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SAN MARTÍN

Dispositivos NanoFluídicos a "Cielo Abierto"

Martín G. Bellino

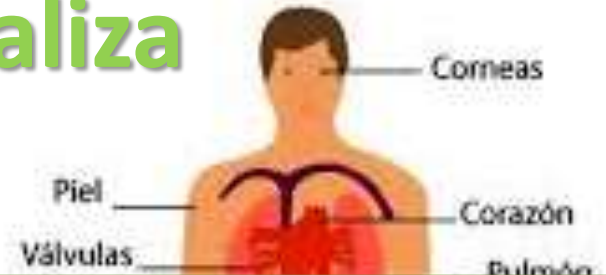
Instituto de Nanociencia y Nanotecnología – CNEA-CONICET
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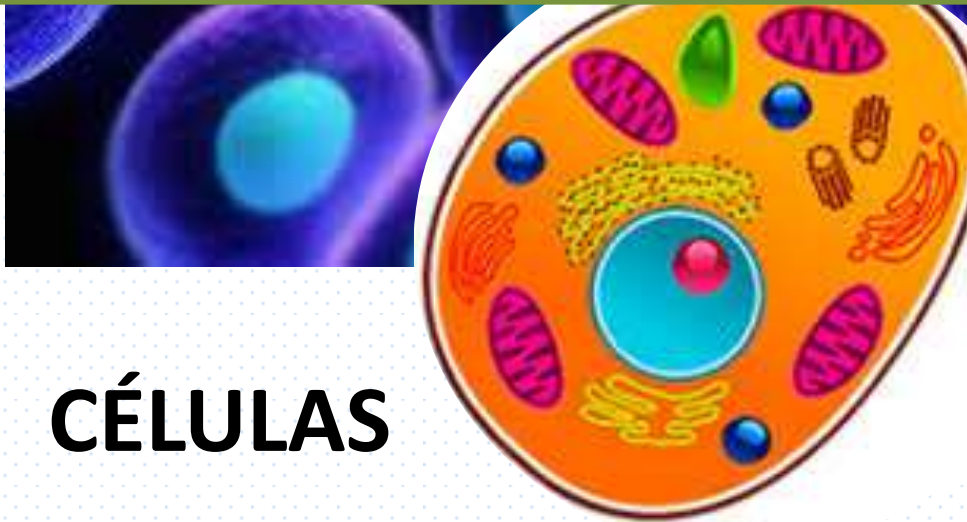
Biología

FLUIDOS SIN CONTACTO DIRECTO

Organiza – Comunica - Localiza



Podré Hacer Interactuar Líquidos Sin Estar "en Contacto"?



CÉLULAS

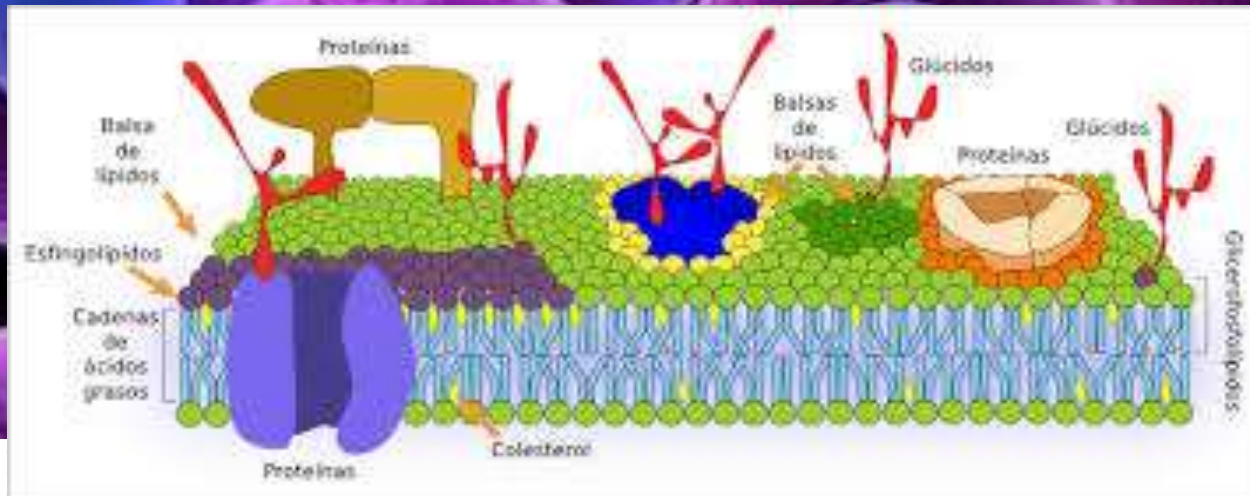


Órganos/Aparatos

**Membranas
Nanoporosas**



Nanofluídica



**La Estrategia de la Naturaleza es la
NanoFluídica**



Dispositivo Nanofluídico

Fácil Fabricación

Fácil Operación

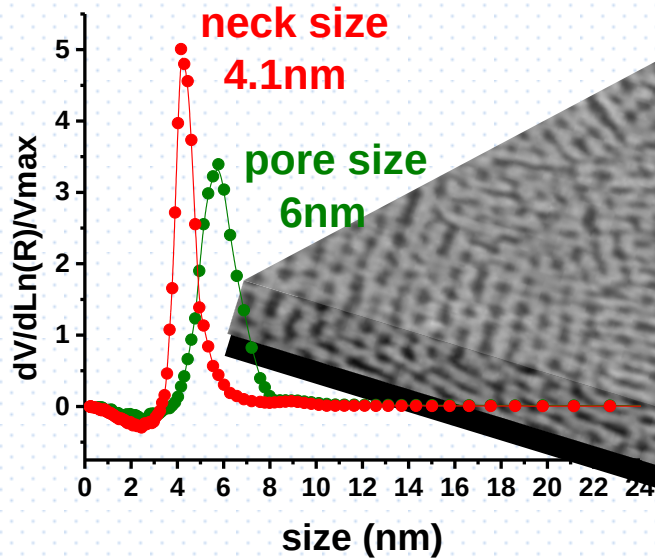
Control de Procesos

**Movimiento Autónomo
del Fluído
*Y Manipularlo?***

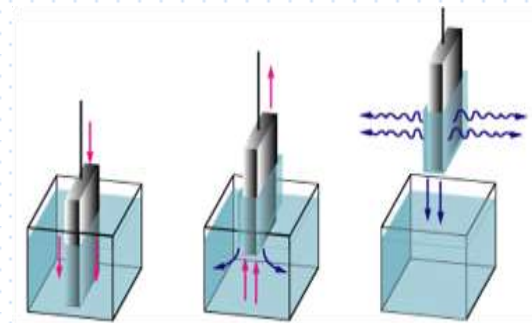
**Si Sólo Consiste en una Superficie
es el Dispositivo más Simple que
Pueda Imaginar**



Films Delgados Nanoporosos como Dispositivos NanoFluídicos

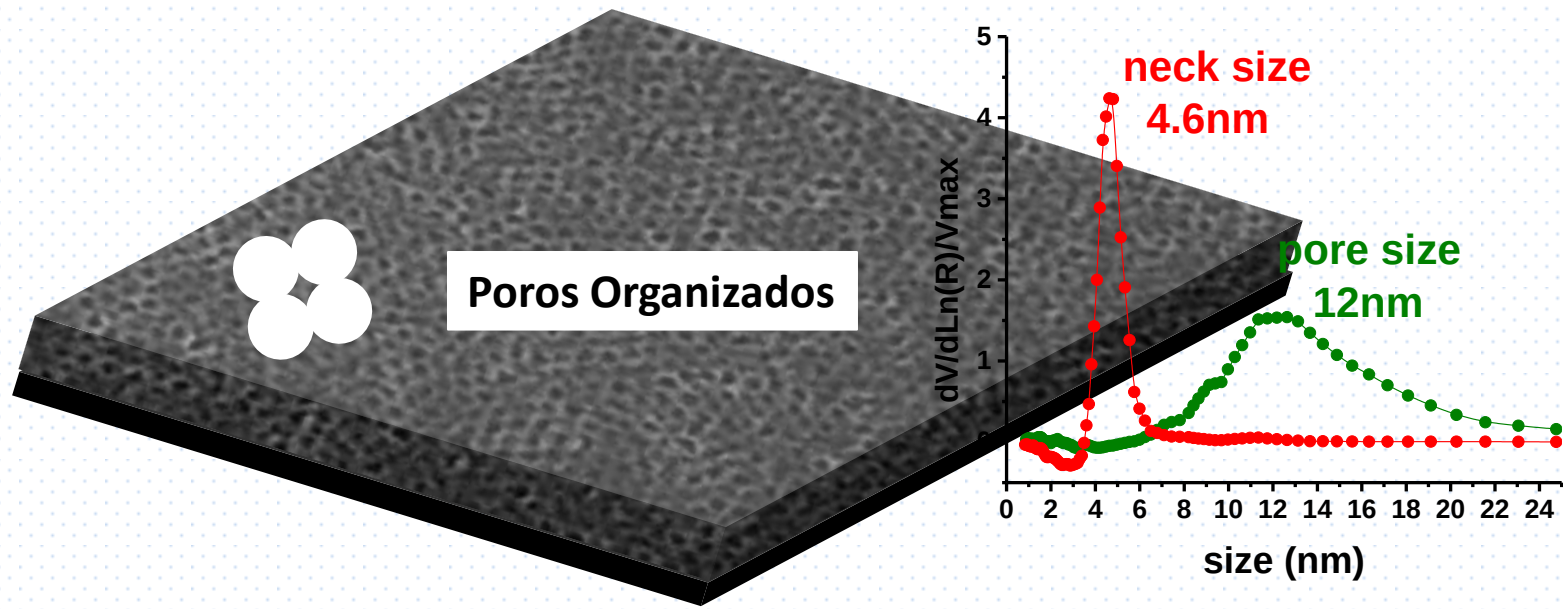


Tipo Conductos



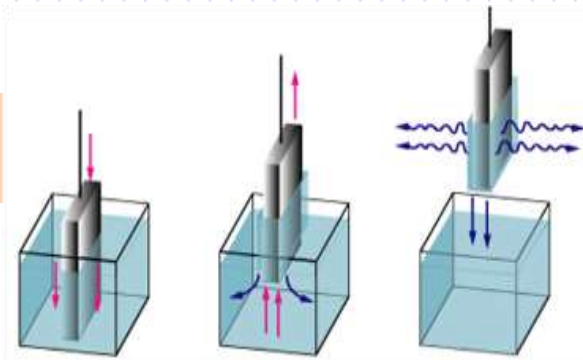
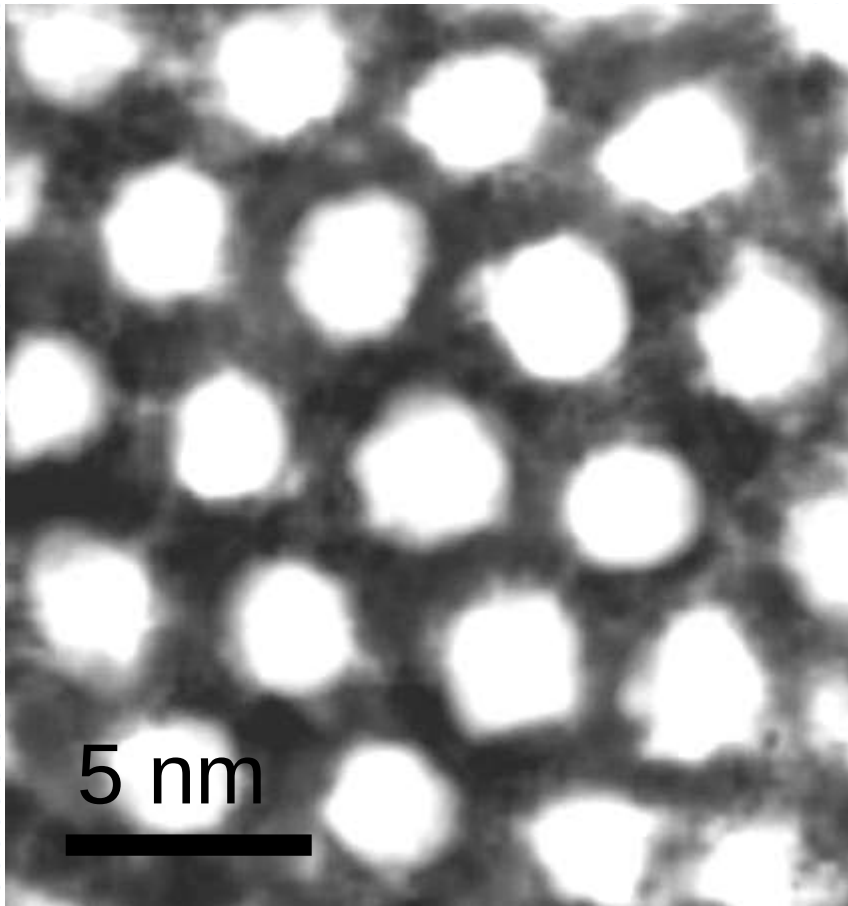
Dip coating

Sol-gel / EISA
(TiO_2 or SiO_2)



Poros Organizados

Fabricación: Sol-Gel + Autoensamblado



Moldeado Supramolecular
EISA

Material
Nanoporoso

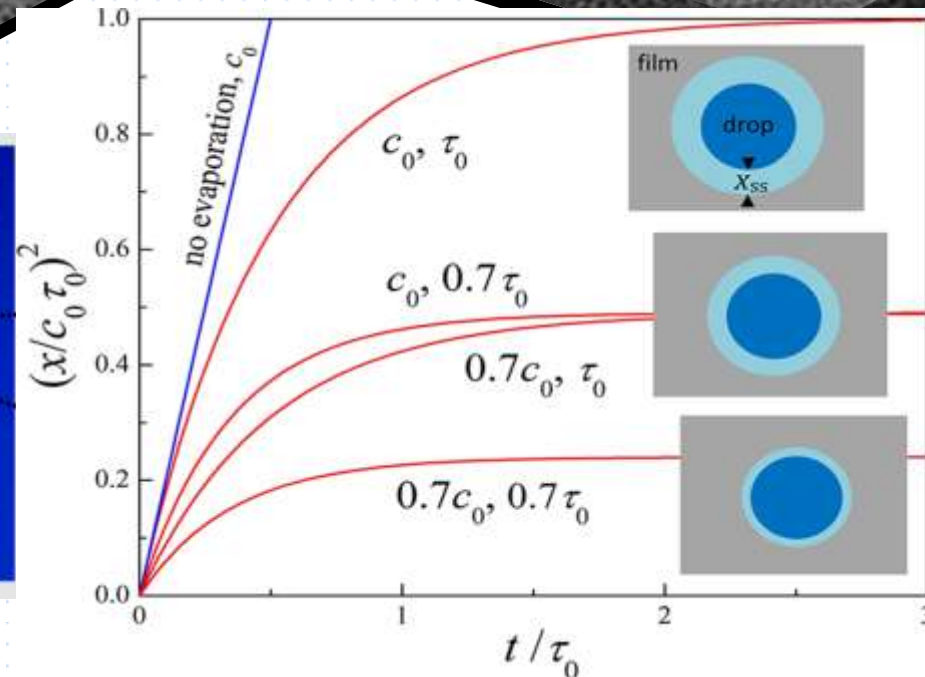
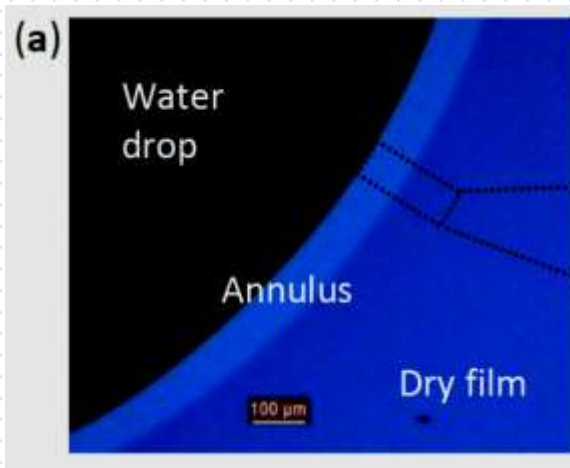
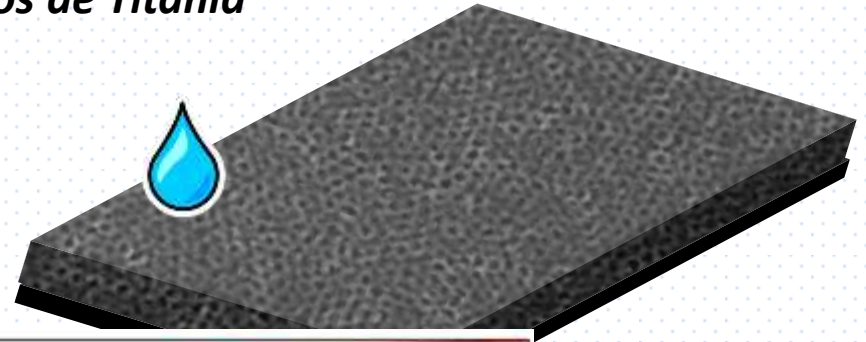
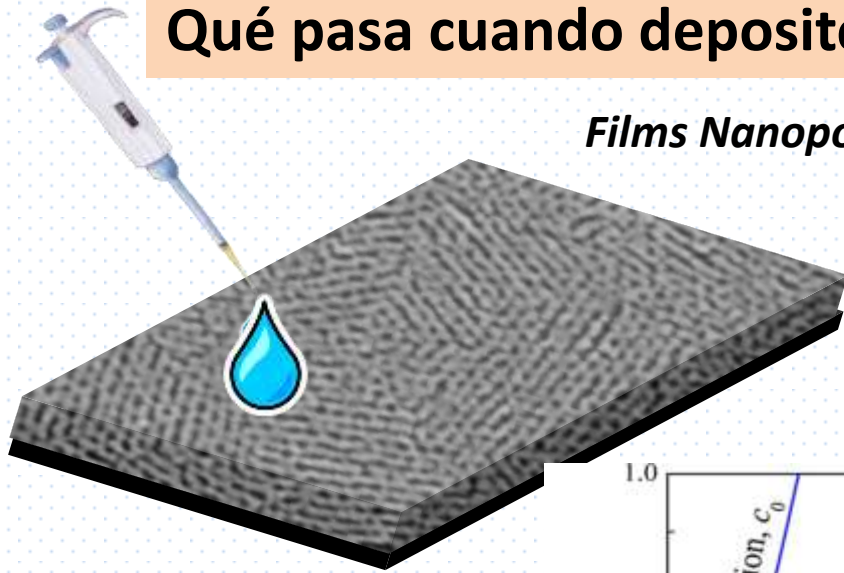
Superficie Controlada

Molde

Soler-Illia G. J. A. A., Angelomé P. C., Fuertes M. C., Calvo A., Wolosiuk A., Zelcer, A., Bellino M. G.
Journal of Sol-Gel Science and Technology, **2011**, 57, 299-312.

Qué pasa cuando deposito una gota en la superficie?

Films Nanoporosos de Titania

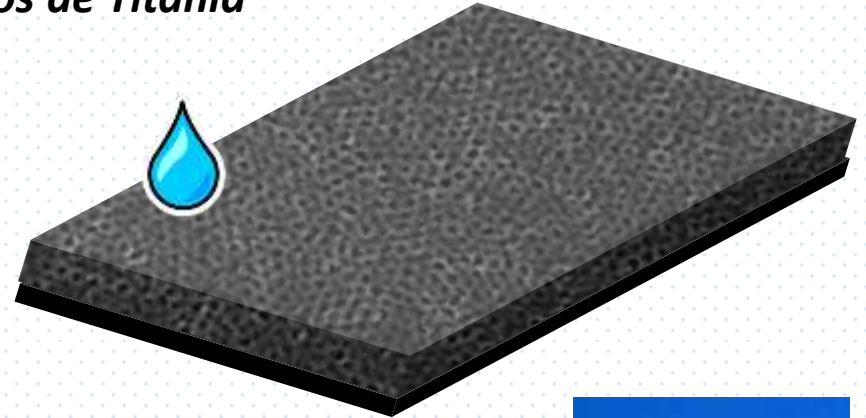
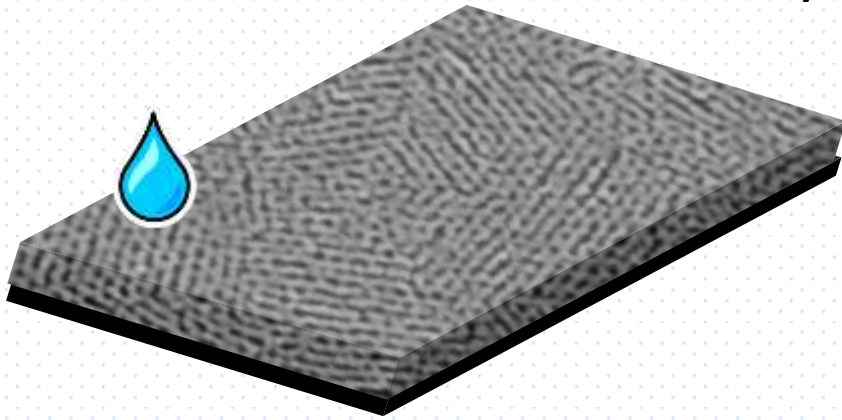


$$\frac{dx}{dt} = \frac{c}{x} - Ex$$

$$x^2 = x_{ss} (1 - \exp(-2t/\tau))$$

Qué pasa cuando deposito una gota en la superficie?

Films Nanoporosos de Titania

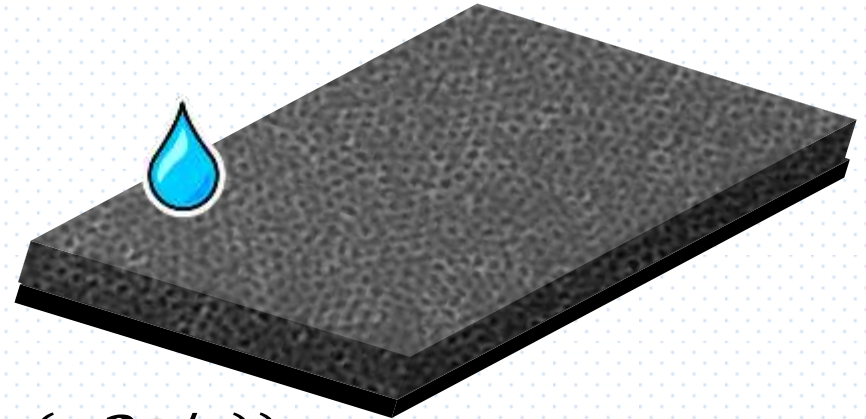
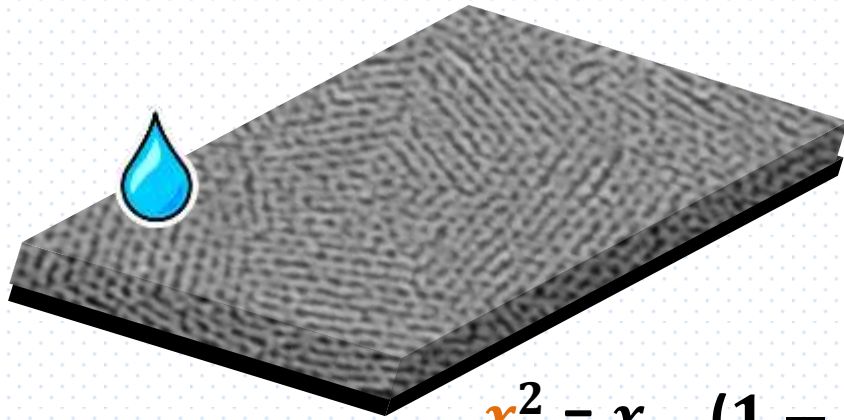


- *Posición de Equilibrio (x_{ss})*
- *Parametro τ*
- *Velocidad de Evaporación*
- *Coeficiente de Infiltración*

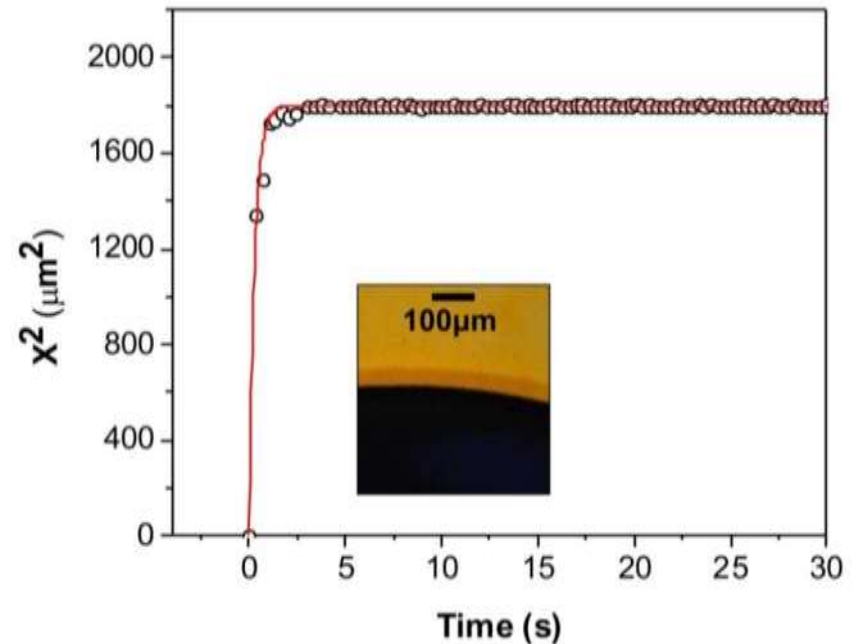
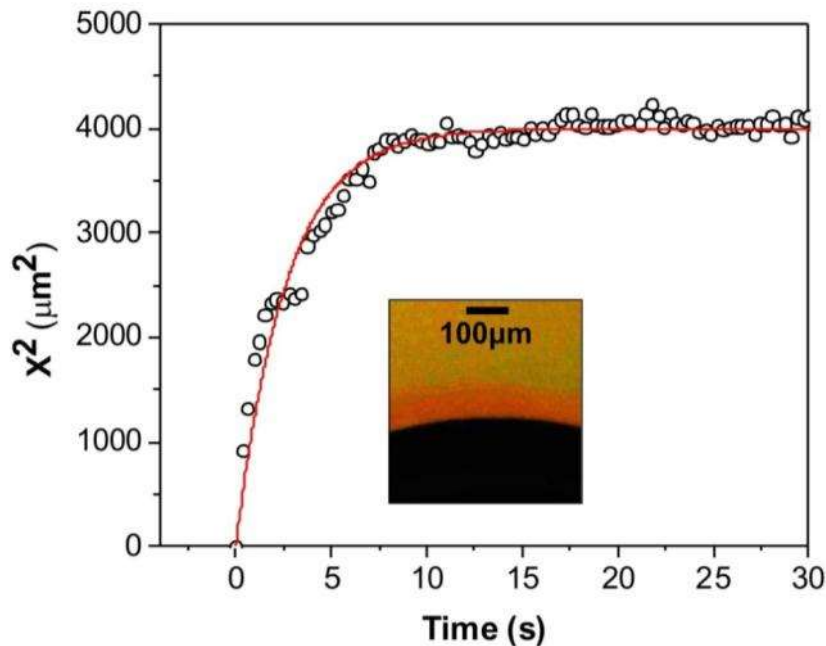
$$x^2 = x_{ss} (1 - \exp(-2t/\tau))$$



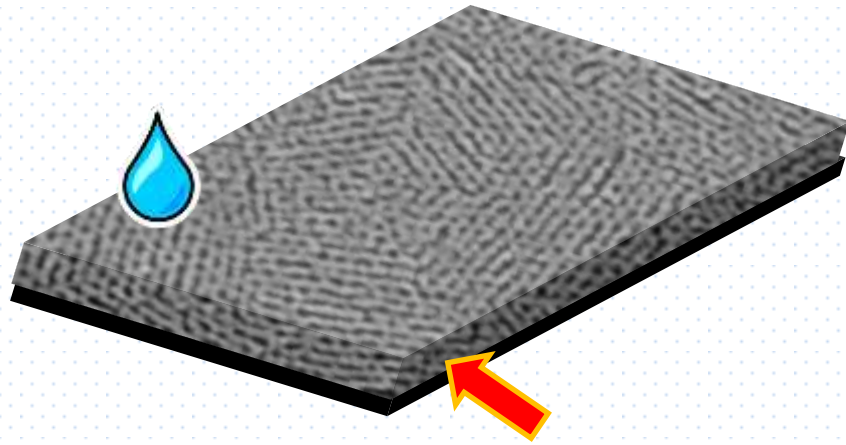
Qué pasa cuando deposito una gota en la superficie?



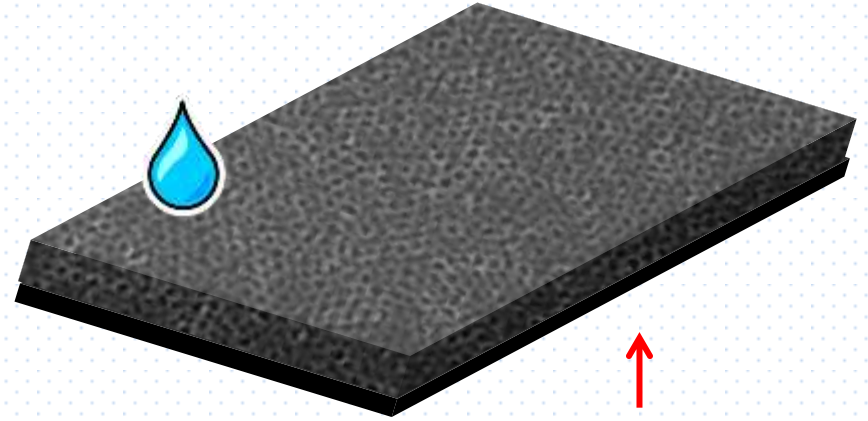
$$x^2 = x_{ss} (1 - \exp(-2t/\tau))$$



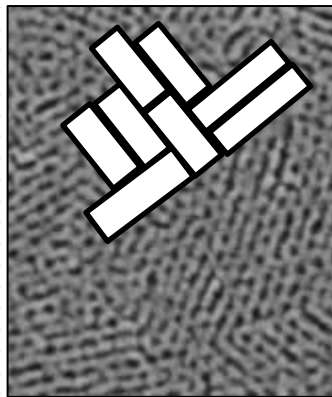
Qué pasa cuando deposito una gota en la superficie?



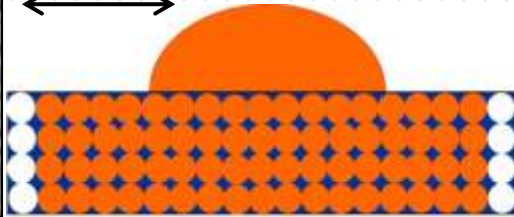
- Mayor Tortuosidad
- Mayor confinamiento en poros más chicos



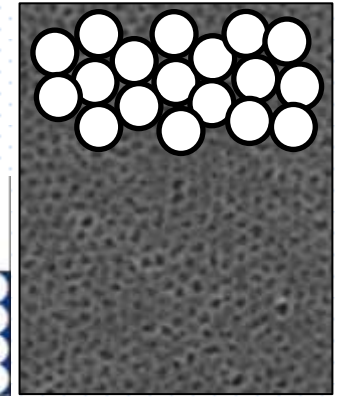
MAYOR EVAPORACIÓN
MAYOR INFILTRACIÓN



$\tau = 5.3 \text{ s}$
 $X_{ss} = 63 \mu\text{m}$



$\tau = 0.6 \text{ s}$
 $X_{ss} = 42 \mu\text{m}$

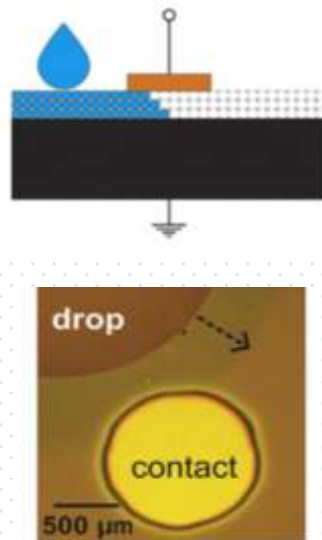
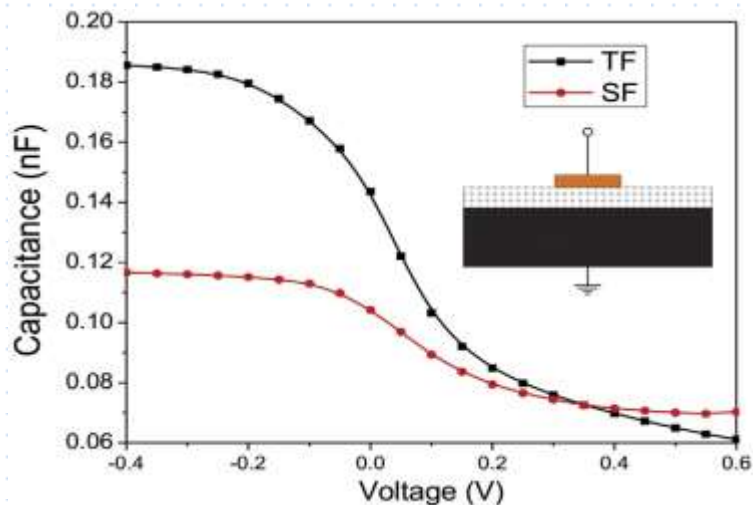


Parámetros Nanofluídicos

Predecir Infiltración en NanoEstructuras Porosas

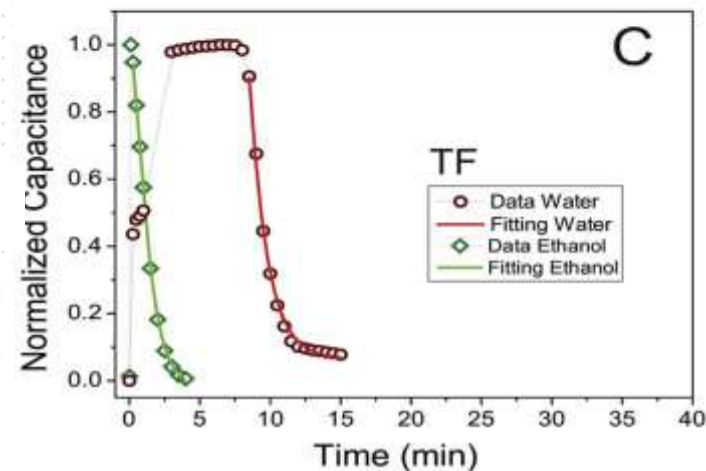
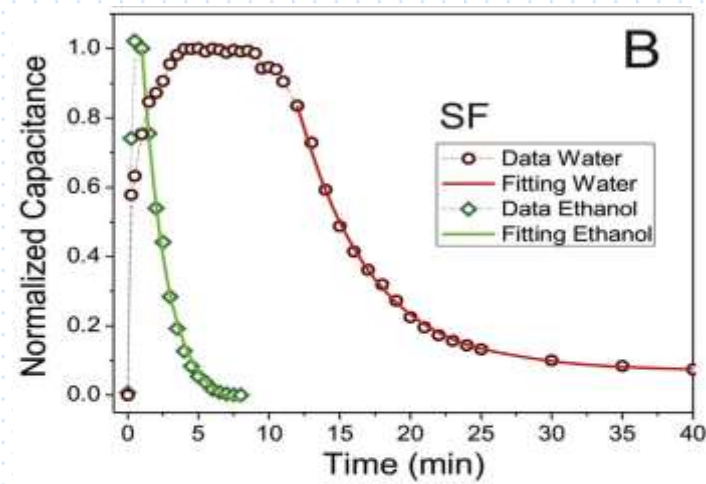
Qué pasa cuando deposito una gota en la superficie?

Capacitor MOS Para Detectar Fluidos



$$\epsilon_{\text{eff}}(t)/\epsilon_0 = (1 - \phi)\epsilon_s + \phi S_0 \exp(-t/\tau)\epsilon_l + \phi[1 - S_0 \exp(-t/\tau)]\epsilon_a$$

Sample	Liquid	τ (s)	$m_{\text{ev}}(\text{kg}/\text{sm}^2) \times 10^{-7}$	S_0	MFF (%)
SF	Water	308	2.5	0.02	4
SF	Ethanol	103	5.9	0.06	13
TF	Water	75	6.7	0.09	18
TF	Ethanol	56	7.1	0.12	25



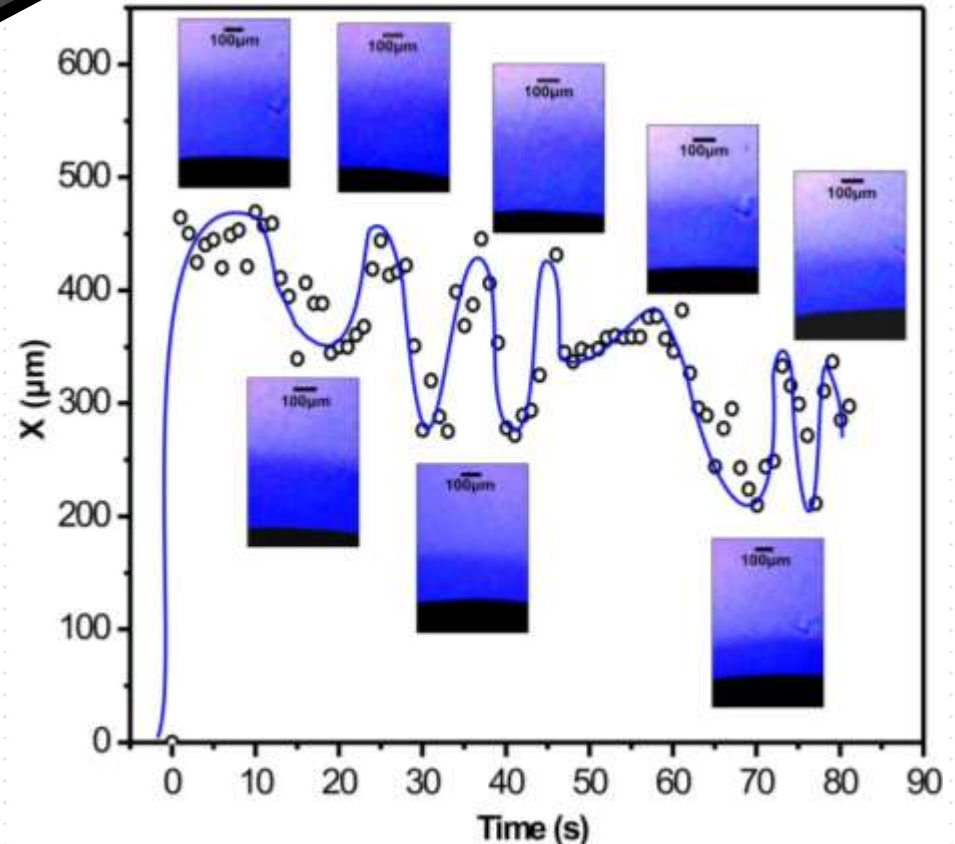
Gimenez R., Delgado D. C., Palumbo F., Berli C. L. A., Bellino M. G. *Colloids and Surfaces A* **2017**, 524, 66-70.

Qué pasa cuando deposito una gota en la superficie?



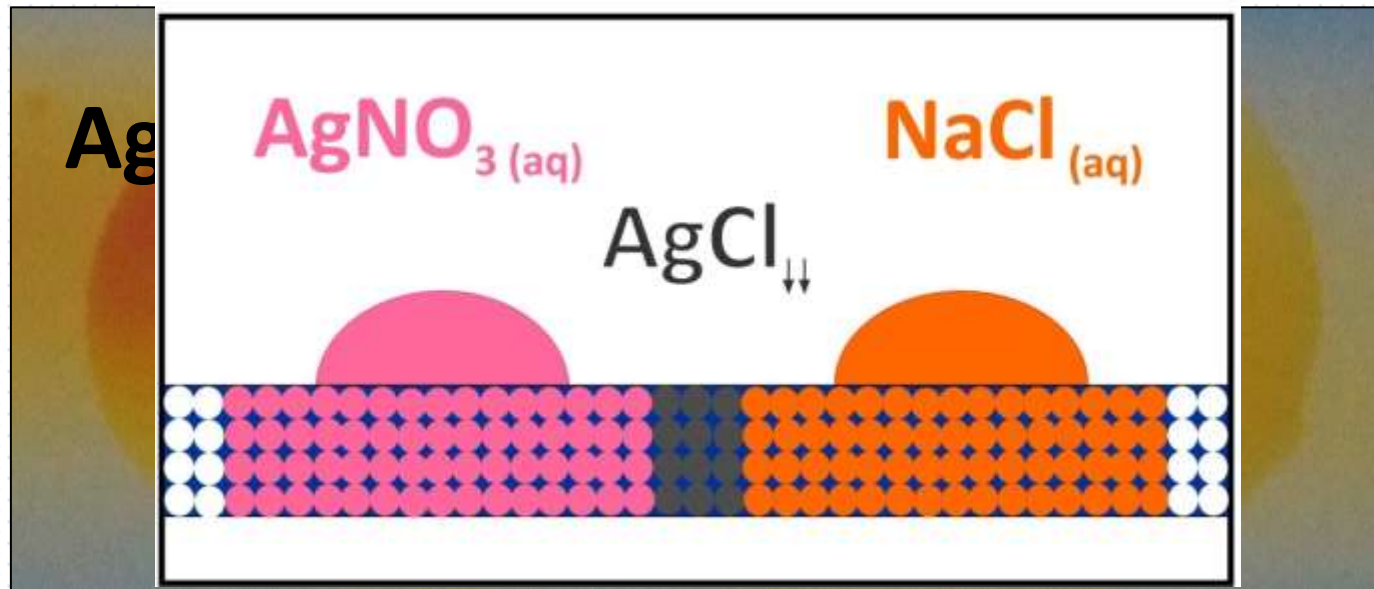
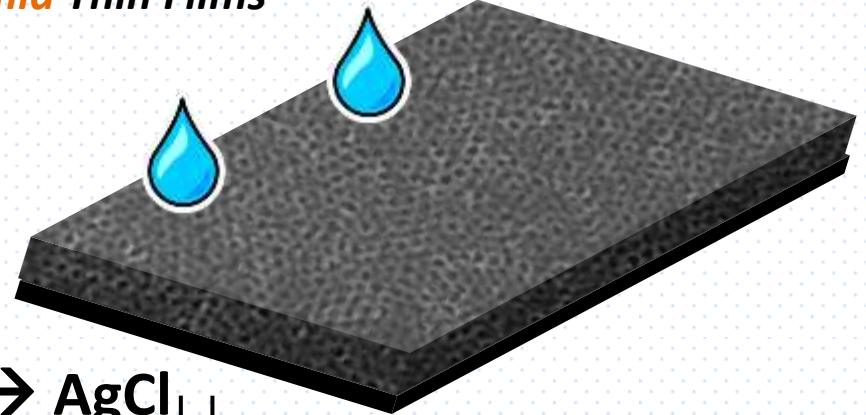
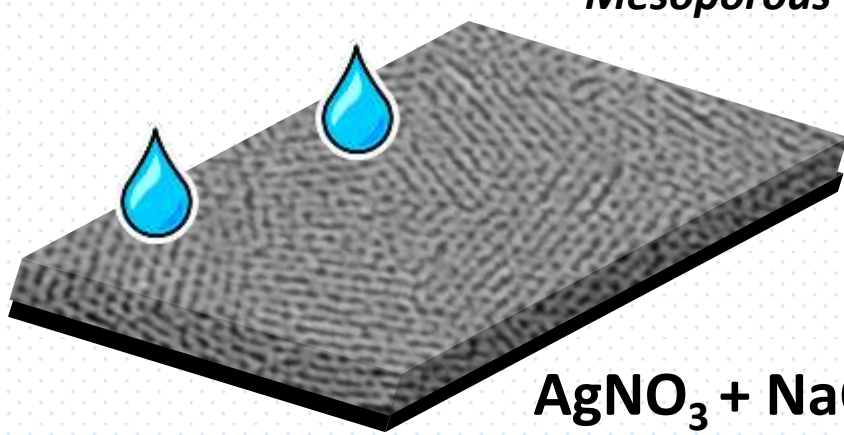
*Mesoporous **Silica** Thin Films*

Capillaridad vs Evaporación !



Qué pasa cuando deposito DOS gotas en la superficie?

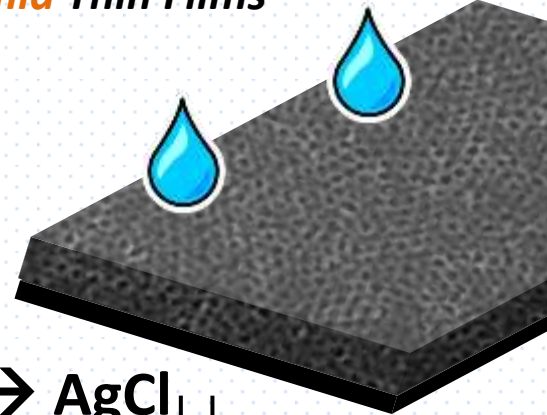
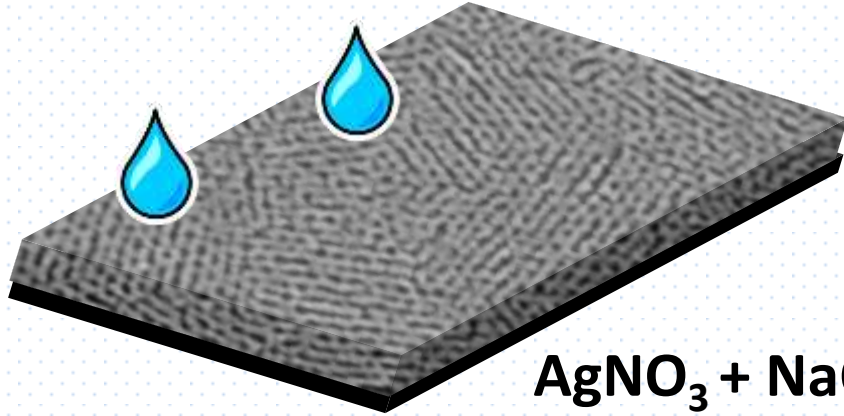
Mesoporous *Titania* Thin Films



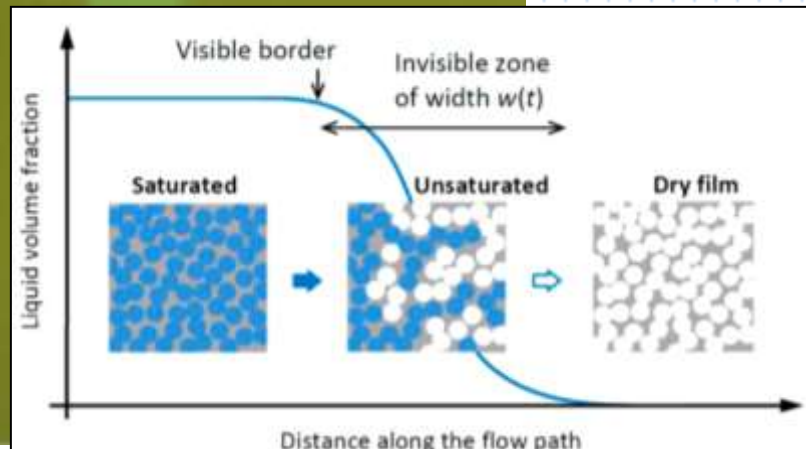
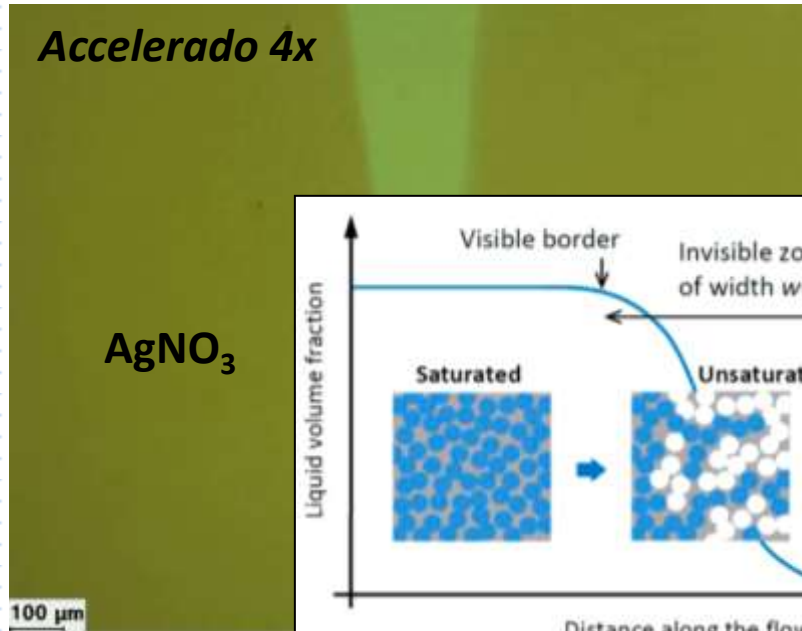
REACCIÓN QUÍMICA LOCALIZADA

Qué pasa cuando deposito DOS gotas en la superficie?

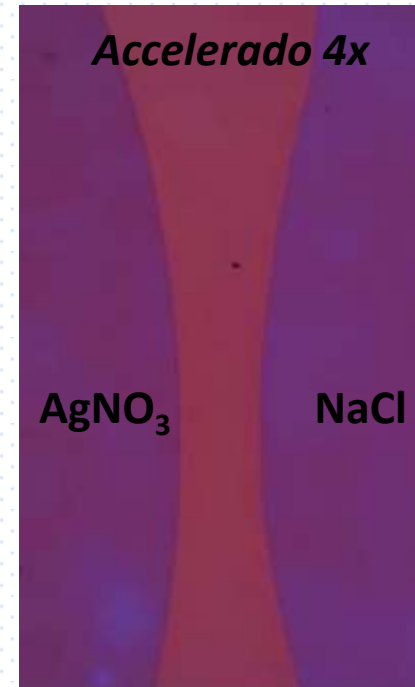
Mesoporous *Titania* Thin Films



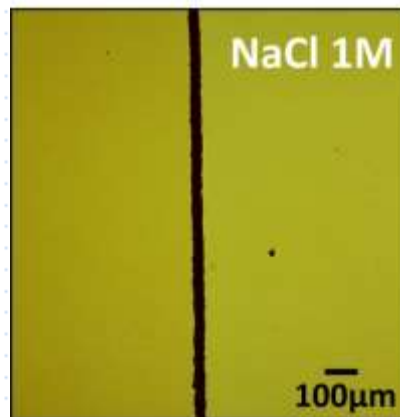
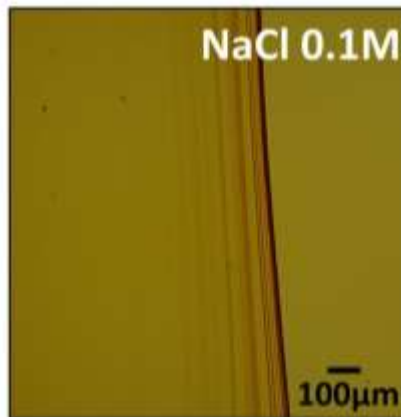
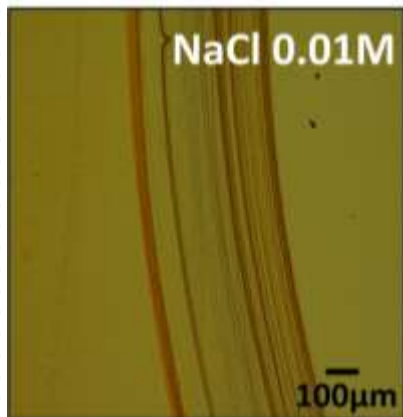
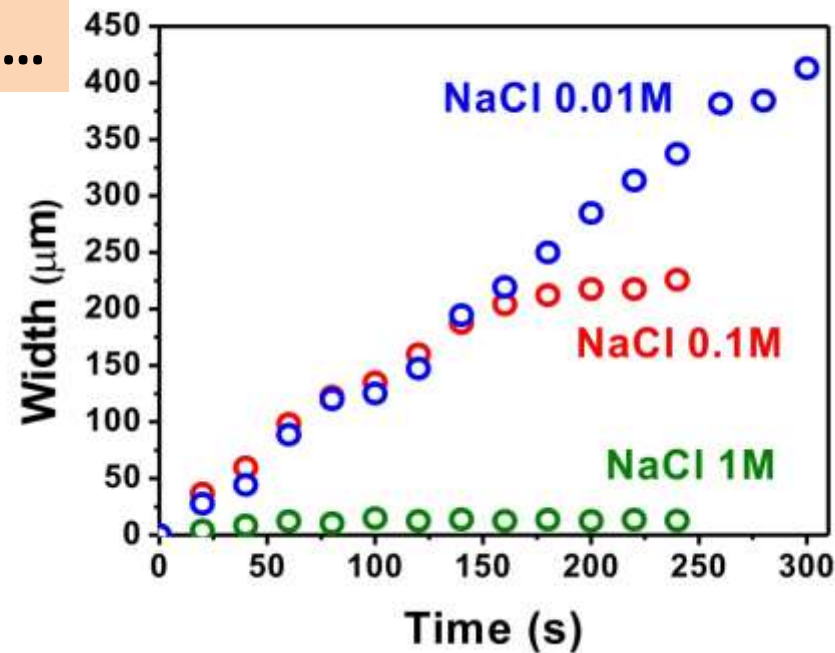
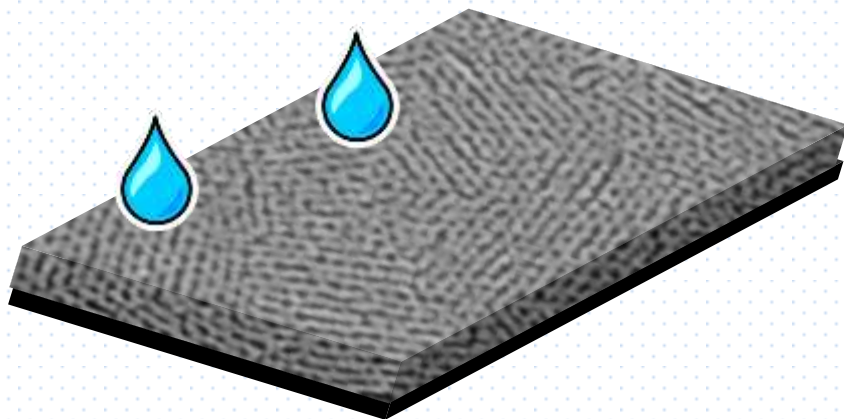
Accelerado 4x



Accelerado 4x



Diferentes concentraciones de NaCl ...



El Tiempo de Reacción depende de la Concentración de NaCl

Por Que Bandas?

Comportamiento Oscilante?

Resumiendo...

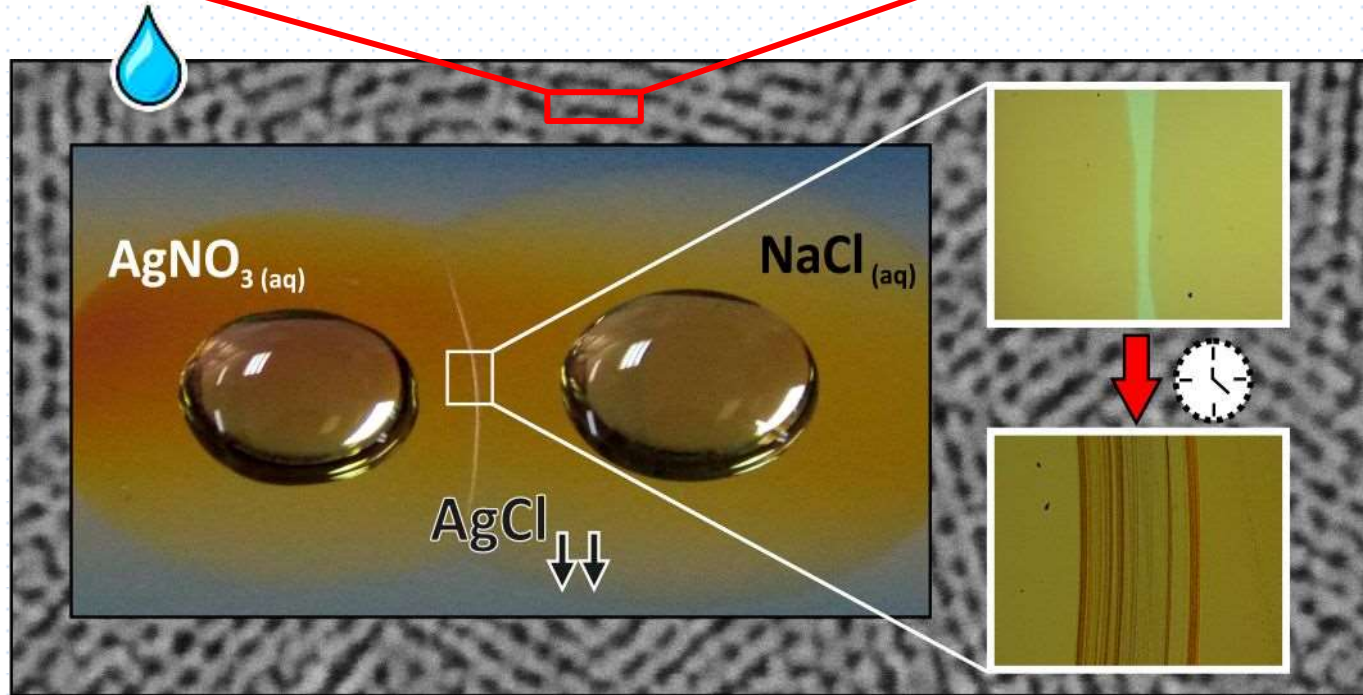
$$x^2 = x_{ss} (1 - \exp(-2t/\tau))$$

**Movimiento Autónomo
del Fluido**

Fácil Operación

**Fácil
Fabricación**

**Control
de Procesos**



Se puede hacer interactuar dos gotas sin estar en contacto físico?
SE PUEDE!

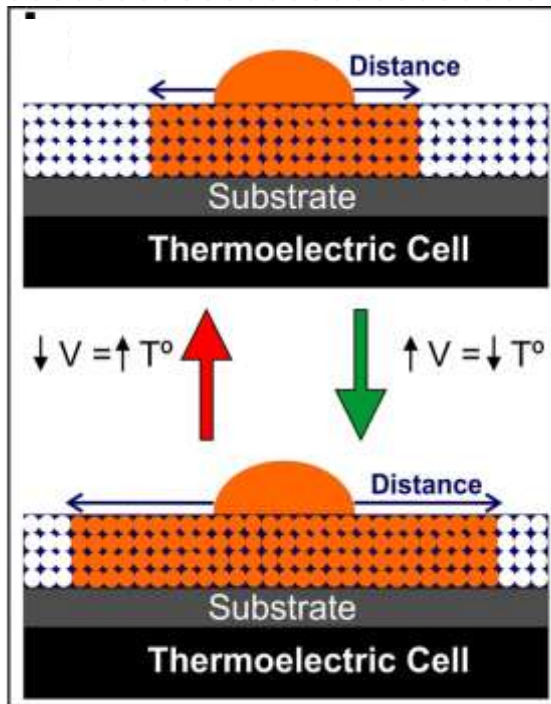
Es el Concepto Más Simple de un Dispositivo? *PROBABLEMENTE...*

Sensado (ej. Fluorescencia) - Diagnóstico - Interacción Celular Controlada

Avancemos Más ...

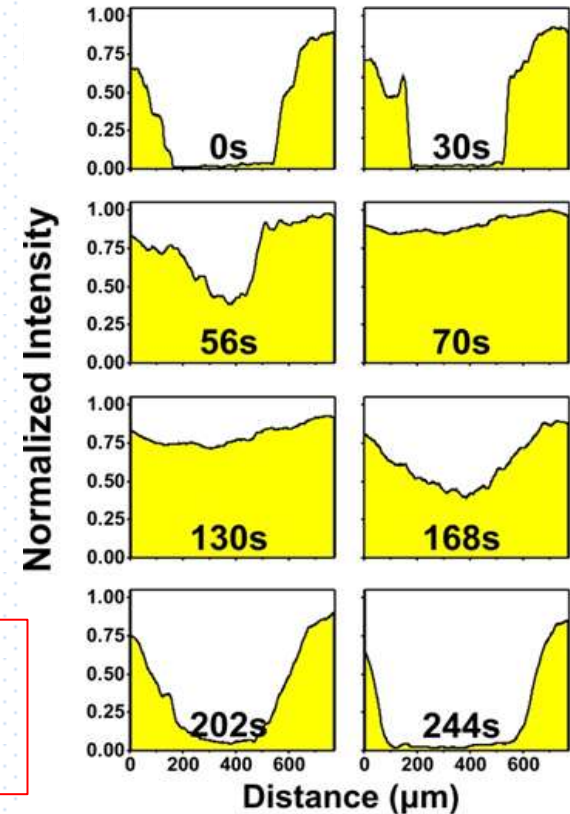
Manipular Fluídos

$$x^2 = x_{ss} (1 - \exp(-2t/\tau))$$



Acelerado x 10

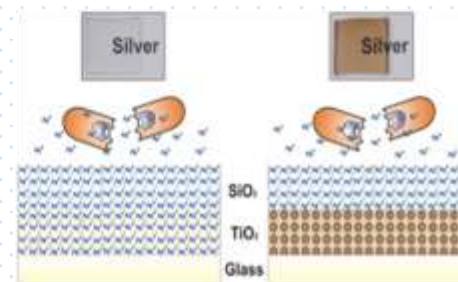
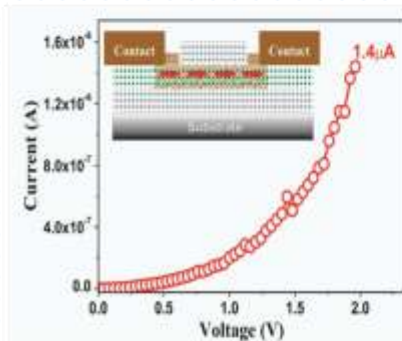
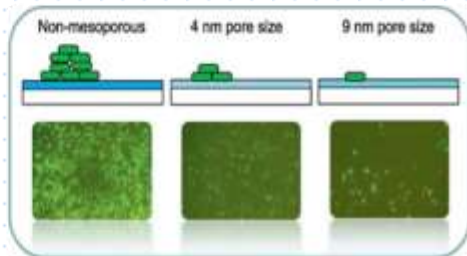
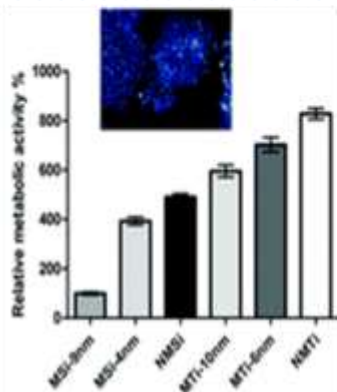
Conexión NanoFluídica
Conmutada



Además

Películas Mesoporosas como Sustratos Bio-Inteligentes

Martín G. Bellino – Paolo Catalano
M. Desimone - Galo Soler Illia



- M. G. Bellino, S. Golbert, M. C. De Marzi, G. J. A. A Soler-Illia, M. F. Desimone "Controlled adhesion and proliferation of a human osteoblastic cell line by tuning the nanoporosity of titania and silica coatings" *Biomaterials Science*, **2013**, 1, 186-189.
- P. N. Catalano, M. Pezzoni, C. Costa, G. J. A. A. Soler-Illia, M. G. Bellino, M. F. Desimone "Optically transparent silver-loaded mesoporous thin film coating with long-lasting antibacterial activity", *Microporous and Mesoporous Materials*, **2016**, 236, 158-166. - *Solicitud Patente* N° 20150102318. 21/07/2015.
- M. Pezzoni, P. Catalano, R. Pizarro, M. F. Desimone, Galo J. A. A. Soler-Illia, M. G. Bellino, C. S. Costa "Antibiofilm Effect of Supramolecularly Templated Mesoporous Silica Coatings" *Materials Science and Engineering: C*, **2017**, 77, 1044-1049. - *Solicitud Patente* N° 20160101253. 03/05/2016.
- D. C. Delgado, D. Perez, P. Catalano, M. G. Bellino "Mesoporous thin film structures as metal nanoparticle reactors for electronic circuits: effects of wall crystallization and nanoparticle functionalization" *Superlattices and Microstructures*, **2017**, en prensa.

Muchas Gracias!

Dr. Claudio Berli

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Lic. Rocio Gimenez

Lic. Diana C. Delgado

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AGENCIA



A Ustedes por Escucharme

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