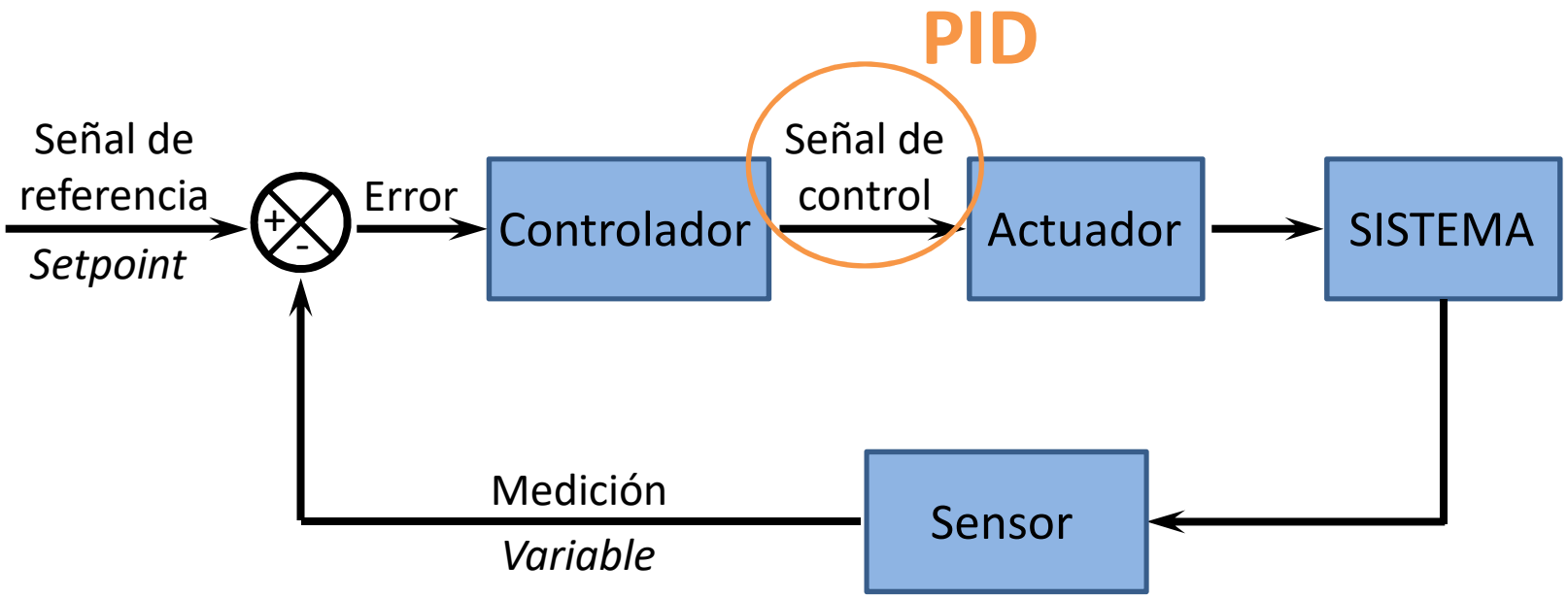
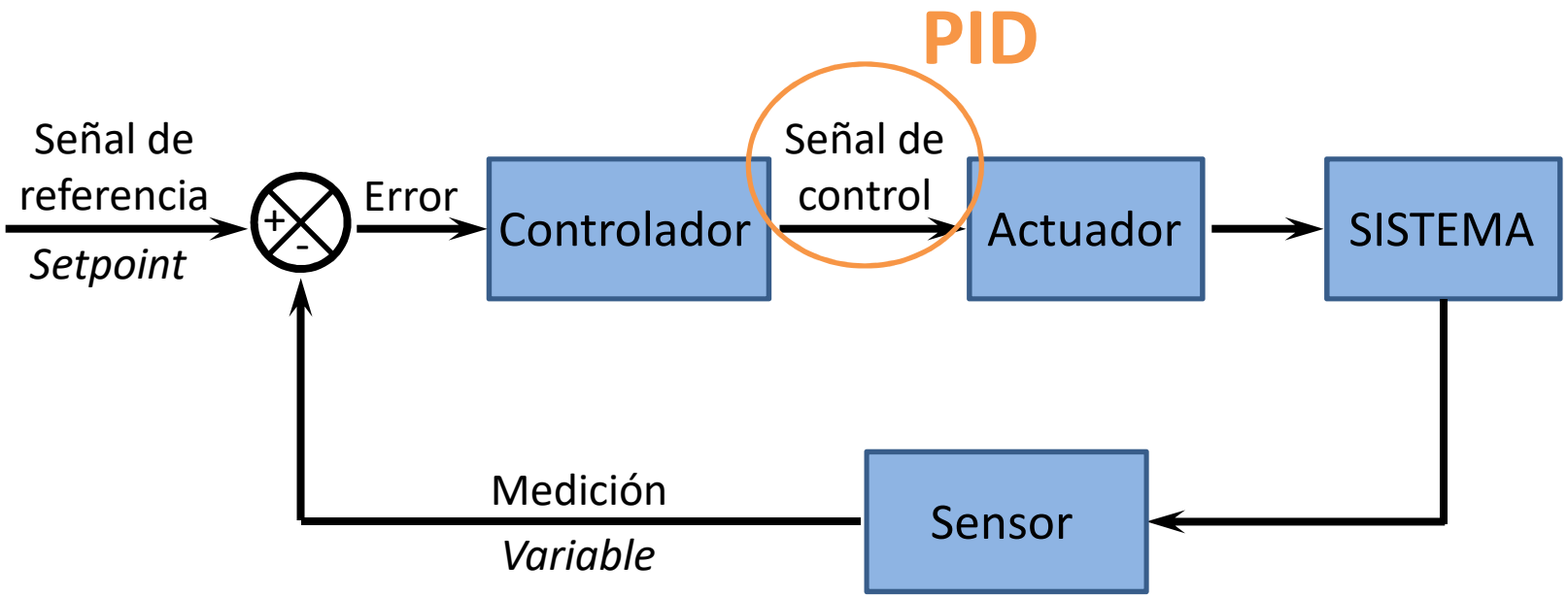
Lazo de realimentación PID (en AFM)

Laboratorio 5 – Abril 2017

Lazo de Control



Lazo de Control



Error

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

Señal de control PID

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

integral

proporcional

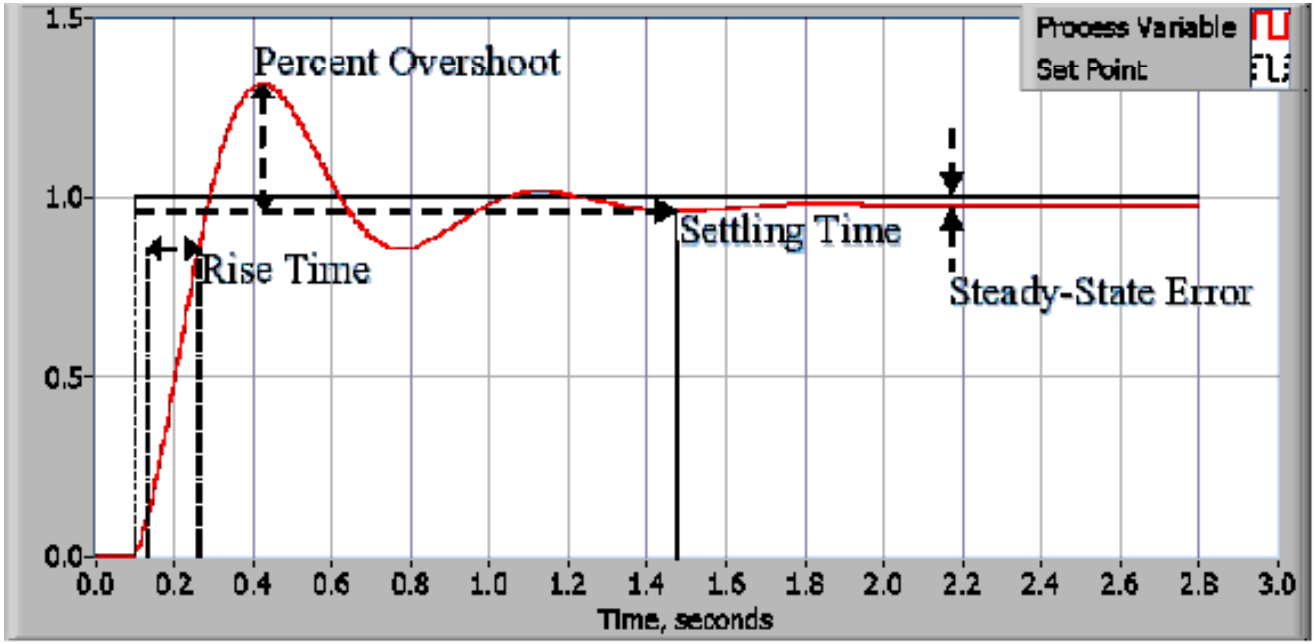
derivativo

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/

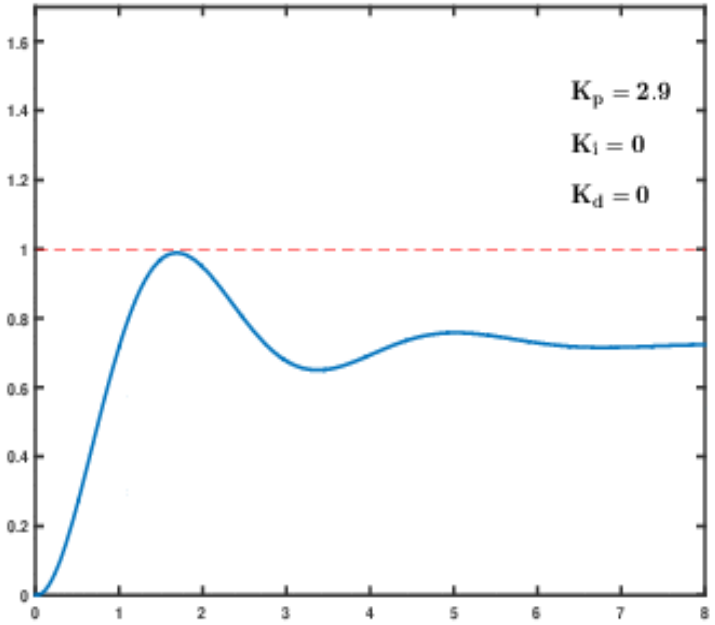
Señal de control PID

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

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

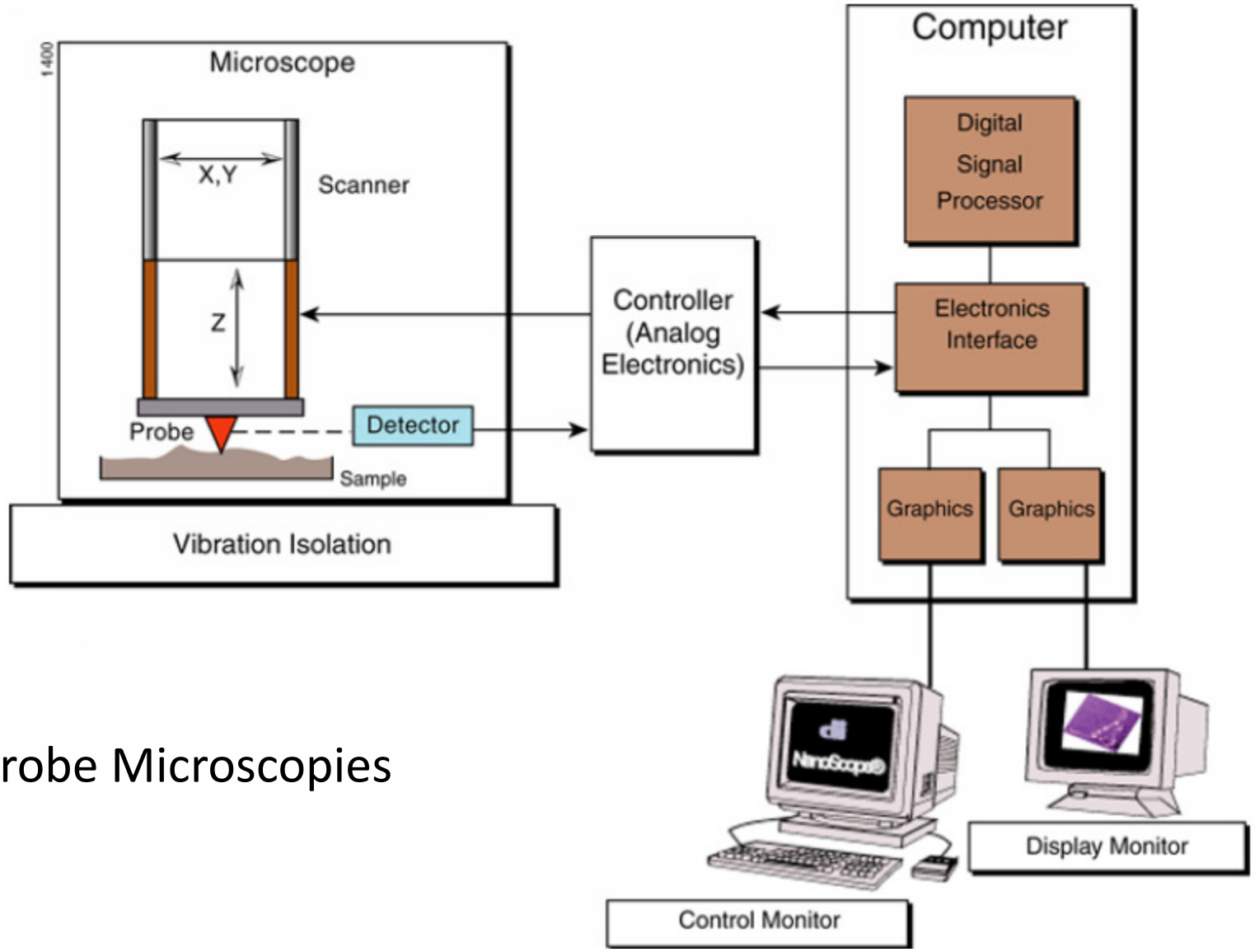
- **Integral:** suma el error en el tiempo. Mayor K_I mejora el steady state error (*Windup*)

- **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

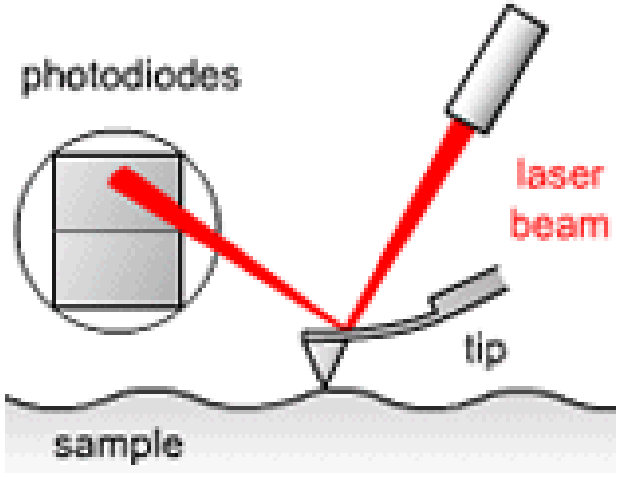
SPM

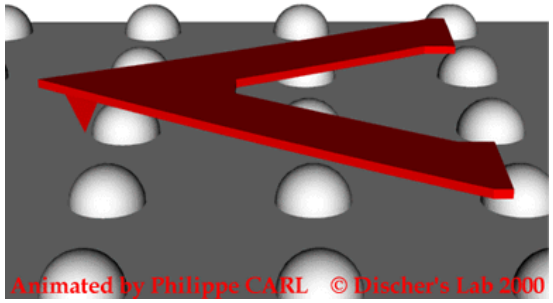


Scanning Probe Microscopies

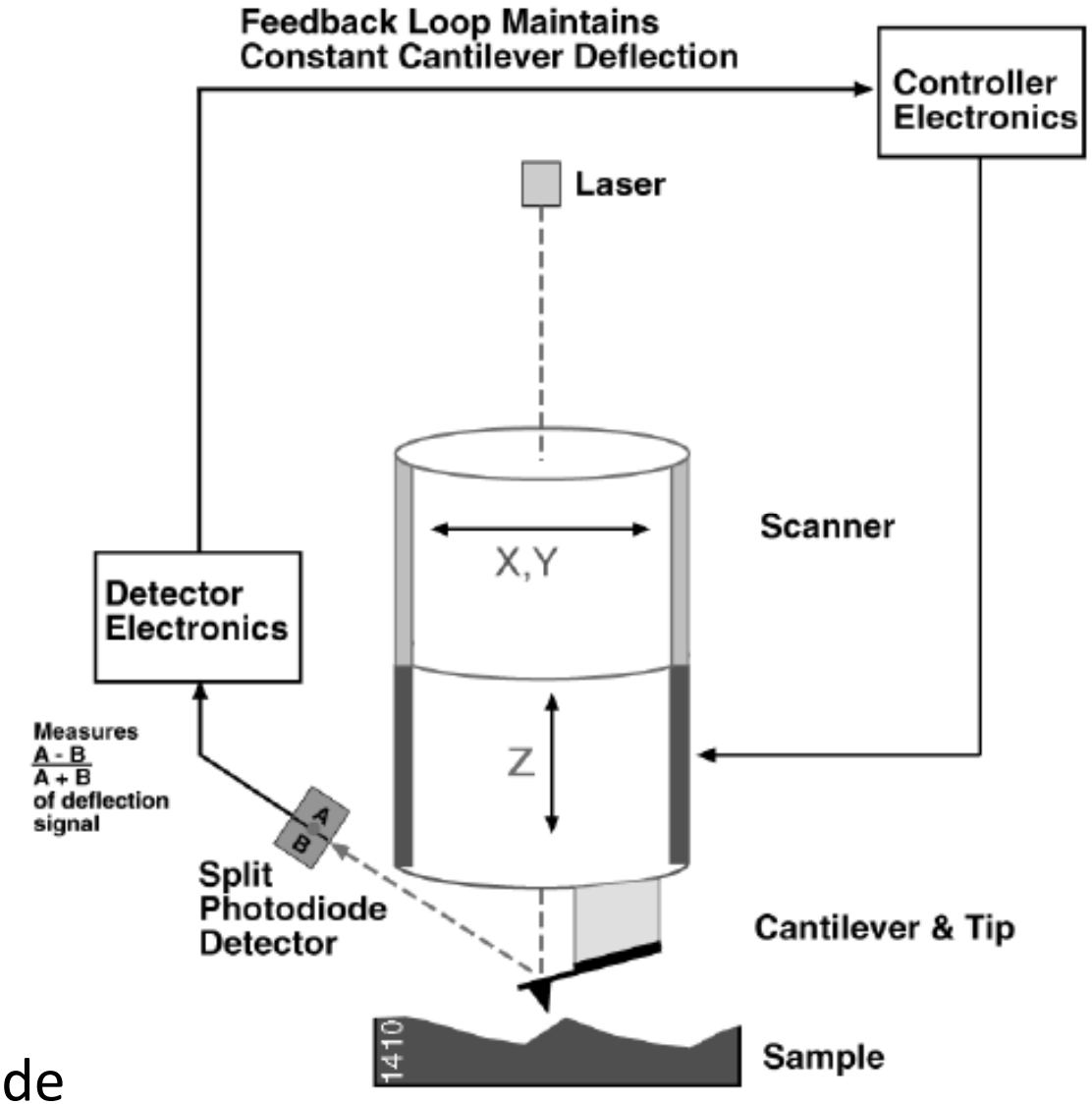
Scanning Probe Microscopy Training Notebook

AFM



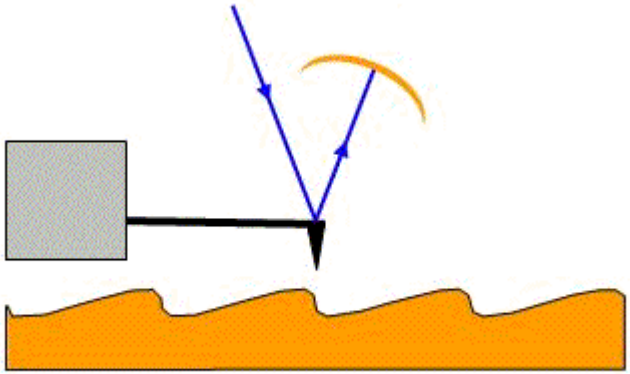


http://perso.univ-lemans.fr/~bardeau/IMMM-PEC/afm

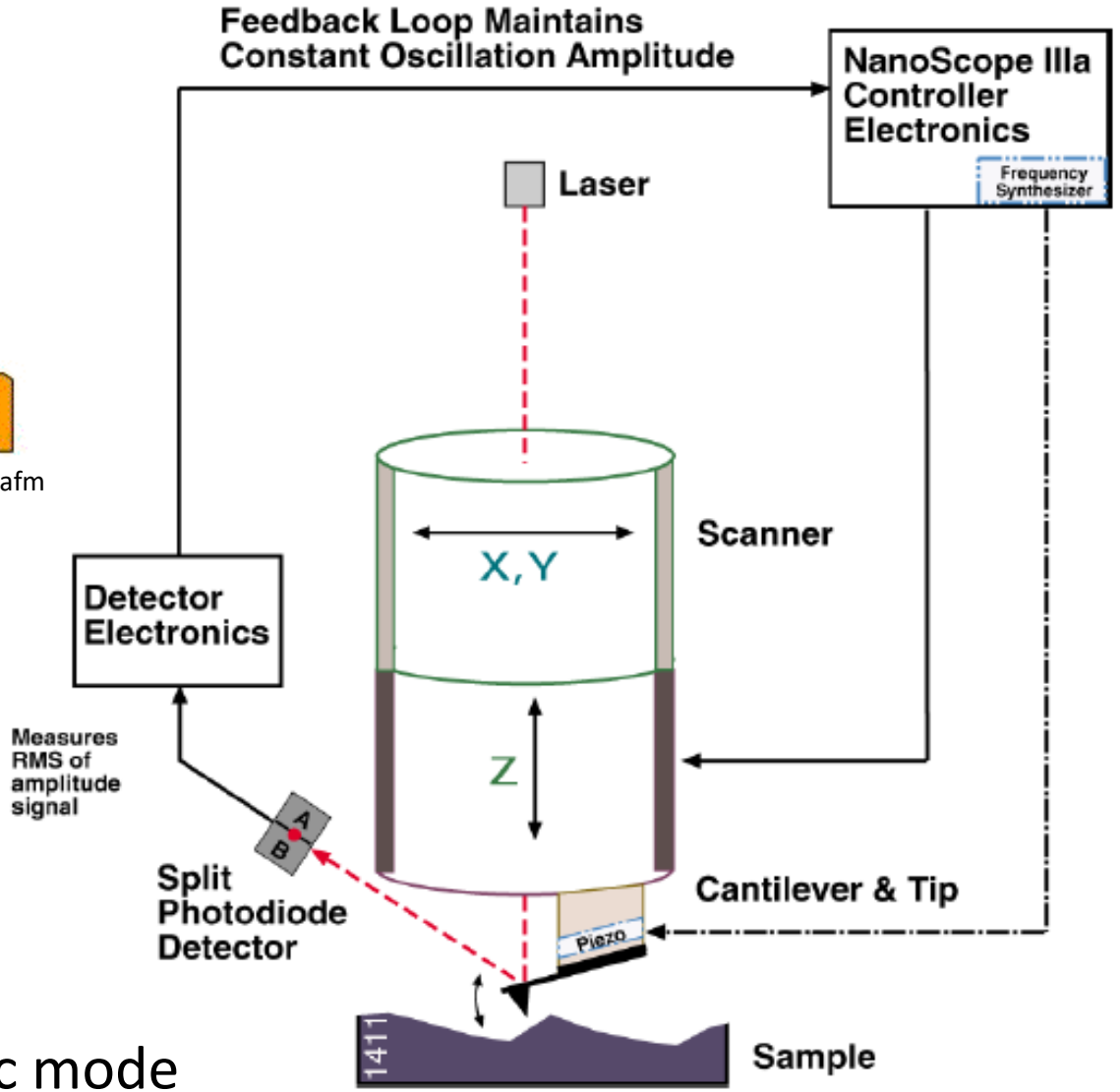


Contact mode / Static mode

AFM



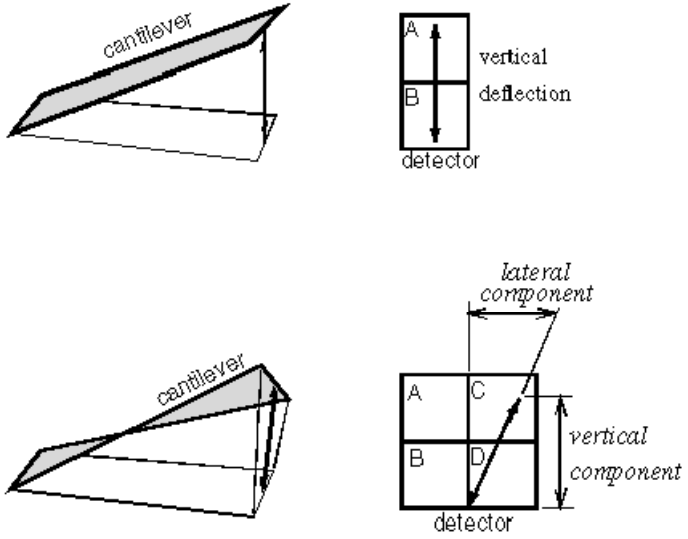
http://perso.univ-lemans.fr/~bardeau/IMMM-PEC/afm



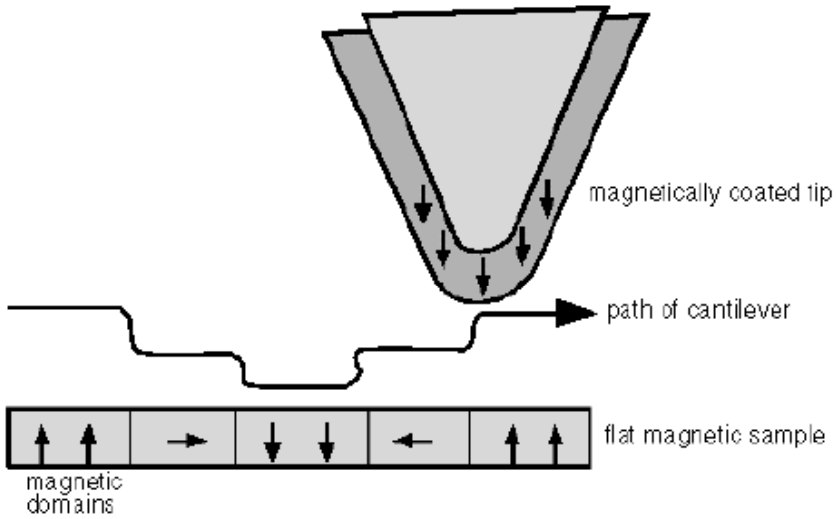
Tapping mode / Dynamic mode

AFM

Otros modos de imaging

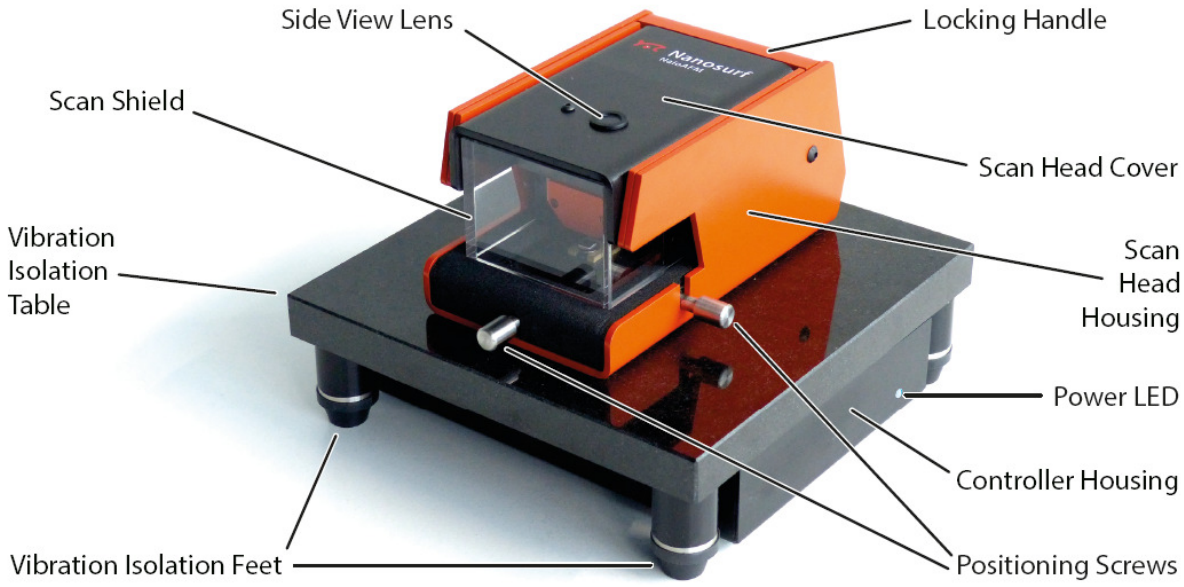


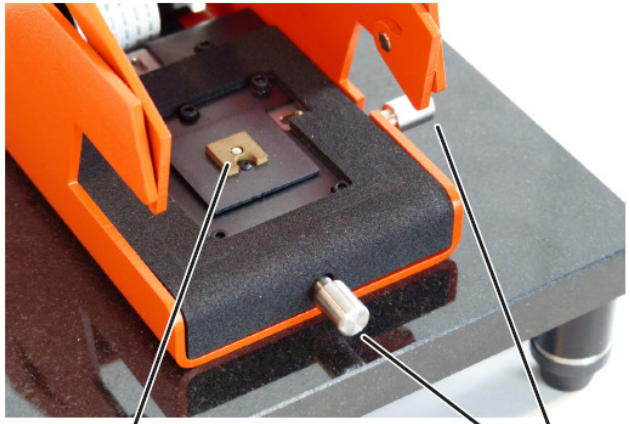
Lateral force
(Friction images)

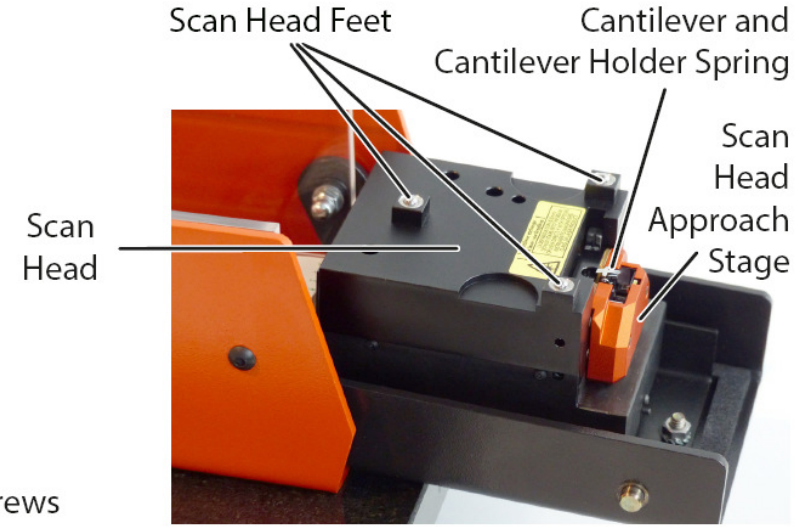


Magnetic Force Microscopy

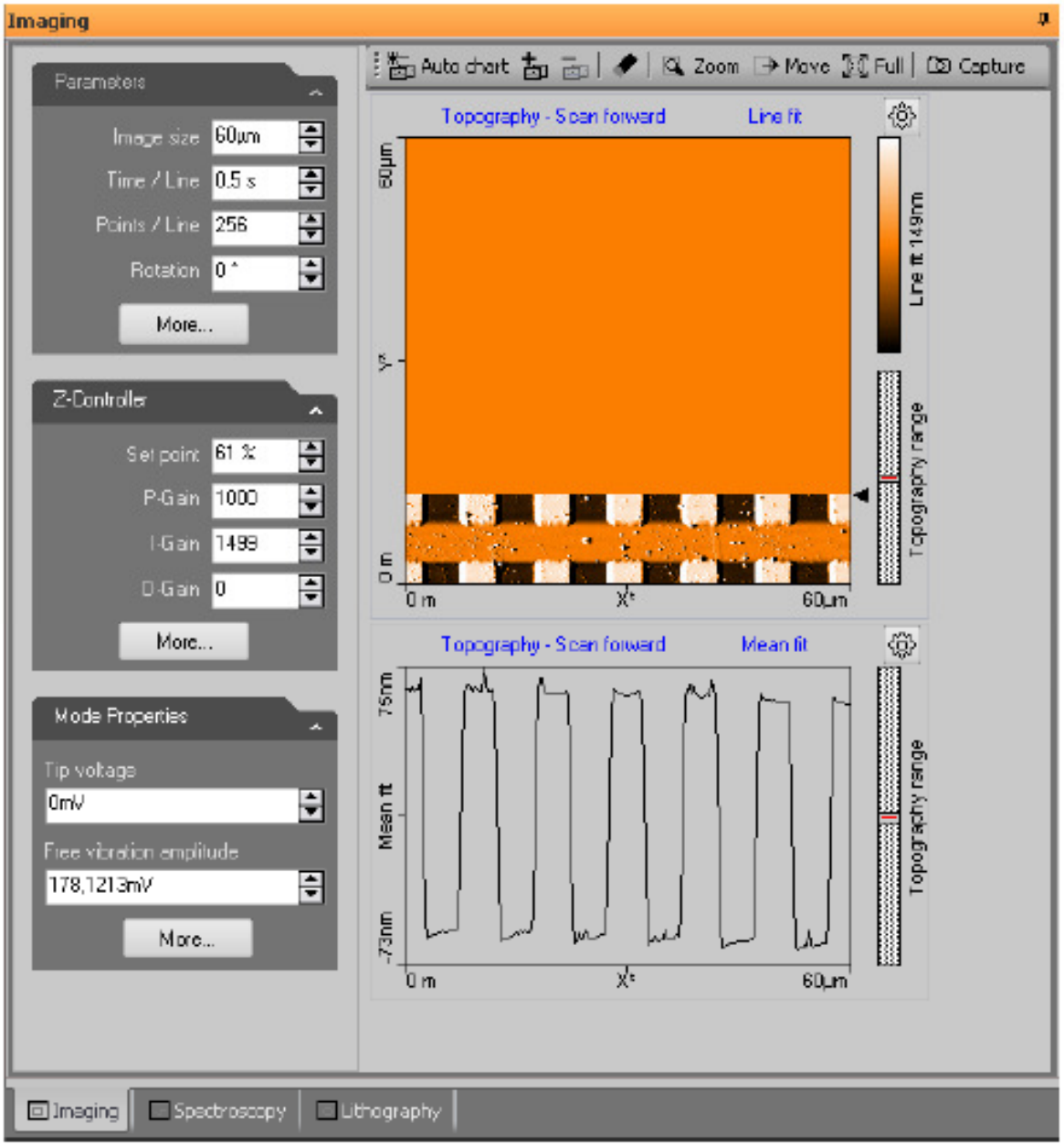
AFM



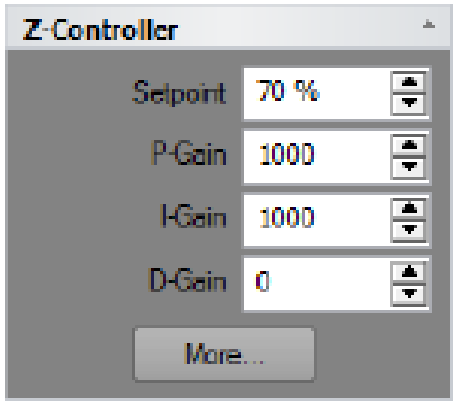




Nanosurf NaioAFM



Z-controller section



Set point (%)

P - Gain

I - Gain

D - Gain

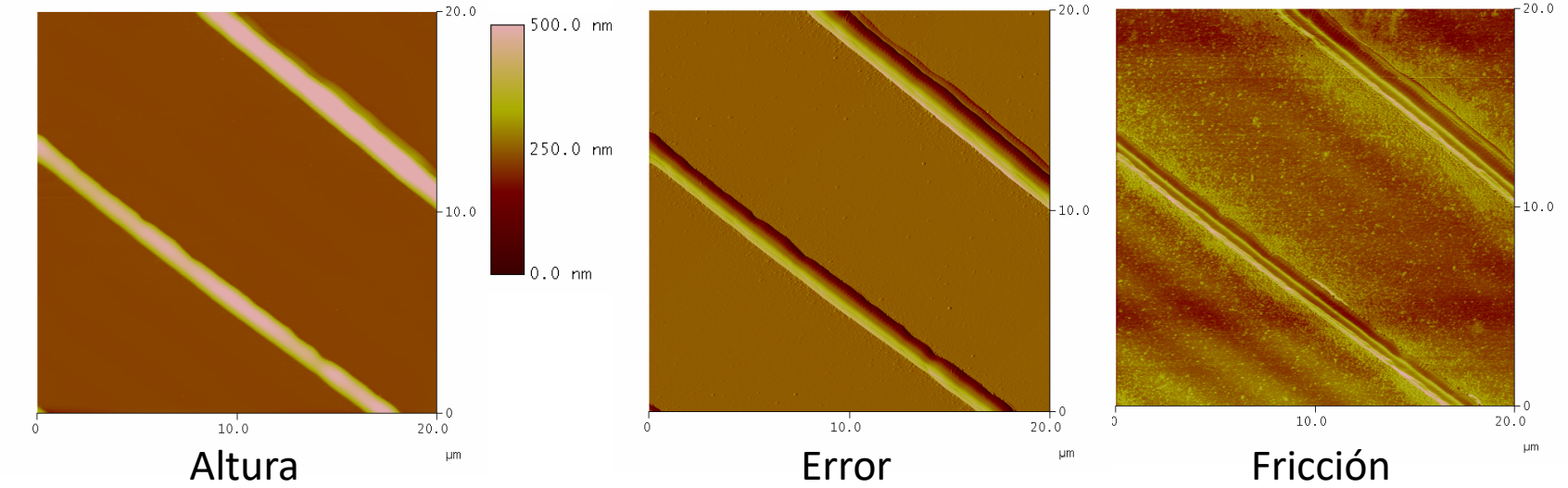
- *El Setpoint y las ganancias se ajustan optimizando la imagen.*
- *La vista de perfiles permite ver el ruido.*

Nanosurf NaioAFM

Distintos tipos de imagen en cada modo

Litografía de polímeros sobre vidrio

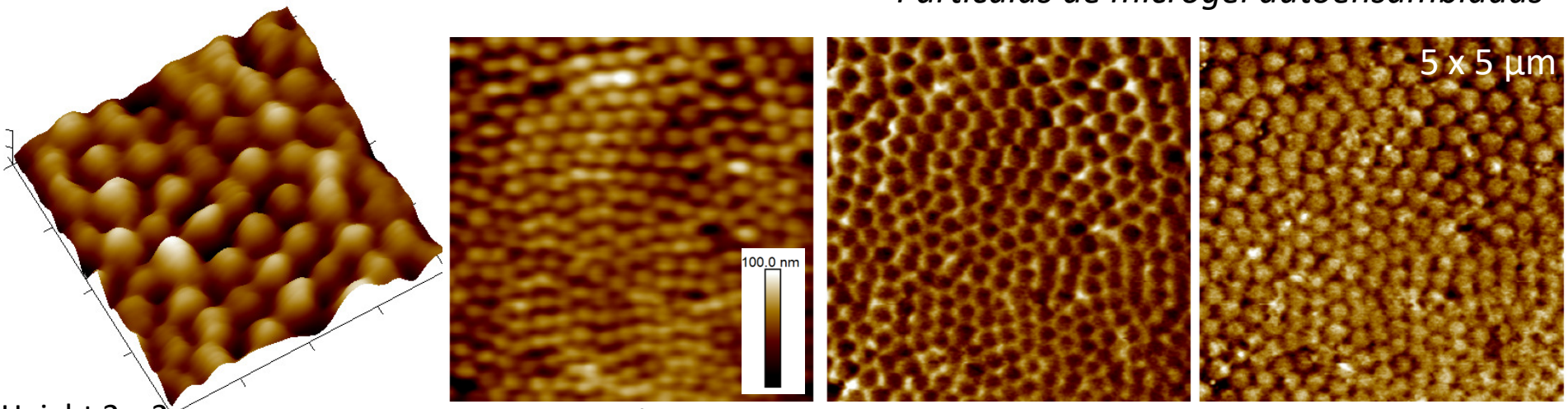
Estático



Altura | Error | Fricción

Dinámico

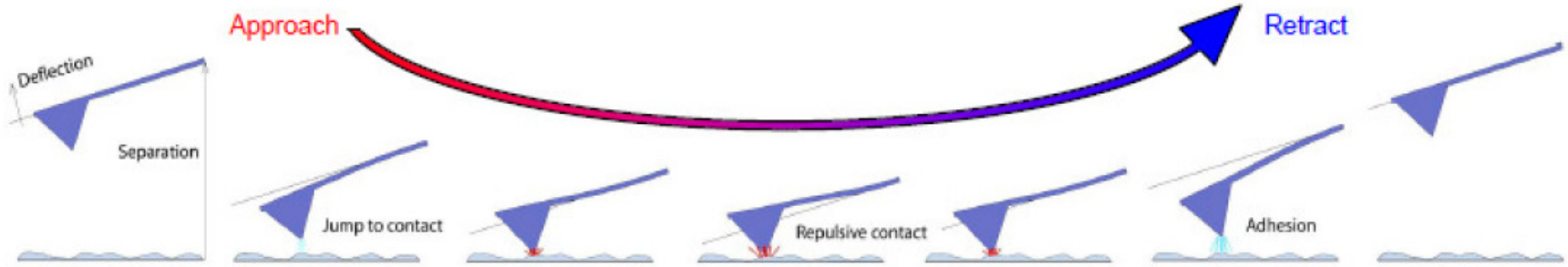
Partículas de microgel autoensambladas

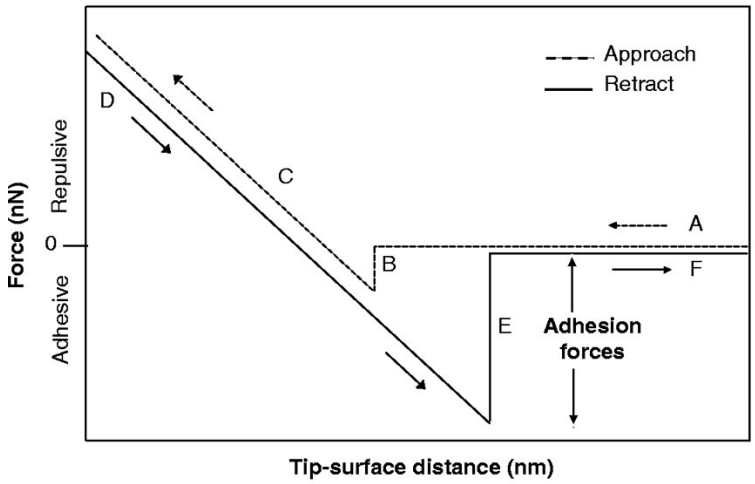


Height 2 x 2 µm
(z scale 60 nm)

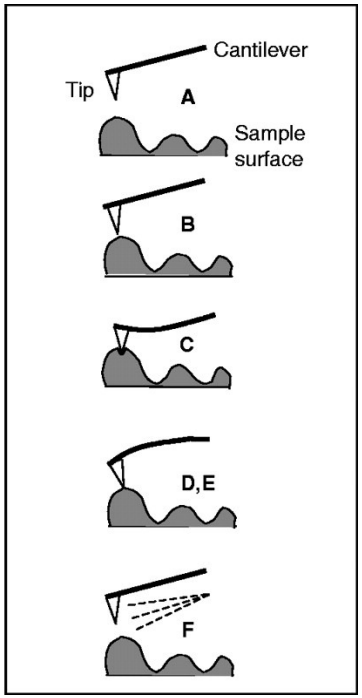
Height | Amplitude | Phase

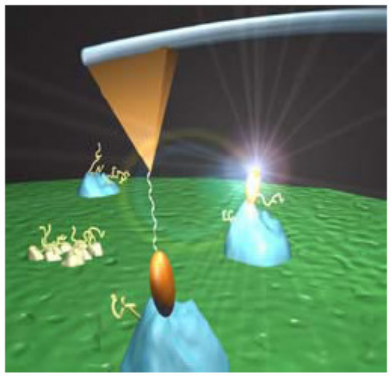
Espectroscopía: curvas de fuerza

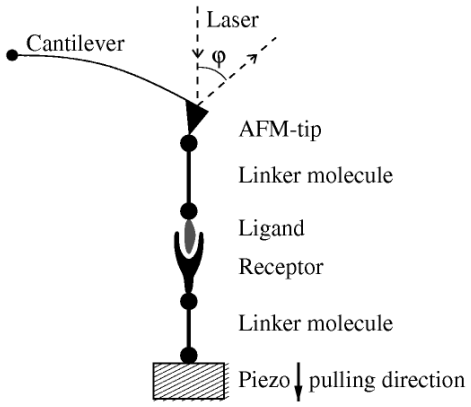




Shahin, V. et al. J Cell Sci 2005;118:2881-2889





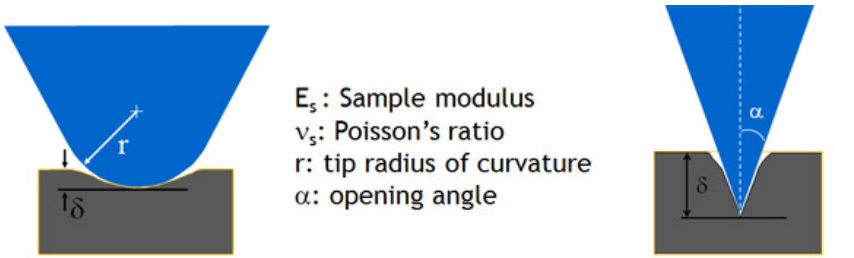


La deflexión puede traducirse a fuerza

$$F = -k.x$$

constante elástica del cantilever

Propiedades nanomecánicas



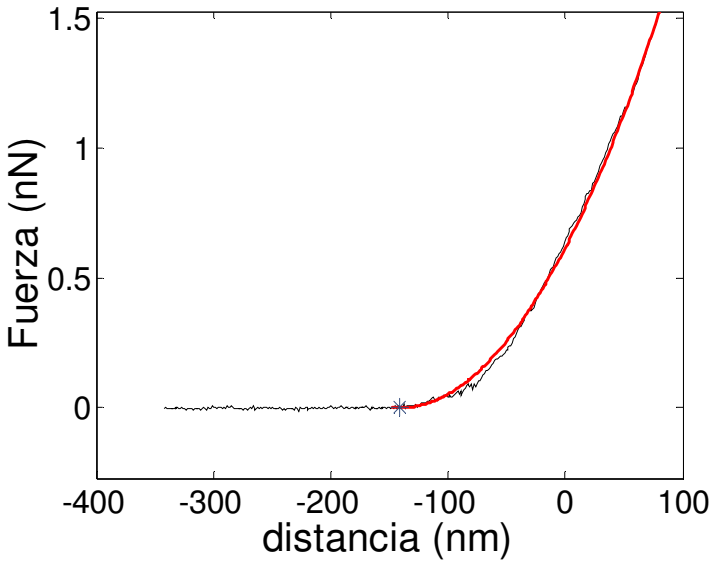
E_s: Sample modulus
ν_s: Poisson's ratio
r: tip radius of curvature
α: opening angle

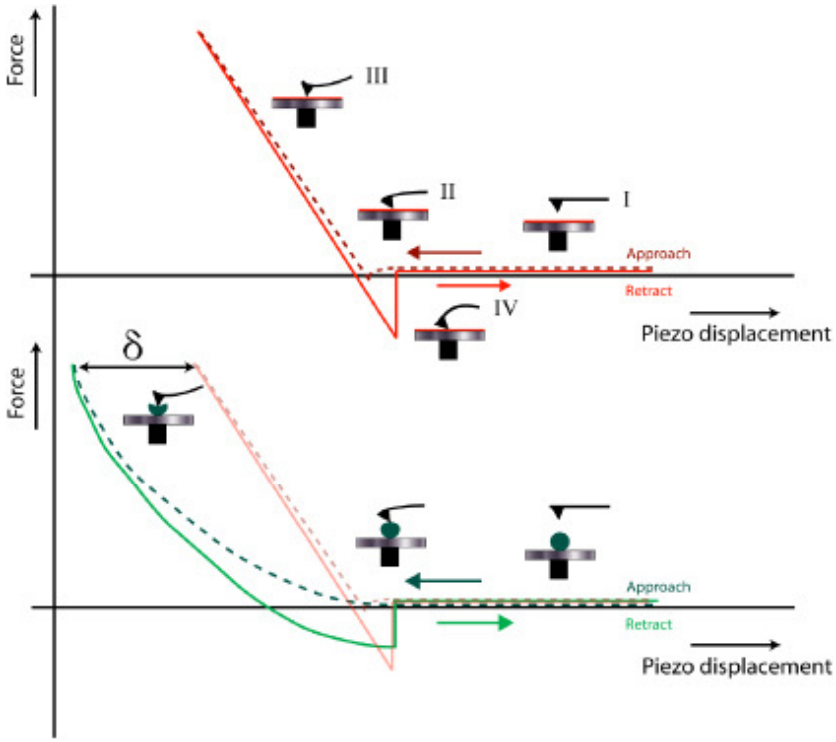
$$F = \frac{4}{3} \cdot \frac{E_s}{1-\nu_s^2} \cdot \sqrt{r} \cdot \delta^{\frac{3}{2}}$$

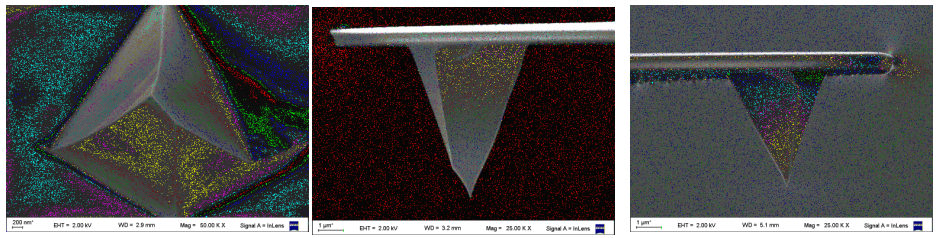
Hertz Model

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

Sneddon Model



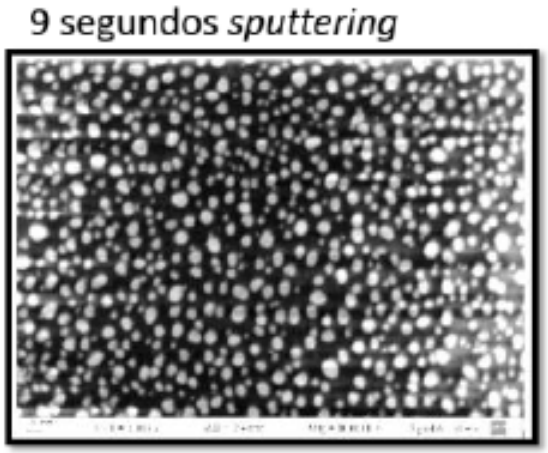




SNL - Bruker

Nanofabricación

- Sputtering metálico



- Síntesis de nanopartículas de plata

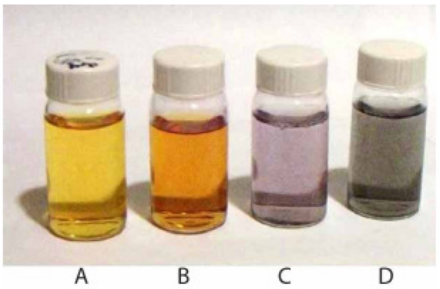


Figure 1. Colloidal silver in various stages of aggregation, (A) clear yellow sol, (B) dark yellow sol, (C) violet sol , and (D) grayish sol, as aggregation proceeds.

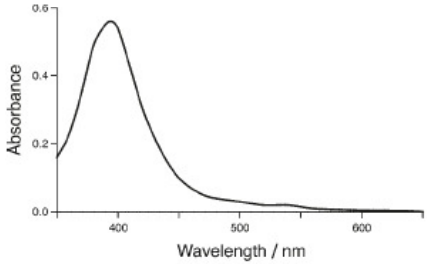
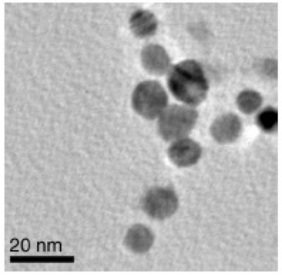


Figure 2. UV–vis absorption spectrum of clear yellow colloidal Ag.

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

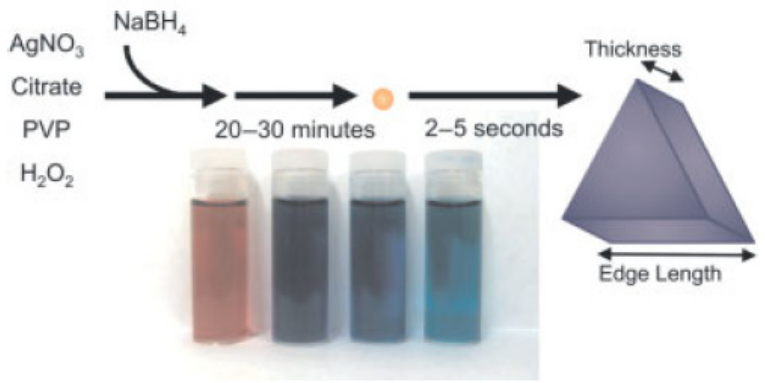
[a][AgNO3] is constant at 1.0 mM.



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

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 $NaBH_4$).

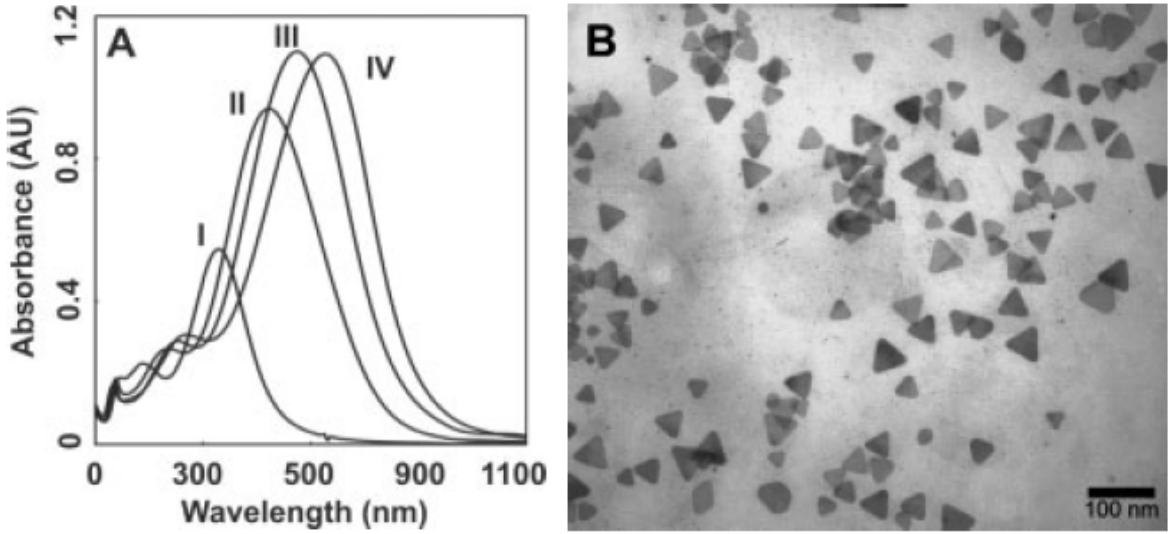


Figure 1. A) UV–vis spectra of nanoprism colloids with various $NaBH_4$ concentrations ($[H_2O_2] = 20$ mM). I) 0.30 mM, II) 0.50 mM, III) 0.67 mM, and IV) 0.80 mM. B) TEM image of Ag nanoprisms ($[H_2O_2] = 20$ mM, $[NaBH_4] = 0.80$ mM).