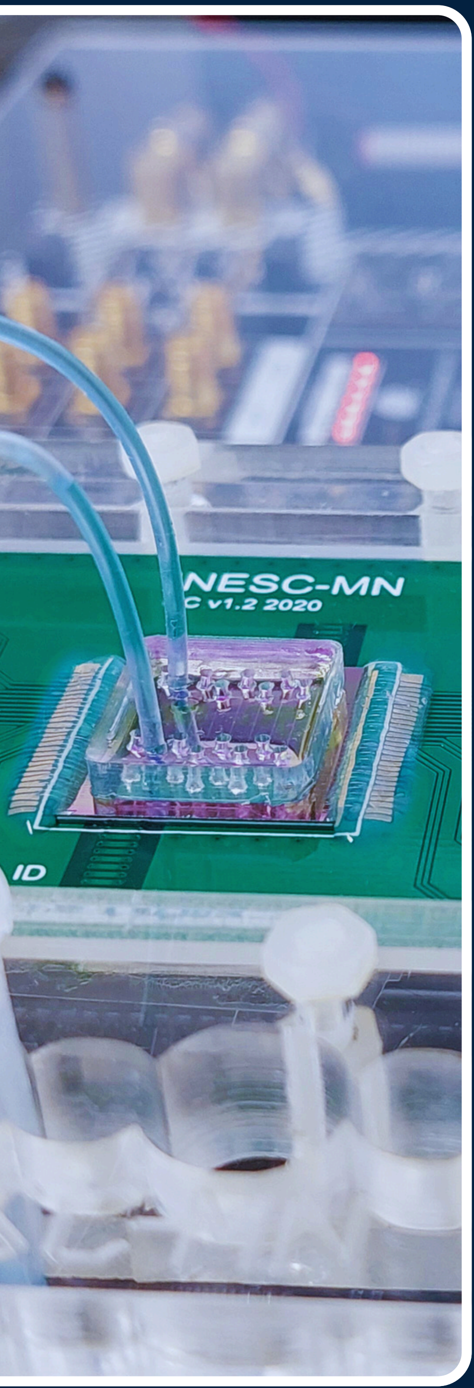
inesc mn
Microssistemas e Nanotecnologias

MICROFLUIDIC PLATFORMS

Development and integration of fluidic elements and sensing and actuation for fully automated microfluidic platforms

FROM DESIGN **TO INTEGRATION**



DESIGN & SIMULATION

- Assessment of requirements and technical consulting
- Use of CAD software for 2D & 3D drawings
- Multiphysics simulation including fluid dynamics

PROTOTYPE

Detailed information on facilities and equipment here

SENSOR / ACTUATOR INTEGRATION

Sensor and actuator innovation is central to INESC MN, covering design, materials, micro/nano fabrication, testing, and integration. We develop a broad range of advanced types, including:

MAGNETIC | THERMAL | FET

OPTICAL | GAS | MEMS

ELECTROCHEMICAL | INTERDIGITAL

Overall dimensions, ports sizes and positions for fluidics, electronics and fixation regions design accordingly to ISO 22916. Feature ranges dependent on material and fabrication technique.

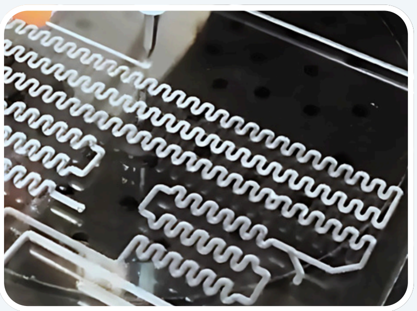
PROTOTYPING FABRICATION

MICROMILLING

A precise subtractive technique used for microfluidic prototyping, where high-speed rotating tools carve features into materials like polymers, metals, and ceramics. This method is ideal for creating complex 3D structures with smooth surfaces and high aspect ratios.

MATERIALS: THERMOPLASTICS, METAL, CERAMICS

- Range: 0.127 – 3.5 mm (endmill) | 0.05 – 3.0 mm (drill)
- Working area: 300 mm x 200 mm
- XY Resolution below 5% relative to nominal dimensions
- Max Resolution: XY 1 µm | Z 0.1 µm
- Roughness: below 1.5 µm (perpendicular to milling direction) and 0.4 um (parallel to milling direction)

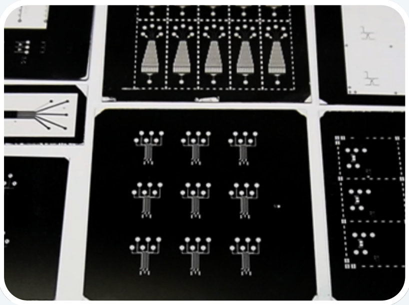


PHOTOLITOGRAPHY

Advanced techniques for precise patterning and device fabrication, comprising optical and electron beam lithography. Through direct write or hard mask assisted exposure, micrometer to nanoscale resolutions, are attainable. Uniform resist coating and precise development ensure high resolution of micro/nano scale feature definition.

MATERIALS: POSITIVE AND NEGATIVE PHOTORESISTS

- Wavelengths: 365 nm | 405 nm | 435 nm | E-beam
- Minimum feature size: 30 nm
- Up to 8 inch substrates

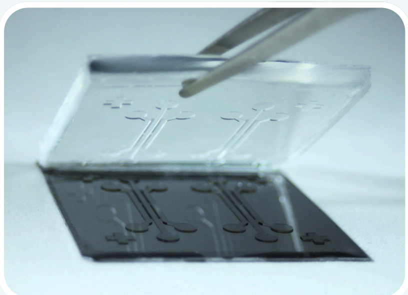


SOFT LITOGRAPHY

A versatile microfabrication technique used to create microfluidic structures by molding elastomeric materials against a master template. The resolution and minimum feature size depend on the master quality and design, curing conditions and properties. This method enables high-fidelity replication of microscale features.

MASTER MATERIALS: PHOTORESIST, THERMOPLASTICS, ELASTOMERS, METALS, EPOXY RESIN
MOLD MATERIALS: ELASTOMERS, THERMOPLASTICS, EPOXY RESIN

- Minimum distance between features: 5 µm
- Resolution: XY 1 µm | Z 0.1 µm
- Minimum features size: Height: 0.1 µm | Width: 1 µm (aspect ratio dependent)



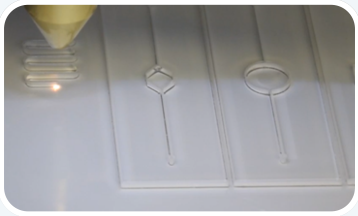
PROTOTYPING FABRICATION

LASER CUTTING & ENGRAVING

Suited for prototyping, enabling the rapid fabrication of channels, reservoirs, and complex geometries in various materials. It offers minimal material waste and compatibility with multilayer assembly, making it ideal for fast iteration and customization.

MATERIALS: THERMOPLASTICS, ADHESIVES, FABRICS, PAPER

- Work area: 400 x 375 x 80 mm
- Laser spec: 40 W CO_2 laser | Wavelength: 10.64 nm
- Laser cutting thickness: 0 - 10 mm (varies by material)

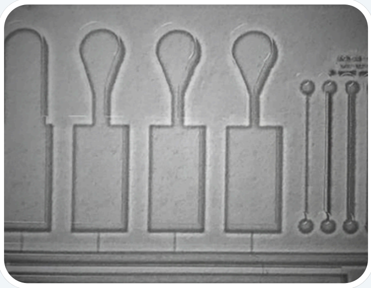


HOT EMBOSSING

A reliable and high-precision technique for microfluidic prototyping, allowing the replication of channels, reservoirs and complex structures onto thermoplastic substrates. Applying heat and pressure, it achieves high-fidelity pattern transfer and smooth surface finishes, making it ideal for batch production and applications requiring optical transparency and chemical resistance.

MASTER MATERIALS: PHOTORESIST, THERMOPLASTICS, ELASTOMERS, METALS
MOLD MATERIALS: THERMOPLASTICS (PMMA, COC, PC)

- Max working temperature: 250 °C
- Heating rate: 9 °C/min, Temperature accuracy ± 1 °C
- Max working pressure: 25 metric Tons (250 KN) | Accuracy: 1.25 KN
- Heated plated area: 200 mm x 200 mm
- Max travel distance (upper platen): 140 mm



XUROGRAPHY

A rapid and low-cost microfabrication technique that uses precision cutting to create microfluidic patterns on adhesive films, paper or polymer sheets. This method is ideal for fast prototyping, offering flexibility in design without the need for complex fabrication setups.

MATERIALS: THERMOPLASTICS, ADHESIVES, PAPER

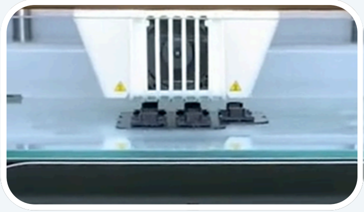
- Minimum feature size: 200 µm
- Resolution: 30 µm

3D PRINTING

3D printing enhances microfabrication and micromachining by enabling rapid and precise prototyping of complex microscale structures. It allows for fast patterning and customization, reducing development time and costs compared to traditional manufacturing techniques.

MATERIALS: PLA, TOUGH PLA, PVA, ABS, PET

- Nozzle: 0.4 mm
- Build volume (XYZ): 230 x 190 x 200 mm3
- Resolution: XY 6.9 µm | Z 2.5 µm



MICROFLUIDICS PORTFOLIO

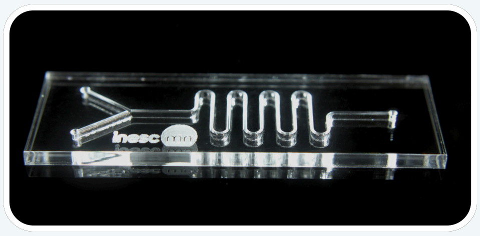
MICROFLUIDICS CIRCUITS

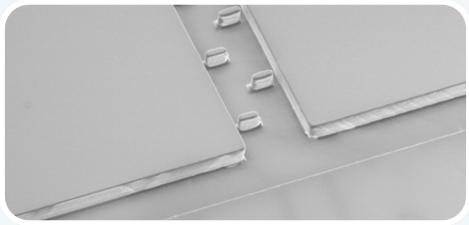
CHANNELS | CHAMBERS | CONSTRICTIONS & EXPANSIONS

Microfluidic circuitry come in various designs — straight, T-shape, Y-shape, spiral, chambers, and constriction-expansion features, each offering unique functionalities for **tailored flow dynamics**, multiple fluids manipulation and controlled environments (e.g. temperature, gas exchange, chemical and nutrient supply) .

Examples of applications

- Reagents merging, mixing and emulsification
- Gradient generation (e.g. chemicals, biomolecules)
- Droplet microfluidics
- Diffusion based separation
- Flow cytometry, biochemical assays, chemical synthesis, nanoparticles synthesis.





References 1 2 3 4

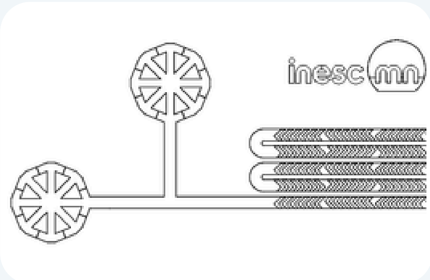
ADVANCED STRUCTURAL DEVICES

MULTI-LEVEL CHANNELS | PATTERNED SURFACES | MEMBRANE INTEGRATION

Complex fluid routing and multiple-step processing attainable in **small footprints** through compact architectures based on stacked layers of channel and chambers. **Micro- or nanoscale patterns** created through chemical or physical modification of surfaces can be integrated, particularly for tailored surface interactions (e.g. molecular capture or cell alignment). **Membranes** can be integrated, leveraging functionalities based on membrane selective permeability, pore size and distribution, surface chemistry and biocompatibility.

Examples of applications

- Lab-on-chip, high-throughput screening
- Tissue engineering, cell cultures, protein assays, microarrays
- Drug delivery applications
- Molecular sieving, filtration, dialysis



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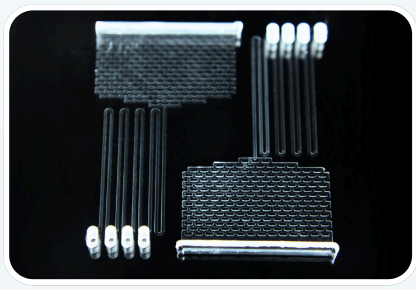
MICROFLUIDICS PORTFOLIO

MIXING AND GRADIENT DEVICES

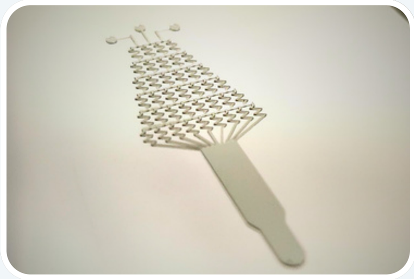
MIXERS | HERRING BONE | GRADIENT GENERATORS

Scalable and customized mixing solutions through passive (e.g. serpentine, herring bone) or active (thermal, magnetic, electrokinetic) designs, for efficient mixing from nanoliter to microliter volumes. Integration of precise gradient generators, including multiple shapes and multi-level chambers to design 3D gradients.



Examples of applications

- Sample preparation, chemical synthesis, nanoparticle formulation
- Biochemical assays, biomolecular detection, drug discovery
- Particle sorting, parallelized cellular studies



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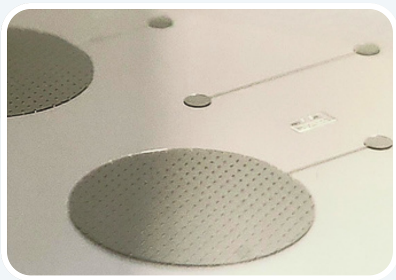
MICROFLUIDICS PLATFORMS

MICROARRAYS | ORGANS-ON-CHIP | MICROCOLUMNS

Integration of small-scale wells/chambers and precise probe deposition for analyte detection. Use of microcolumns with tailored materials/porosities and high surface-to-volume ratios. Design and prototyping of organs-on-chip with controlled microenvironments and flow/shear stress. Multi-tissue integration in single devices to mimic organ-level functions and interactions. Inclusion of vasculature.

Examples of applications

- Gene expression profiling, DNA/RNA analysis
- Protein assays, biomarker discovery
- Pharmaceutical testing, personalized medicine, disease modelling
- Chromatography, analyte purification, biosensing

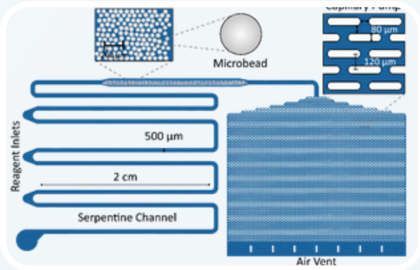


References 10 11 12 13 14

FLOW MANIPULATION METHODS

CAPILLARY CHIPS

Precise flow control using capillary forces for passive fluid movement, ideal for low-flow applications without the need of external pumps. Microfluidic designs result in compact and simple solutions with minimal power requirements, perfect for portable devices and on-site testing.

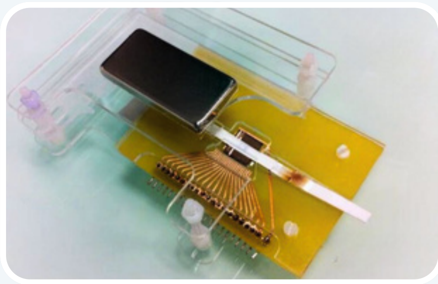


Examples of applications

- Point-of-care diagnostics, portable lab-on-a-chip
- Microreactor systems

LATERAL FLOW

Rapid and user-friendly diagnostic solution by guiding the fluid along a defined path for analysis. It can incorporate test and control zones for colorimetric, fluorescent and magnetic signals.

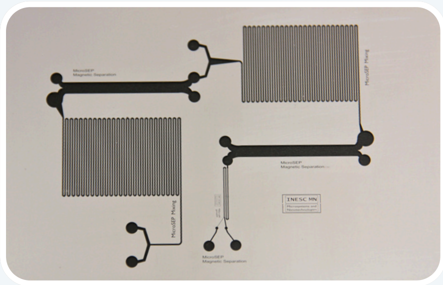


Examples of applications

- Medical diagnostic, environmental monitoring
- On-site testing of pathogens, hormones or pollutants.

MAGNETIC & ELECTRIC MANIPULATION

Use of magnetic fields to selectively separate magnetic content (e.g. magnetic particles, cells or fluids) from a fluid stream. Integration of customized on-chip coil design and adjustable field strength and channel configuration for optimized trapping, mixing, separation and detection efficiency.



Examples of applications

- Cell sorting, biomolecule capture
- Analyte detection, targeted drug delivery.

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OPEN ACCESS TO FACILITIES

INESC MN is a member of the NFFA, EuroNanoLab and RIANA networks, providing open-access to resources and advanced facilities to users from both Academia and Industry to carry out multidisciplinary research at the nano and microscale.

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