Introducción:
Fundamentos, Historia, Motivación, Aplicaciones, Tendencias...
A que llamamos Microfluídica?

“Es la ciencia y tecnología que utiliza sistemas que procesan o manipulan cantidades pequeñas de fluidos (entre $10^{-18}$ y $10^{-9}$ litros), mediante canales cuyo tamaño está entre decenas y cientos de micrones”

G. M. Whitesides
Microfluídica
Para que sirve?

<table>
<thead>
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<th>Investigación Básica</th>
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<td>Condición de no deslizamiento entre un fluido y un sólido</td>
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Investigación Básica Dispositivos y Sistemas Cultivo de Células y respuesta a estímulos externos

<table>
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<th>Investigación Aplicada Nuevas o Mejores Tecnologías</th>
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<td>Mejor: Cromatografía</td>
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<td>Nueva: Separación entrópica</td>
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Nuevas oportunidades aprovechando las diferencias en el comportamiento a escala microscópica

La física no cambia, pero los mecanismos dominantes pueden ser diferentes.

Ejemplo: Movimiento Browniano

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There’s Plenty of Room at the Bottom

Richard P. Feynman

I imagine experimental physicists must often look with envy at men like Kamerlingh Onnes, who discovered a field like low temperature, which seems to be bottomless and in which one can go down and down. Such a man is then a leader and has some temporary monopoly in a scientific adventure. Percy Bridgman, in designing a way to obtain higher pressures, opened up another new field and was able to move into it and to lead us all along. The development of ever higher vacuum was a continuing development of the same kind.

I would like to describe a field, in which little has been done, but in which an enormous amount can be done in principle. This field is not quite the same as the others in that it will not tell us much of fundamental physics (in the sense of, “What are the strange particles?”) but it is more like solid-state physics in the sense that it might tell us much of great interest about the strange phenomena that occur in complex situations. Furthermore, a point that is most important is that it would have an enormous number of technical applications.

dots on the fine half-tone reproductions in the Encyclopaedia. This, when you demagnify it by 25 000 times, is still 80 angstroms in diameter—32 atoms across, in an ordinary metal. In other words, one of those dots still would contain in its area 1000 atoms. So, each dot can easily be adjusted in size as required by the photoengraving, and there is no question that there is enough room on the head of a pin to put all of the Encyclopaedia Britannica.

Furthermore, it can be read if it is so written. Let’s imagine that it is written in raised letters of metal; that is, where the black is in the Encyclopaedia, we have raised letters of metal that are actually 1/25 000 of their ordinary size. How would we read it?

If we had something written in such a way, we could read it using techniques in common use today. (They will undoubtedly find a better way when we do actually have it written, but to make my point conservatively I shall just take techniques we know today.) We would press the metal into a plastic material and make a mold of it, then peel the plastic off very carefully, evaporate silica into the
G. Moore, doble número de transistores cada año, por lo menos hasta 1975!!
Figure 7. Scanning electron micrograph of the all-surface-micromachined "tent" microphone made at the MCNC foundry.

The main construction steps for the "tent" microphone are shown in Figure 8. Here one can see that the assembly requires the pulling of the apex up out of the plane and the pushing in from the two sides to form the tetrahedron.

D. Lopez, F. Pardo y otros @ Lucent (2005)
Figure 7. Scanning electron micrograph of the all-surface-micromachined “tent” microphone made at the MCNC foundry.

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determined by the size and tension of the membrane but by the tunable length of the beams. The assembly is accomplished in one step by pulling upwards with a micropipette from the vertex as shown in Figure 8.

Several self-assembly techniques have also been tried but measurements have not yet been made on these devices. A sound pressure difference between the interior and exterior of the chamber forces the membrane to move and the change in capacitance is detected by a charge sensitive amplifier.

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Hinges

Figure 8. Main MEMS “tent” microphone construction steps.
Orígenes

70’ Microelectrónica

80’ MEMS

Acelerómetros

The main construction steps for the "tent" MEMS microphone are shown in Figure 8. Here one can see that the thin film is pulled upwards with a micro-pipette from the vertex as shown in Figure 7. The motion of the thin film causes the change in capacitance which is then amplified and fed into a signal conditioning circuit.

Disclaimer: The information provided is for educational purposes only and does not constitute professional advice. Always consult with a qualified professional before making any changes to your system or equipment.

Figure 17. The ADXL50 Sensor Momentarily Responding to an Externally Applied Acceleration
Figure 7. Scanning electron micrograph of the all-surface-micromachined "tent" microphone made at the MCNC foundry.

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(1977) Gas Chromatograph
S. C. Terry, J. H. Jerman & J. B. Angell

Columna de 30um x 200um y 1.5 metros!

Grabado en Silicon
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Figure 8. Main MEMS “tent” microphone construction steps.

(2003) Large Scale Integration
T. Thorsen, S. J. Maerkl & S. R. Quake

Miles de válvulas y conexiones
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Historia Breve (e incompleta)

• **1975**
  - 1\textsuperscript{st} dispositivo analítico en miniatura (cromatografía)
  - Fabricación: grabado en silicon. (Stanford; Terry y otros)

• **1990**
  A. Manz introduce la idea de μTAS (Micro-Total-Analysis-Systems)
  Se fabrican dispositivos

• **2000**
  Se introduce la idea de “soft-lithography”.
  Se simplifica y populariza la fabricación de distintos sistemas
  Se amplia el concepto de μTAS a Lab-o-a-chip

• **2010**
  Empiezan a surgir ideas para simplificar aun más la fabricación:
  “Paper-based microfluidics”; “CD-microfluidics” y otros
  Impresoras 3D con resolución ~ 100 micrones.
Popularidad

Microfluidic lab-on-a-chip platforms: requirements, characteristics and applications

Imposible mantenerse al día!!
Microfluidica: desarrollo de tecnología
μTAS & Lab-on-a-chip

Información y cálculo:

Automatización
Integración
Miniaturización
Microfluidica: desarrollo de tecnología

μTAS & Lab-on-a-chip

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Información y cálculo:

Tubos de ensayo...

Automatización
Integración
Miniaturización
μTAS & Lab-on-a-chip

Que ventajas tiene?
más chico; más rápido; más simple, más economico, ...mejor!!

• Portátil
• Menos volumen de químicos
• Mayor seguridad
• Reduce la contaminación
• Bajo costo y producción masiva
• Más rápido
• Análisis en paralelo
• Usos novelosos (implantes?)
• Métodos novelosos?
Microfluídica:
Areas de mayor uso y crecimiento

Química analítica;
control de reacciones químicas;
detección y muestreo;
ensayos químicos en paralelo;

Ej. Desarrollo de técnicas y dispositivos de separación
Microfluídica:
Areas de mayor uso y crecimiento

**Ventajas:** Bioquímica: Numero grande de estudios simultáneos; Biología: Células: Control preciso de los estímulos/condiciones

Ej. Respuesta de células Madre a la falta de oxígeno

Desarrollo de medicamentos; ingeniería de tejidos; genética; ensayos bioquímicos, celulares;
Non-sticking drops

David Quéré

Laboratoire de Physique de la Matière Condensée, URA 7125 du CNRS, Collège de France, 75231 Paris Cedex 05, France

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Abstract

While the behaviour of large amounts of liquid is dictated by gravity, surface forces become dominant at small scales. They have for example the remarkable ability to make droplets stick to their substrates (even if they are inclined), which is a practical issue in many cases (windshields, window panes, greenhouses, or microfluidic devices). Here we describe how this problem can be overcome with super-hydrophobic materials. These materials are often developed thanks to micro-textures, which decorate a solid surface, and we describe the way such textures modify the wettability of that solid. We conclude by showing the unusual dynamics of drops in a super-hydrophobic situation.
Microfluidic diagnostic technologies for global public health

Paul Yager1, Thayne Edwards1, Elain Fu1, Kristen Helton1, Kjell Nelson1, Milton R. Tam2 & Bernhard H. Weigl3

The developing world does not have access to many of the best medical diagnostic technologies; they were designed for air-conditioned laboratories, refrigerated storage of chemicals, a constant supply of calibrators and reagents, stable electrical power, highly trained personnel and rapid transportation of samples. Microfluidic systems allow miniaturization and integration of complex functions, which could move sophisticated diagnostic tools out of the developed-world laboratory. These systems must be inexpensive, but also accurate, reliable, rugged and well suited to the medical and social contexts of the developing world.
Systems Biology and New Technologies Enable Predictive and Preventative Medicine

Leroy Hood,1* James R. Heath,2,3 Michael E. Phelps,3 Biaoyang Lin1

Systems approaches to disease are grounded in the idea that disease-perturbed protein and gene regulatory networks differ from their normal counterparts; we have been pursuing the possibility that these differences may be reflected by multi-parameter measurements of the blood. Such concepts are transforming current diagnostic and therapeutic approaches to medicine and, together with new technologies, will enable a predictive and preventive medicine that will lead to personalized medicine.