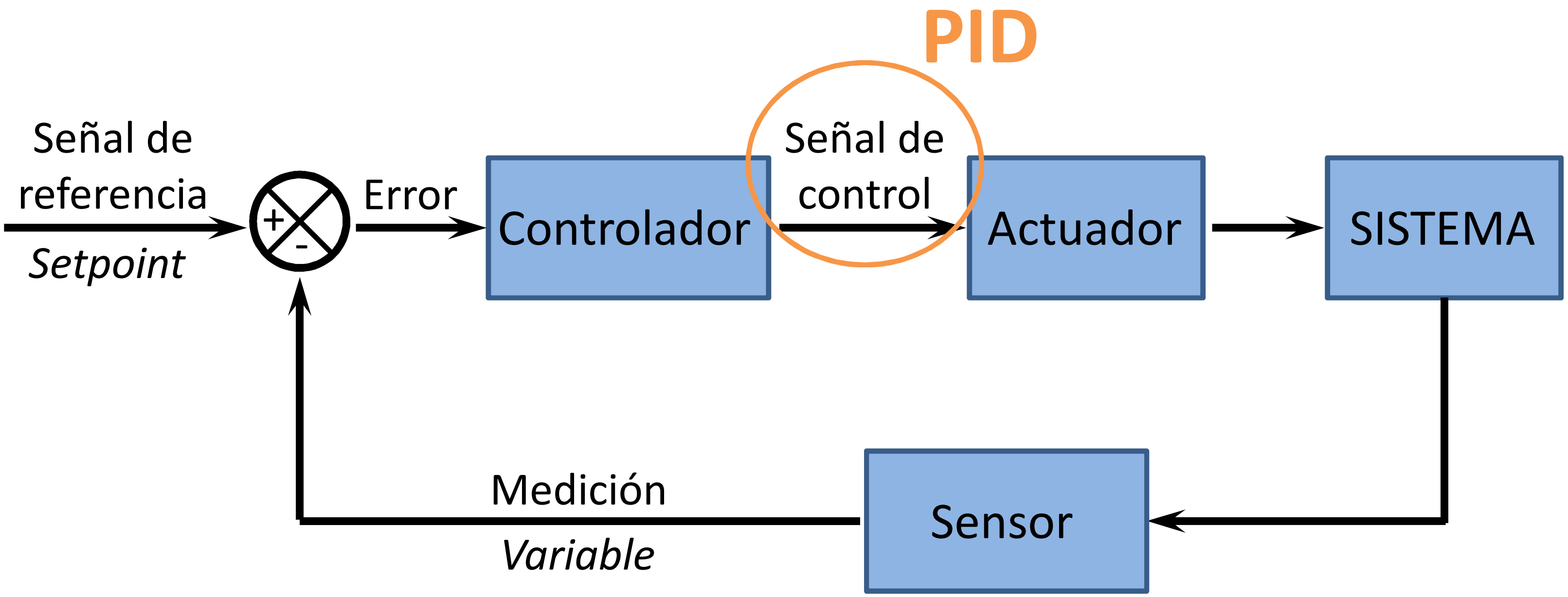
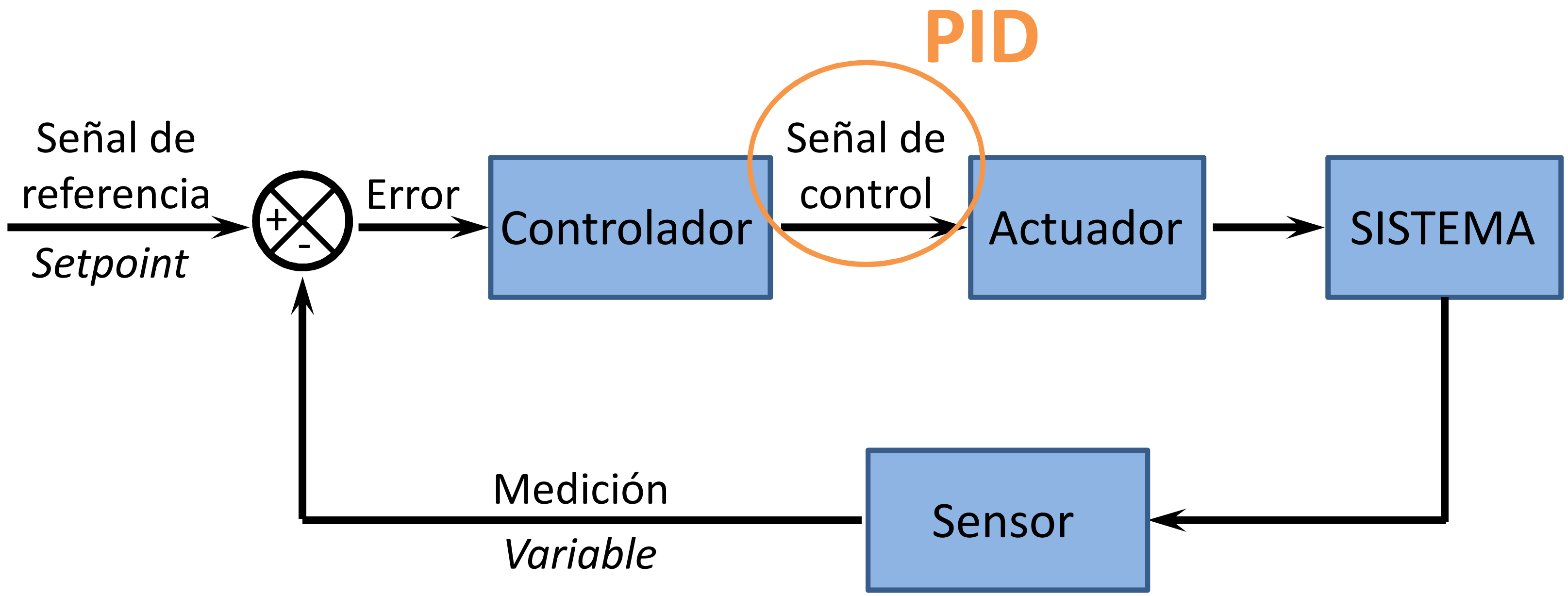
Lazo de realimentación PID
(en labo 5)

Laboratorio 5 – Abril 2018

Lazo de Control



Lazo de Control



PID

Señal de referencia

Setpoint

+

-

Error

Controlador

Señal de control

Actuador

SISTEMA

Sensor

Medición

Variable

Error

$$e(t) = setpoint - variable(t)$$

Señal de control PID

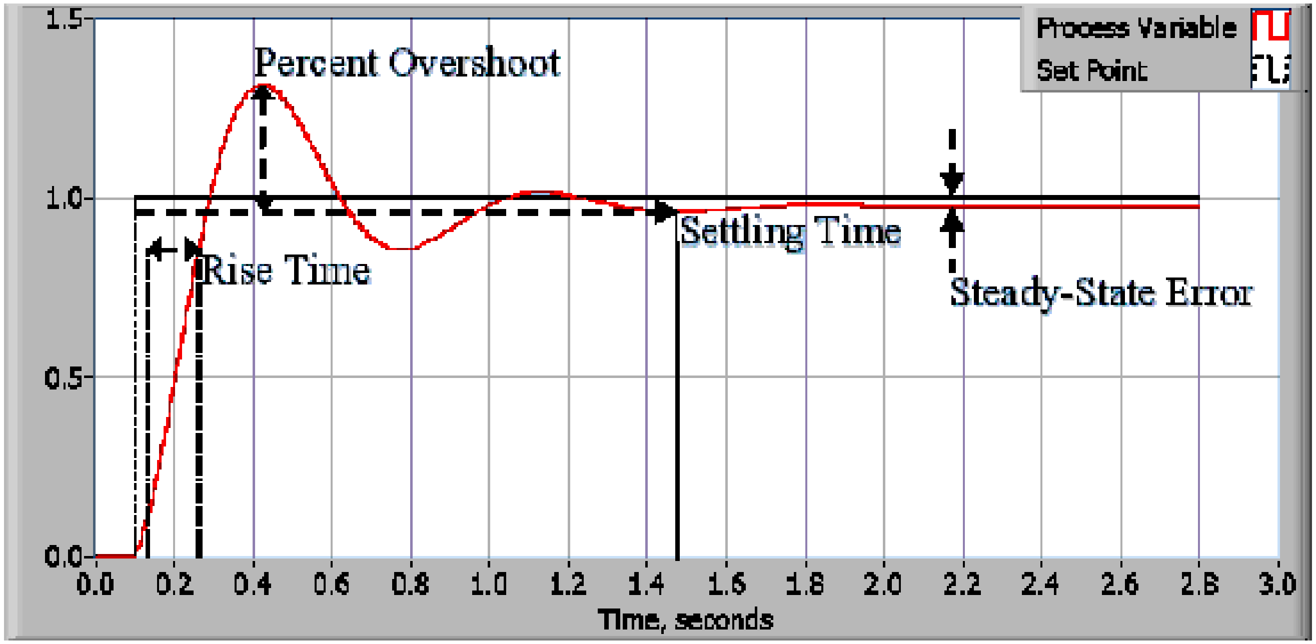
$$u(t) = \underbrace{K_P.e(t)}_{\text{proporcional}} + \overbrace{K_I.\int_0^t e(\tau)d\tau}^{\text{integral}} + \underbrace{K_D.\frac{de(t)}{dt}}_{\text{derivativo}}$$

Señal de control PID

$$u(t) = K_P . e(t) + K_I . \int_0^t e(\tau) d\tau + K_D . \frac{de(t)}{dt}$$

K_P, K_I , K_D ?

Las ganancias influyen en la performance del sistema:
cómo responde el sistema ante un cambio de Setpoint



http://www.ni.com/white-paper/3782/en/

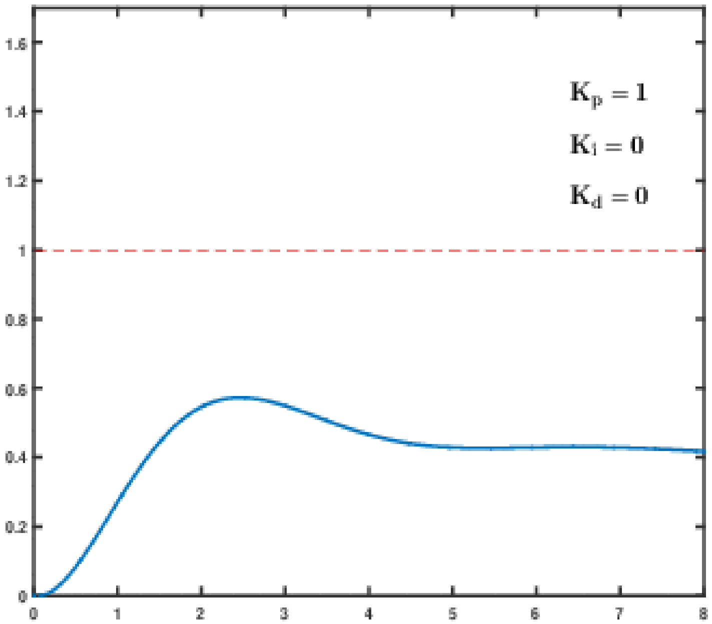
Señal de control PID

$$u(t) = K_P . e(t) + K_I . \int_0^t e(\tau) d\tau + K_D . \frac{de(t)}{dt}$$

- **Proporcional:** Directamente proprcional al error. Aumentar K_P mejora la velocidad de respuesta. Empiezan a verse oscilaciones.

- **Integral:** suma el error en el tiempo. Mayor K_I mejora el steady state error (*Windup*)

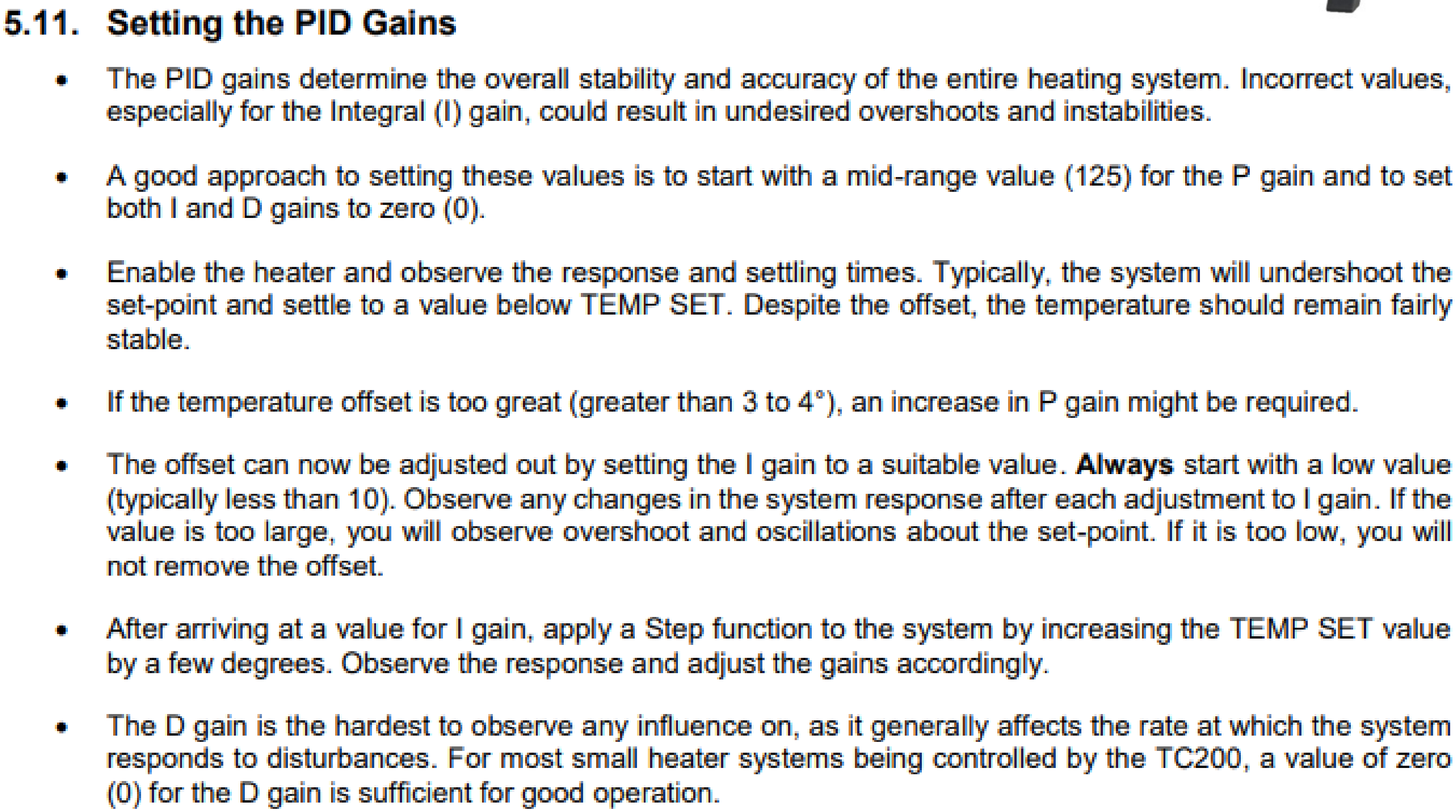
- **Derivativo:** Proporcional a la tasa de cambio. Mejora la respuesta. Muy sensible al ruido.



en.wikipedia.org/wiki/PID_controller#/media /File:PID_Compensation_Animated.gif

Espectroscopía láser

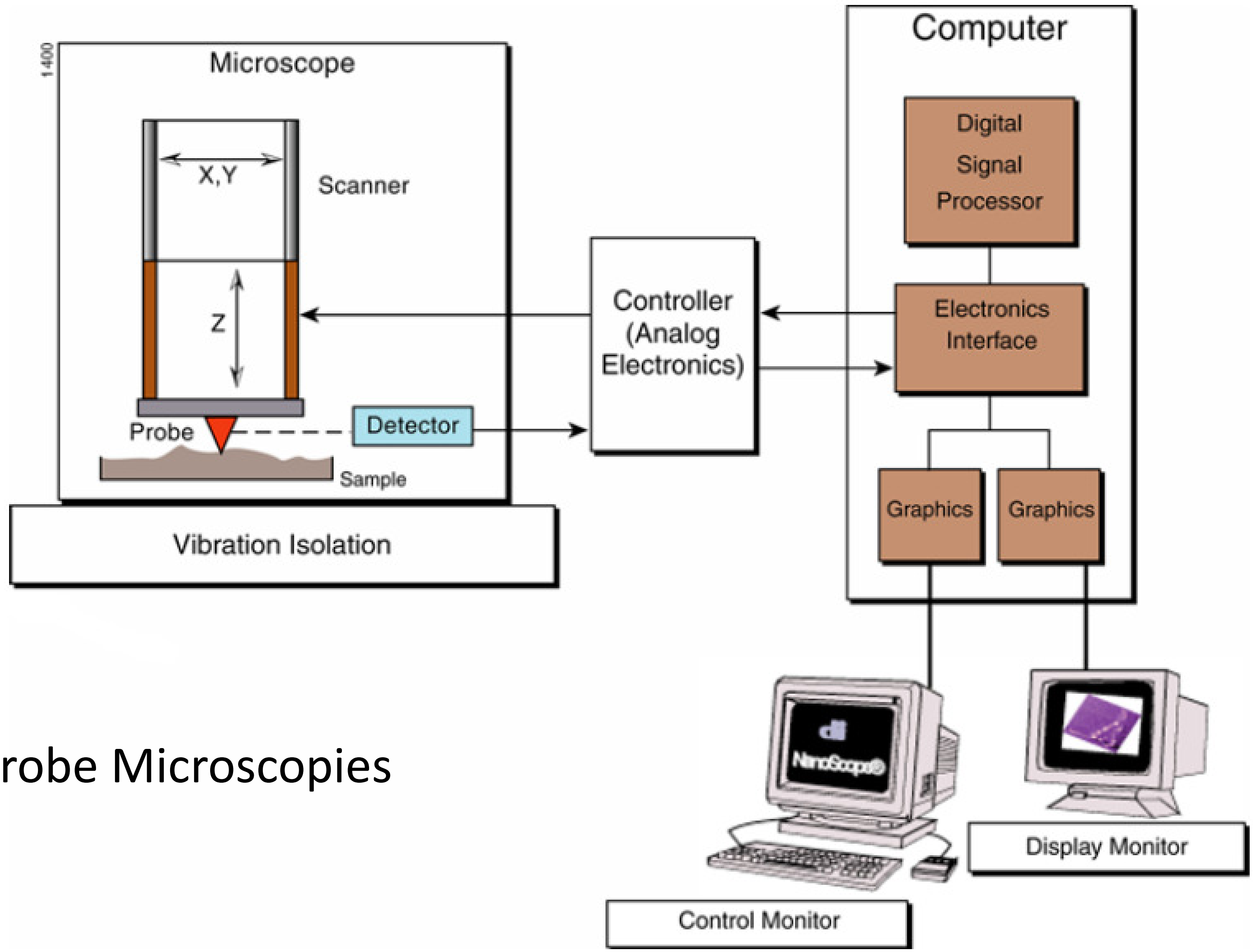
Control de temperatura por PID



5.11. Setting the PID Gains

- The PID gains determine the overall stability and accuracy of the entire heating system. Incorrect values, especially for the Integral (I) gain, could result in undesired overshoots and instabilities.
- A good approach to setting these values is to start with a mid-range value (125) for the P gain and to set both I and D gains to zero (0).
- Enable the heater and observe the response and settling times. Typically, the system will undershoot the set-point and settle to a value below TEMP SET. Despite the offset, the temperature should remain fairly stable.
- If the temperature offset is too great (greater than 3 to 4°), an increase in P gain might be required.
- The offset can now be adjusted out by setting the I gain to a suitable value. **Always** start with a low value (typically less than 10). Observe any changes in the system response after each adjustment to I gain. If the value is too large, you will observe overshoot and oscillations about the set-point. If it is too low, you will not remove the offset.
- After arriving at a value for I gain, apply a Step function to the system by increasing the TEMP SET value by a few degrees. Observe the response and adjust the gains accordingly.
- The D gain is the hardest to observe any influence on, as it generally affects the rate at which the system responds to disturbances. For most small heater systems being controlled by the TC200, a value of zero (0) for the D gain is sufficient for good operation.

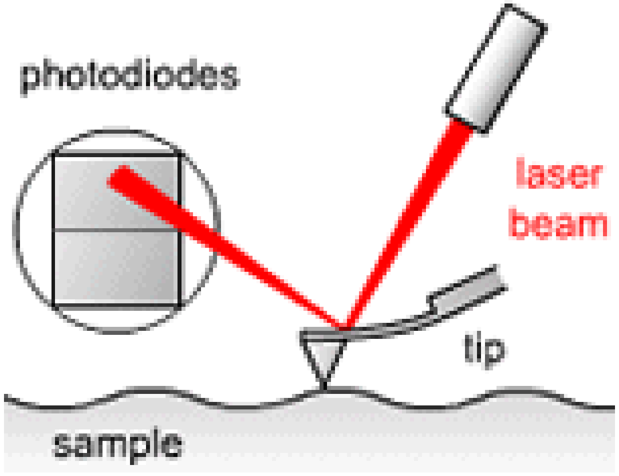
SPM

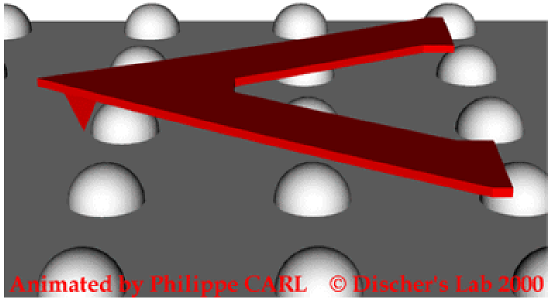


Scanning Probe Microscopies

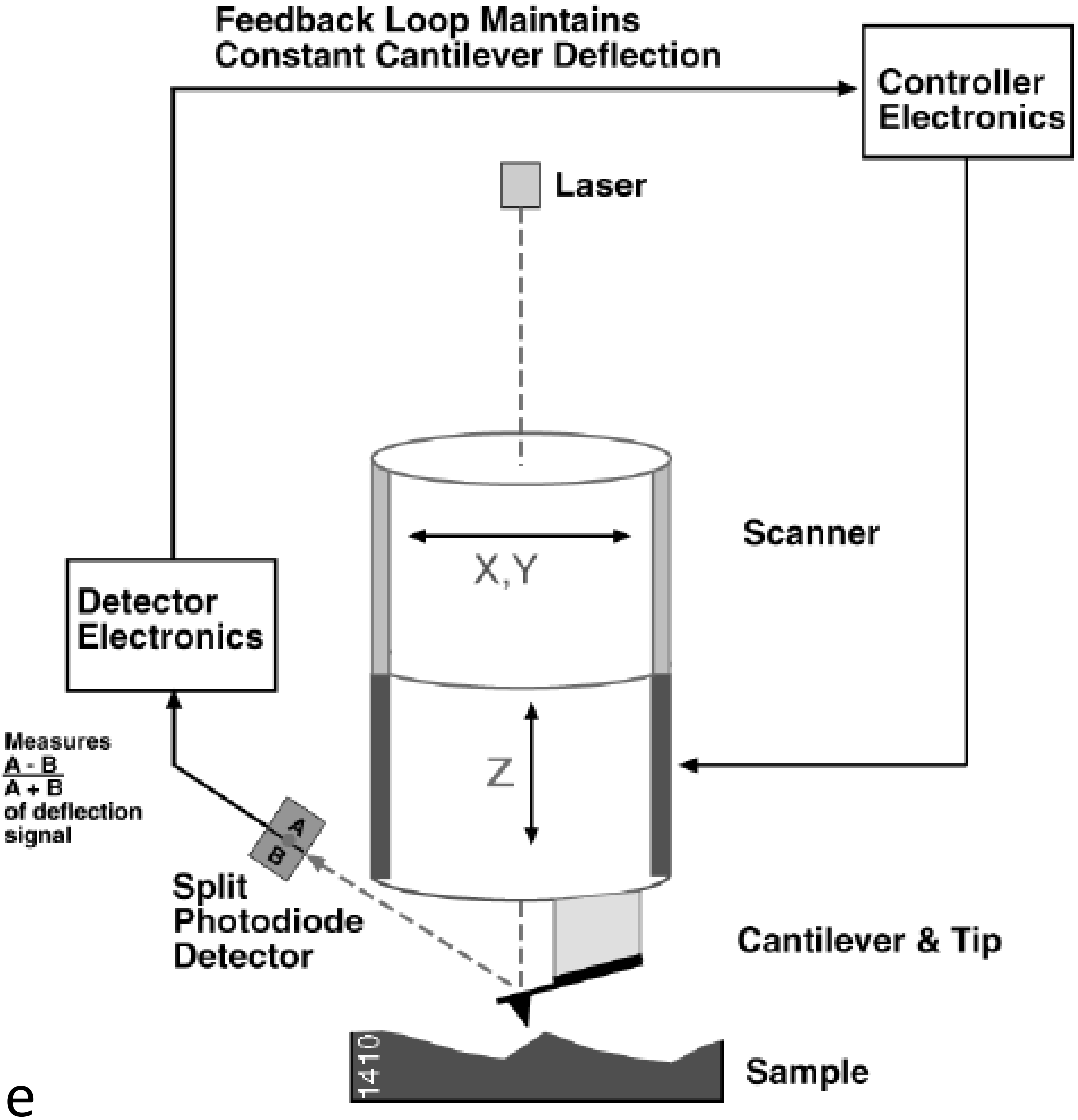
Scanning Probe Microscopy Training Notebook

AFM



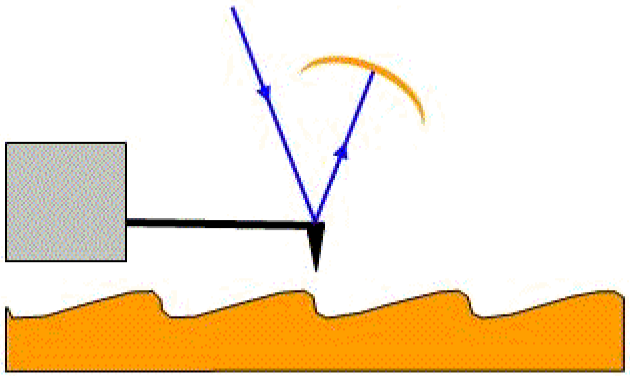


http://perso.univ-lemans.fr/~bardeau/IMMM-PEC/afm

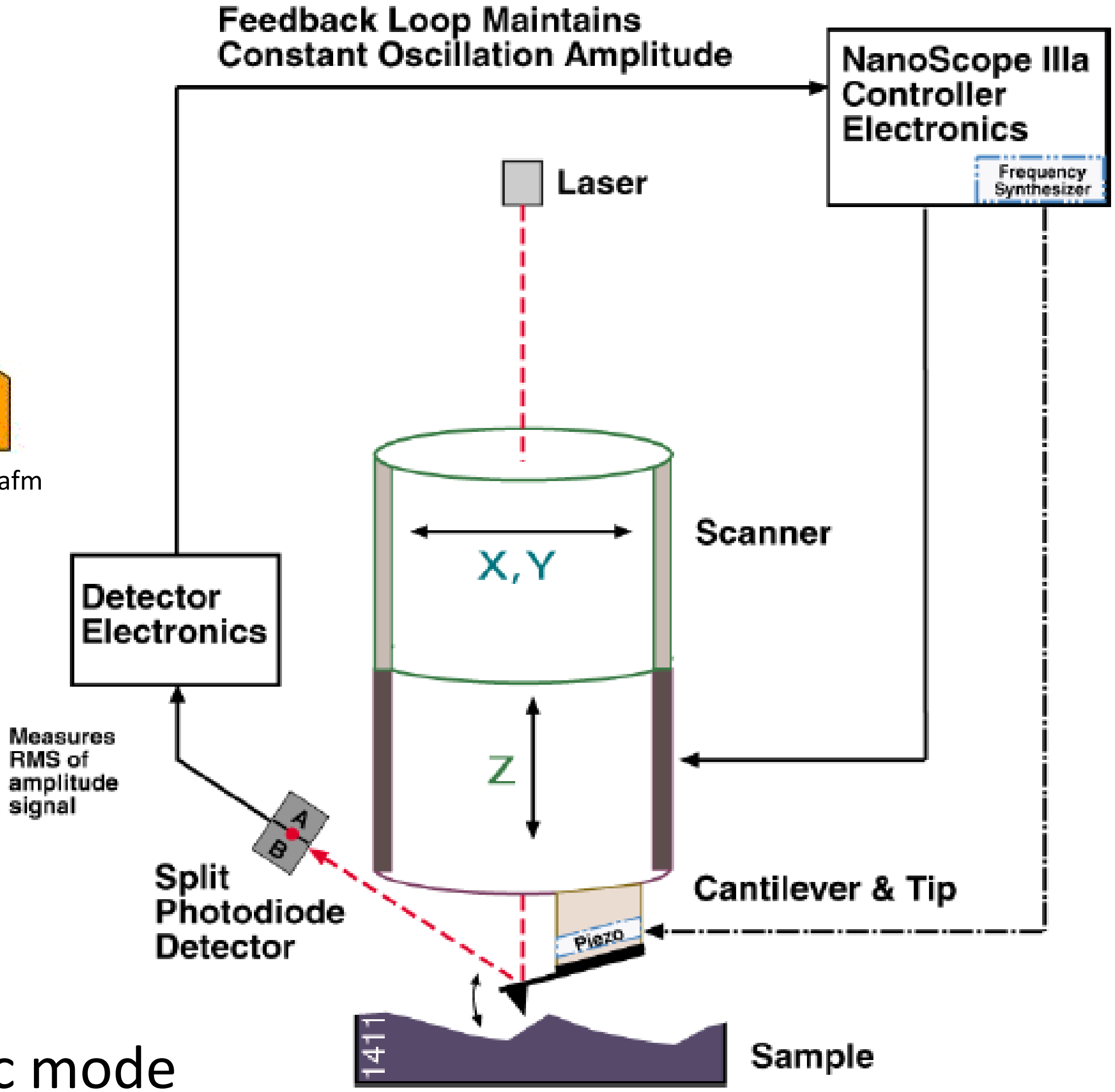


Contact mode / Static mode

AFM



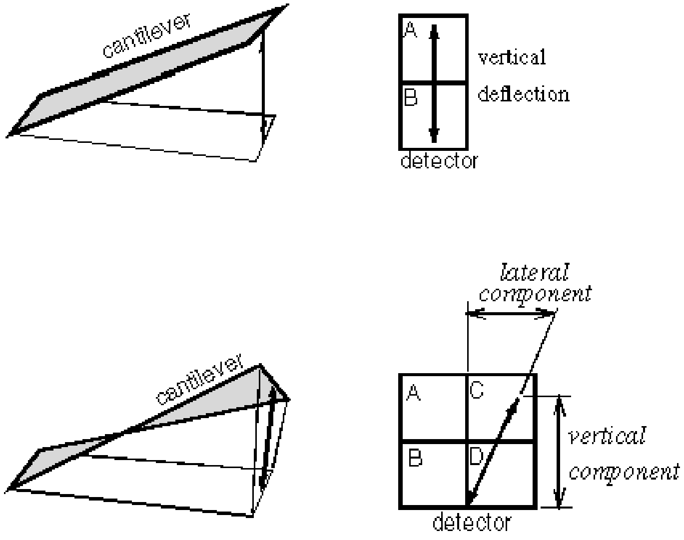
http://perso.univ-lemans.fr/~bardeau/IMMM-PEC/afm



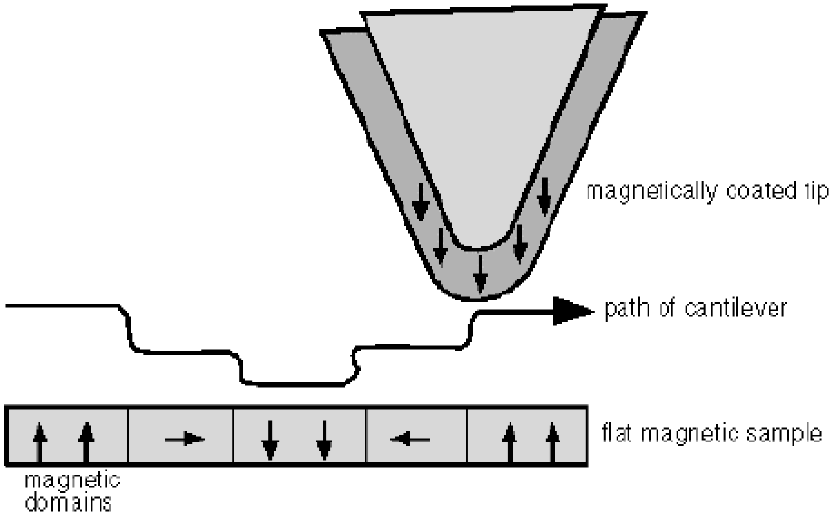
Tapping mode / Dynamic mode

AFM

Otros modos de imaging

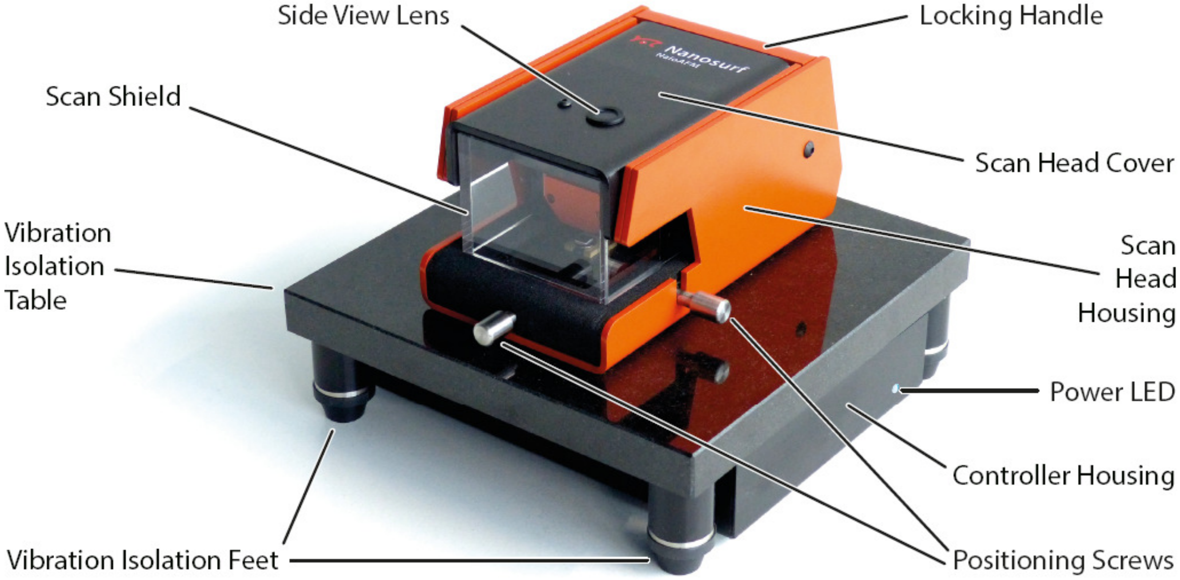


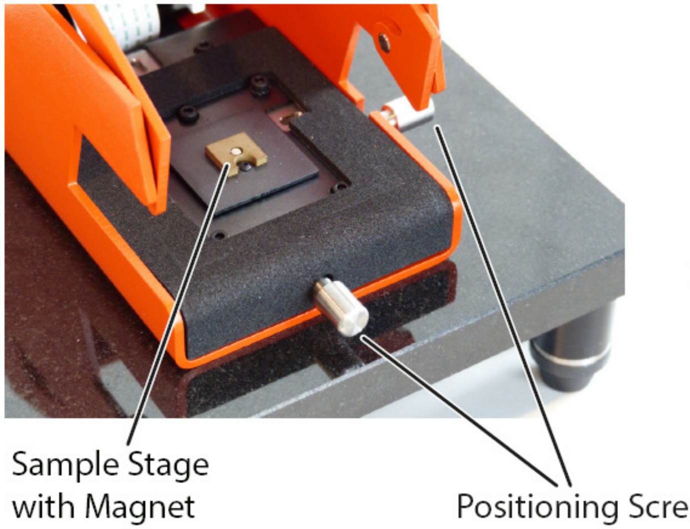
Lateral force
(Friction images)

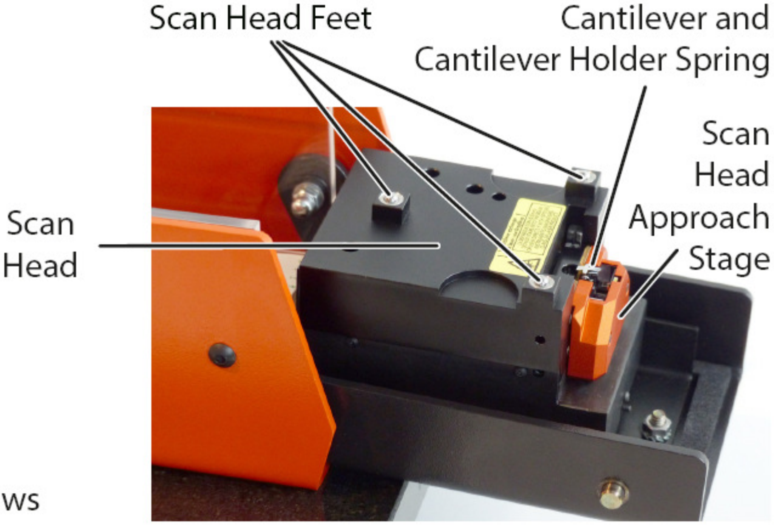


Magnetic Force Microscopy

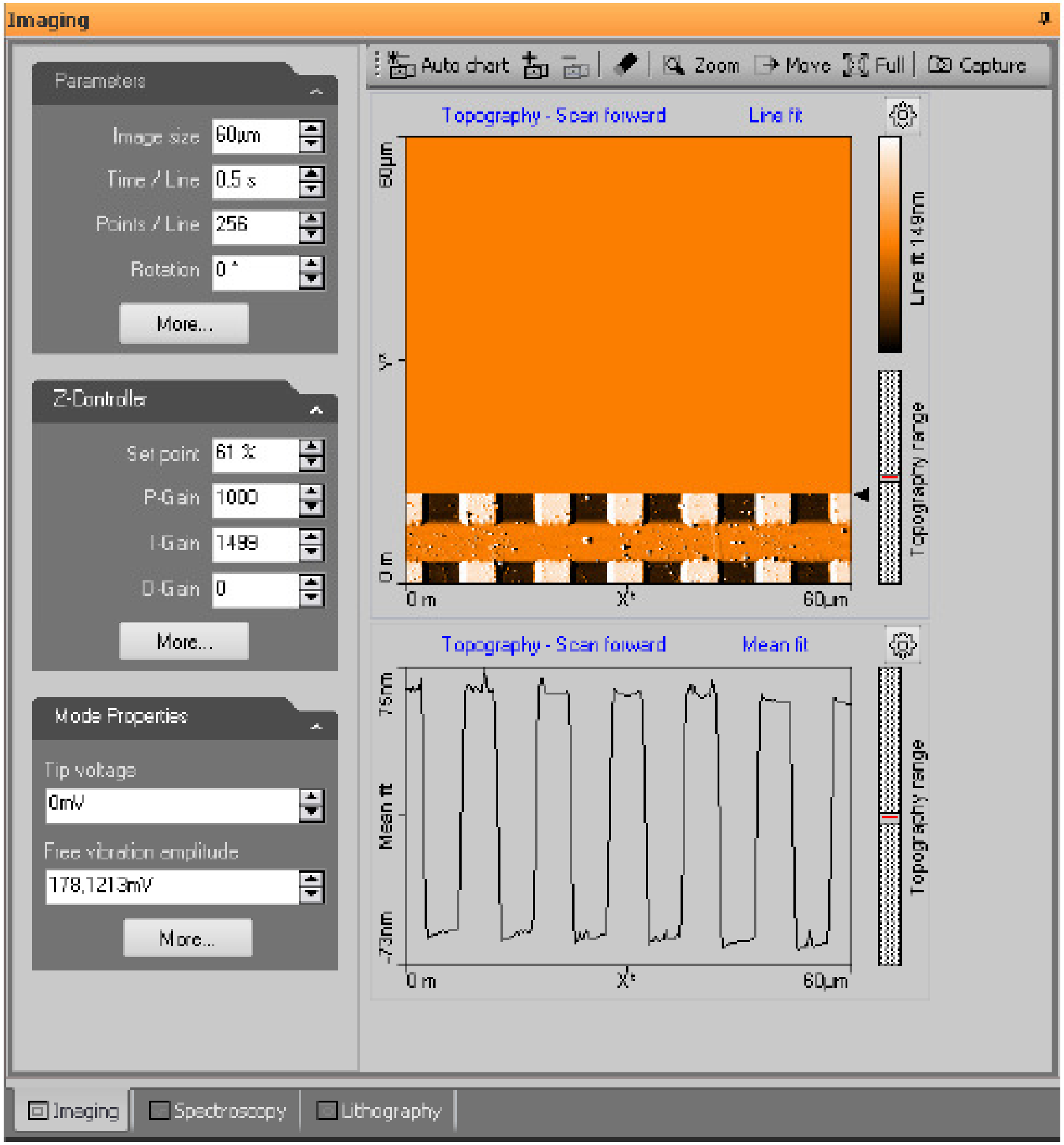
AFM







Nanosurf NaioAFM



Parameters

Image size 60µm
Time / Line 0.5 s
Points / Line 256
Rotation 0 °

Z-Controller

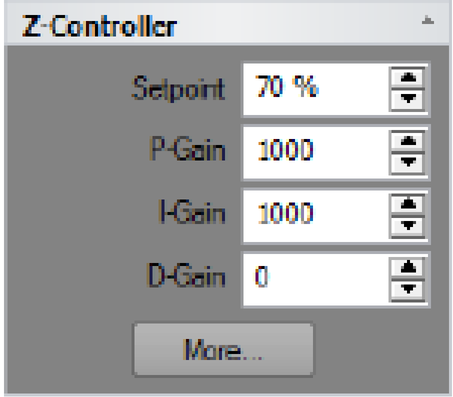
Set point 61 %
P-Gain 1000
I-Gain 1499
D-Gain 0

Mode Properties

Tip voltage 0mV
Free vibration amplitude 178,1213mV

Nanosurf NaioAFM

Z-controller section



Setpoint 70 %
P-Gain 1000
I-Gain 1000
D-Gain 0

Set point (%)

P - Gain

I - Gain

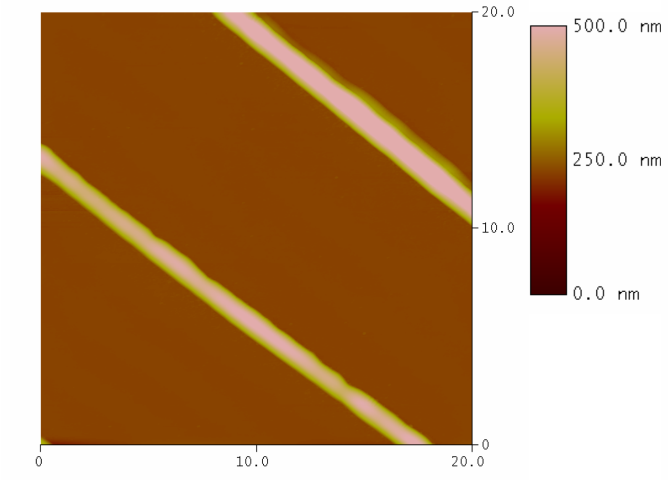
D - Gain

- *El Setpoint y las ganancias se ajustan optimizando la imagen.*
- *La vista de perfiles permite ver el ruido.*

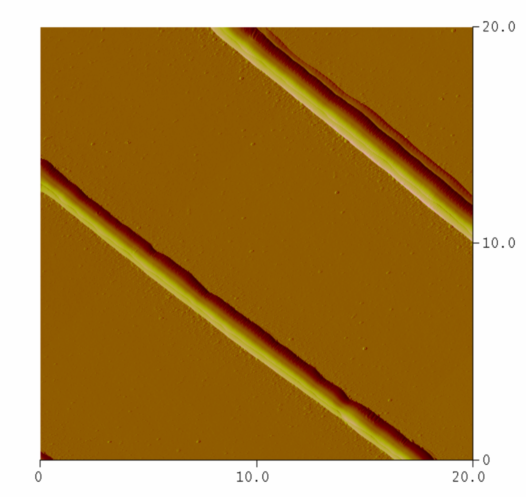
Distintos tipos de imagen en cada modo

Litografía de polímeros sobre vidrio

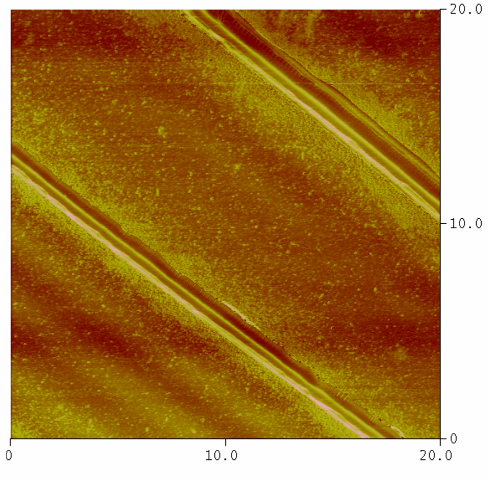
Estático



Altura



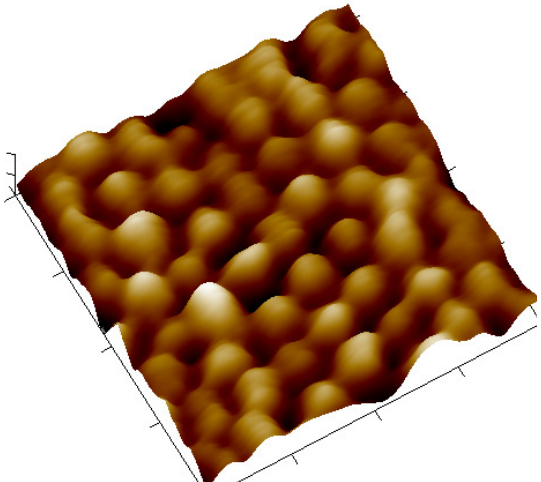
Error



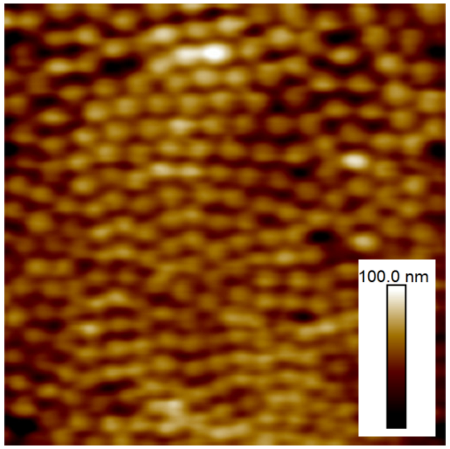
Fricción

Dinámico

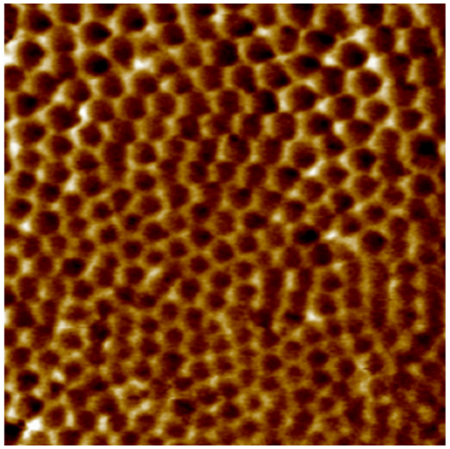
Partículas de microgel autoensambladas



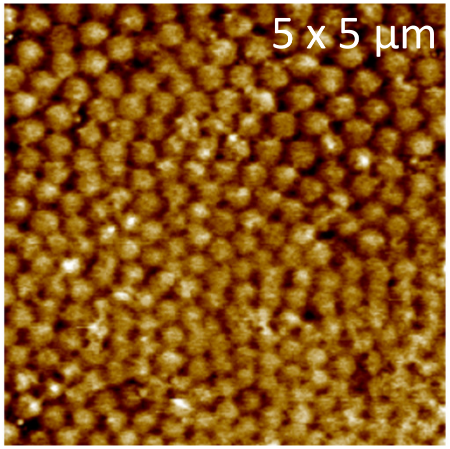
Height 2 x 2 µm
(z scale 60 nm)



Height



Amplitude



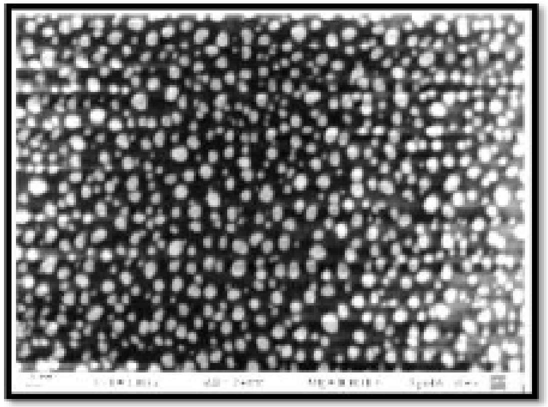
Phase

Aplicaciones AFM-nanofabricación

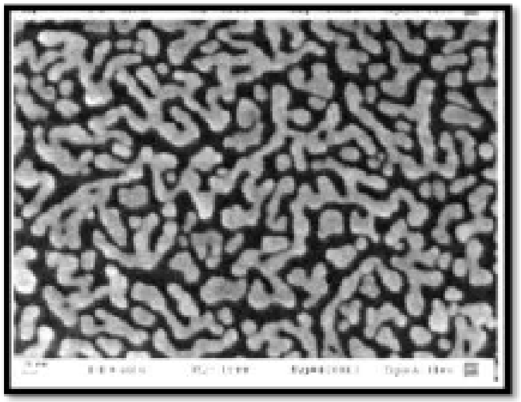
Nanofabricación

- Sputtering metálico

9 segundos *sputtering*



21 segundos *sputtering*



- Síntesis de nanopartículas de plata

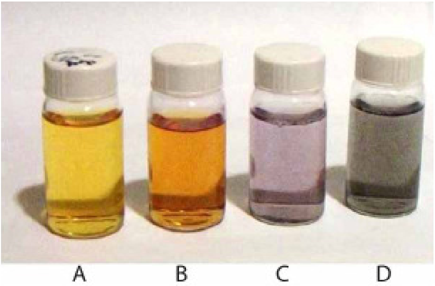


Figure 1. Colloidal silver in various stages of aggregation, (A) clear yellow sol, (B) dark yellow sol, (C) violet sol , and (D) grayish sol, as aggregation proceeds.

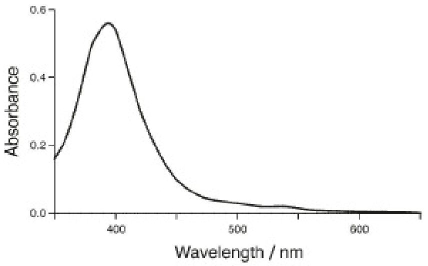


Figure 2. UV–vis absorption spectrum of clear yellow colloidal Ag.

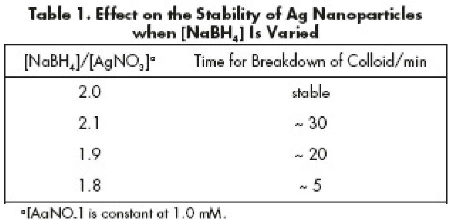
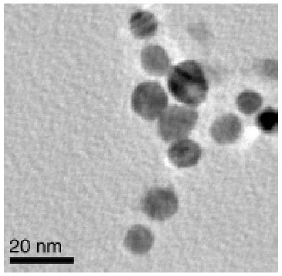


Table 1. Effect on the Stability of Ag Nanoparticles when [NaBH$_4$] Is Varied

[NaBH$_4$]/[AgNO$_3$]^a	Time for Breakdown of Colloid/min
2.0	stable
2.1	~ 30
1.9	~ 20
1.8	~ 5

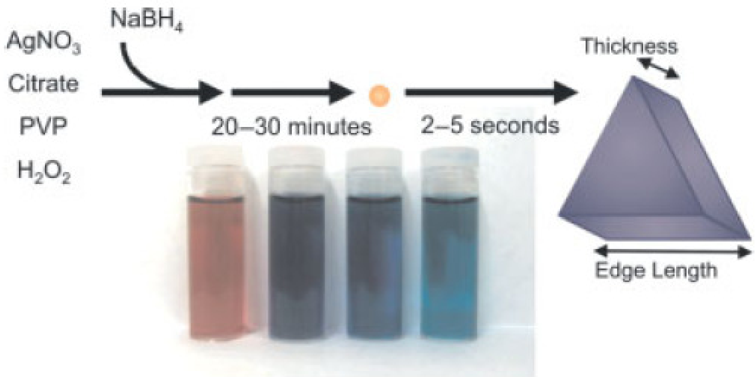
^{a}[AgNO$_3$] is constant at 1.0 mM.



$$4\,AgNO_3 + NaBH_4 + 3H_2O \rightarrow 4Ag + H_3BO_3 + 3HNO_3 + NaNO_3 + 2H_2$$

Nanofabricación

- Síntesis de nanoprismas de plata



Scheme 1. The conversion of silver nanoparticles to silver nanoprisms with $NaBH_4$ and H_2O_2. Inset: Solutions of silver nanoprisms containing various concentrations of $NaBH_4$ (left to right: 0.30 mM, 0.50 mM, 0.67 mM, and 0.80 mM $NaBH_4$).

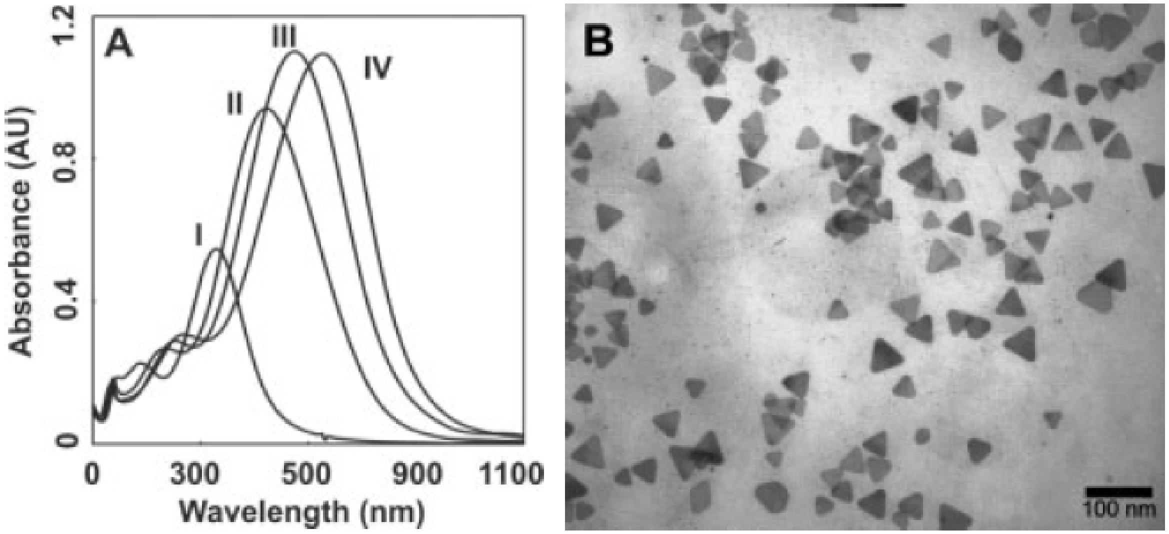
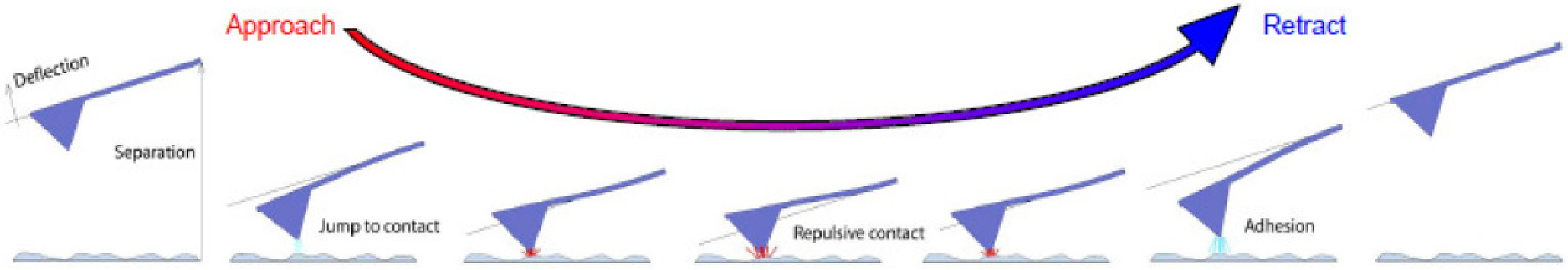
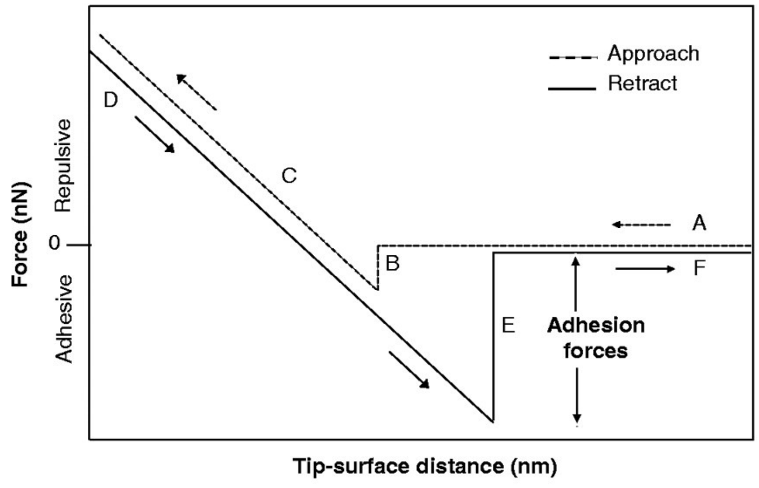


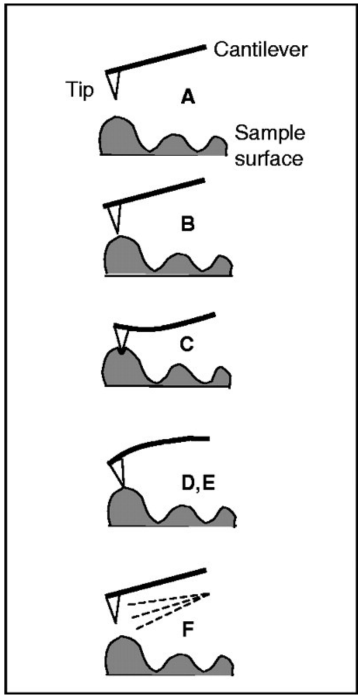
Figure 1. A) UV–vis spectra of nanoprism colloids with various $NaBH_4$ concentrations ($[H_2O_2] = 20$ mM). I) 0.30 mM, II) 0.50 mM, III) 0.67 mM, and IV) 0.80 mM. B) TEM image of Ag nanoprisms ($[H_2O_2] = 20$ mM, $[NaBH_4] = 0.80$ mM).

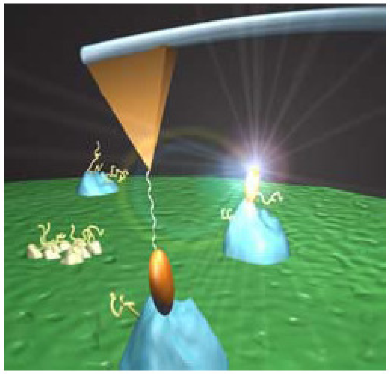
Espectroscopía: curvas de fuerza

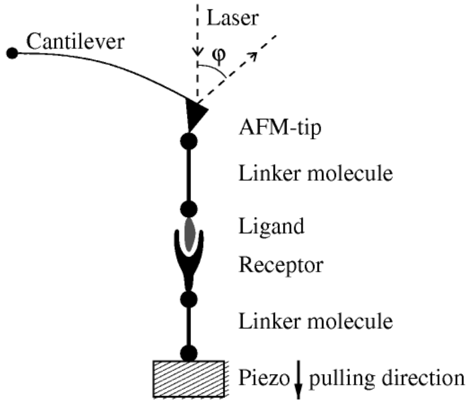




Shahin, V. et al. J Cell Sci 2005;118:2881-2889





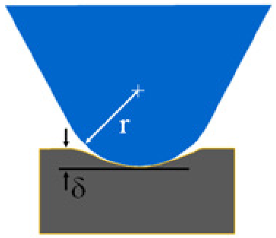


La deflexión puede traducirse a fuerza

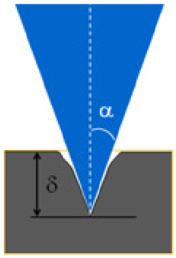
$$F = -k.x$$

constante elástica del cantilever

Propiedades nanomecánicas



E_s : Sample modulus
ν_s: Poisson's ratio
r: tip radius of curvature
α: opening angle

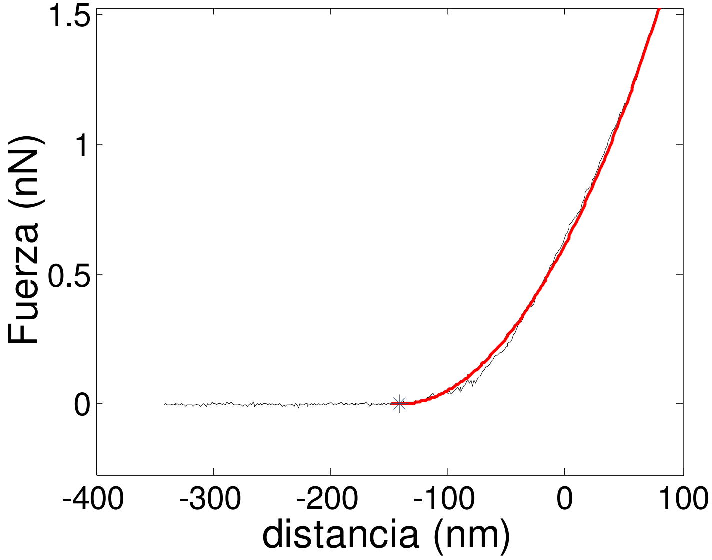


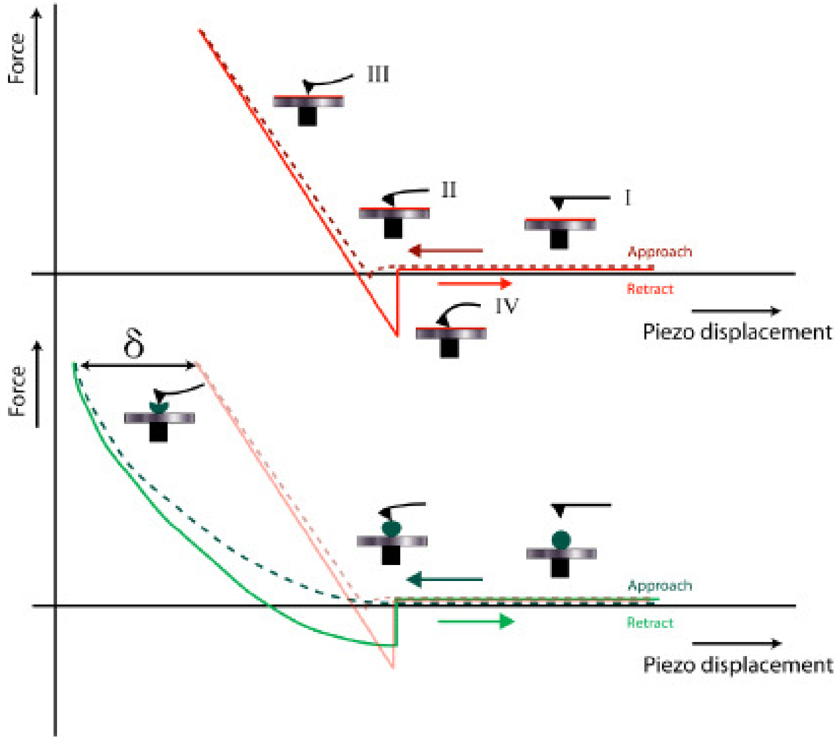
$$F = \frac{4}{3} \cdot \frac{E_s}{1-\nu_s^2} \cdot \sqrt{r} \cdot \delta^{\frac{3}{2}}$$

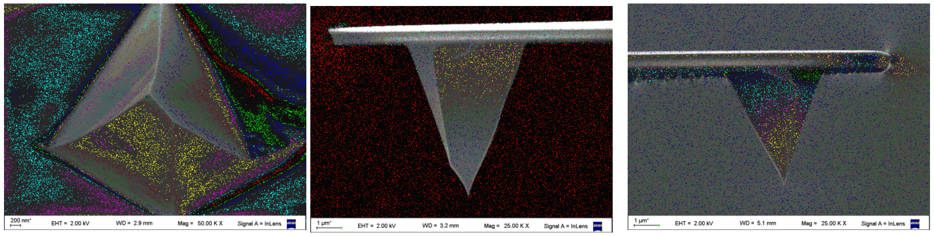
Hertz Model

$$F = \frac{2}{\pi} \cdot \frac{E_s}{1-\nu_s^2} \cdot \tan\alpha \cdot \delta^2$$

Sneddon Model







SNL - Bruker