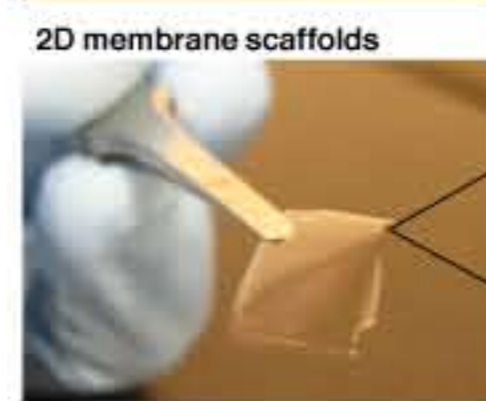
Cross-section image of a human aorta vessel by Time-of-Flight Secondary Ion Mass Spectroscopy (TOF-SIMS).
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Scaffolds for tissue engineering and regenerative medicine

3D gel scaffolds



3D bioactive hydrogel scaffold designed for bone regeneration and representative SEM zoom-in image.



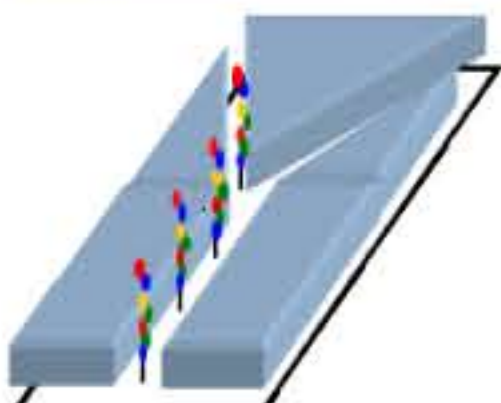
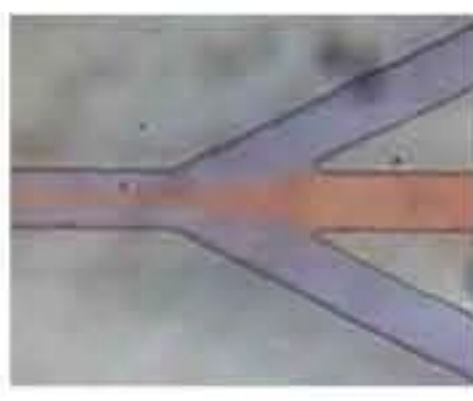
2D bioactive membrane designed for stem cell growth fabricated by Photolithography and SEM zoom-in image exhibiting topographical patterns and stem cells (inset).



Cross-sectional view of a cell body sliced by the FIB.
Courtesy of Dr. Elena Martínez, IBEC.

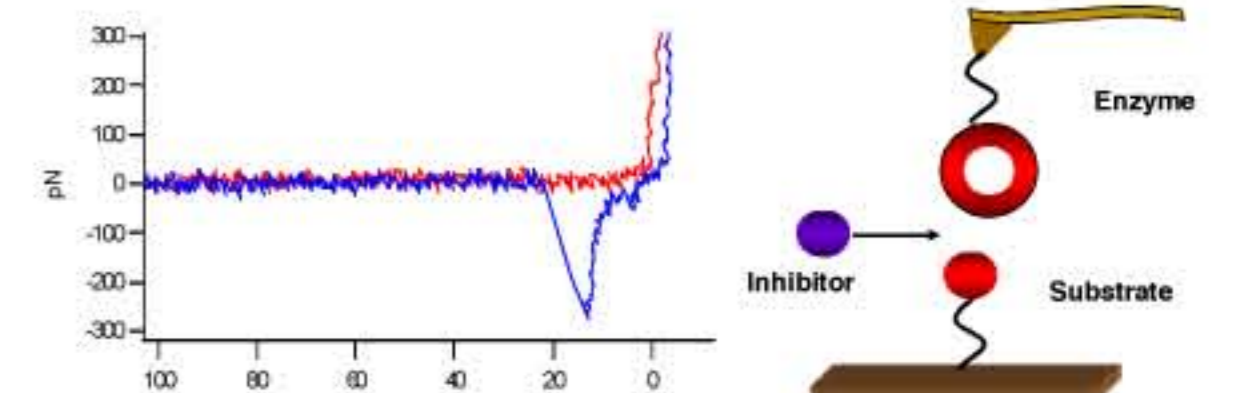
Microfluidic systems

Microfluidic systems made from glass and poly(dimethylsiloxane) PDMS.

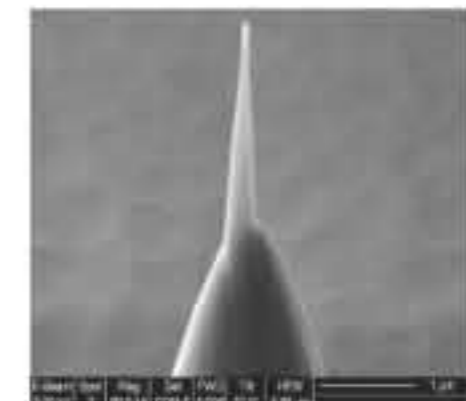


Biochemical functionalization of surfaces: scheme of polynucleotides immobilized on a microfluidic channel.

Molecular interactions



Characterization of ligand – receptor interactions by chemical force spectroscopy using the AFM.



Sharpened AFM tip.
Courtesy of Dr. David Caballero, IBEC.

Fabrication

Dip-Pen Nanolithography (DPN)

- Precise nanoscale deposition of molecules on surfaces.
- Multiple tip chips to pattern large areas.
- Controlled tip functionalization by "ink wells".
- Environmental camera controls humidity and temperature.

Nscipitor, NanoInk Inc.

Direct Write Laser Lithography

- For patterning photosensitive materials.
- Lateral resolutions down to 1 μm.
- Used to fabricate masks for photolithography.

DWL 66, Heidelberg.

Hot Embossing Lithography (HEL)

- Replication of structures with microscale resolution in thermoplastic polymers by controlling pressure and temperature.

HEX 01, Jenoptik.

Focused Ion Beam (FIB)

- Gallium ion beam for precise ion etching of materials.
- Deposition of different materials: metals (W and Pt) and silicon dioxide with resolutions down to 30 nm.

Strata DB235, FEI

Electron Beam Lithography (EBL)

- Pattern generator: 2.66MHz.
- Minimum features ~20nm.
- Design CAD software program.
- Write Fields: from 25 μm to 1mm.
- Proximity effect correction.

Raith PLUS80, RAITH.

UV-Photolithography

- UV-light to transfer a geometric 2D pattern from a mask to a light-sensitive polymer.
- Topographical patterns with features down to 1 μm.

Mask Aligner MJB4, SUSS Microtec.

Spin Coater (Left)

- Generation of uniform thin films down to nm scales.

Spin Processor, Laurell Tec.

Chemical Bath (Right)

- Wet-Etching and Lift-off processes.
- Cleaning routines.
- Resist development.

Chemical bath, Quimipol.

Nanoimprint Lithography (NIL)

- Replication of structures with nanoscale resolution in thermoplastic polymers by controlling pressure and temperature.

The Eitre NIL, Obducat.

Reactive Ion Etching (RIE)

- Etching and modification of different material surfaces.
- Contains six gas lines for Ar, O₂, Cl₂, HBr, BCl₃, and CHF₃.

Plasmalab 80, Oxford Instruments.

The Thermal and E-beam Metal Evaporator

- Homogeneous deposition of metals such as titanium, gold, copper, and aluminium on surfaces.

Univex 450, Leybold.

Characterization

Time-of-Flight Secondary Ion Mass Spectroscopy (TOF-SIMS)

Surface Spectroscopy:

- Detection of all elements, isotope sensitivity.
- Low detection limit (ppm-ppb).

Surface Imaging:

- Mass resolved secondary ion images.
- Chemical maps, ~200nm lateral resolution.

Depth Profiling:

- Dual beam operation: sputtering and analysis.
- Conditions can be independently optimized.
- Elements in-depth distribution (SD analysis).

TOF-SIMS IV, Ion TOF.

Contact Angle Measurements

- Measures dynamic and static contact angles by means of sessile drop and/or captive drop techniques.
- Quantification of the free surface energy of solid materials with a variety of different dispersive, polar, or acid/base solutions.

Oca 15+ Plus, Dataphysics.

White Light Interferometric Microscopy

- Visualization and topographical analysis of 3D micro/nanostructures.
- Vertical resolutions of 1 nm.
- Lateral resolutions down to 400 nm.

Wyko NT1100, Veeco.

Mechanical Profilometry

- Examination of surface topography.
- Vertical resolutions of nm scale.
- Lateral resolutions of 1 nm.

Dektak 6M, Veeco.

Scanning Electron Microscopy (SEM)

- Visualization of surface features of different materials.
- Resolution: 1.5nm (at 1kV), 1nm (at 30kV) at HV.
- Field Emission Electron Gun.
- Low vacuum mode: No conductive samples.
- Accelerating Voltage: 0.2 to 30kV.
- High stable probe current (1pA-100nA).

Nova NANOSEM 230, FEI.

Optical Reflectance Microscopy

- Examination of both transparent and opaque substrates.
- Magnifications from 50X to 1000X.

Eclipse L150, Nikon.

Atomic Force Microscopy (AFM) Molecular Imaging Microscope

- Electrical and conductivity measurements.
- Characterisation of surface molecular patterns.
- Environmental camera for precise control of humidity and temperature.

Molecular Force Probe 3D, Aylum Research.

Atomic Force Microscopy (AFM) 3D-Molecular Force Probe (MFP-3D)

- Analysis in wet/dry conditions.
- Examination of fluorescent microscope for analysis of biological samples.
- Analysis of mechanical properties at molecular level: elasticity, adhesion, indentation, receptor-ligand-interactions, and molecular unfolding.

Molecular Imaging, Scientec.