Estudios Ópticos en el Procesamiento de Películas Delgadas

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I Taller Internacional de Ciencia de Materiales
Universidad Autónoma de Puebla
Instituto de Física "Luis Rivera Terrazas"
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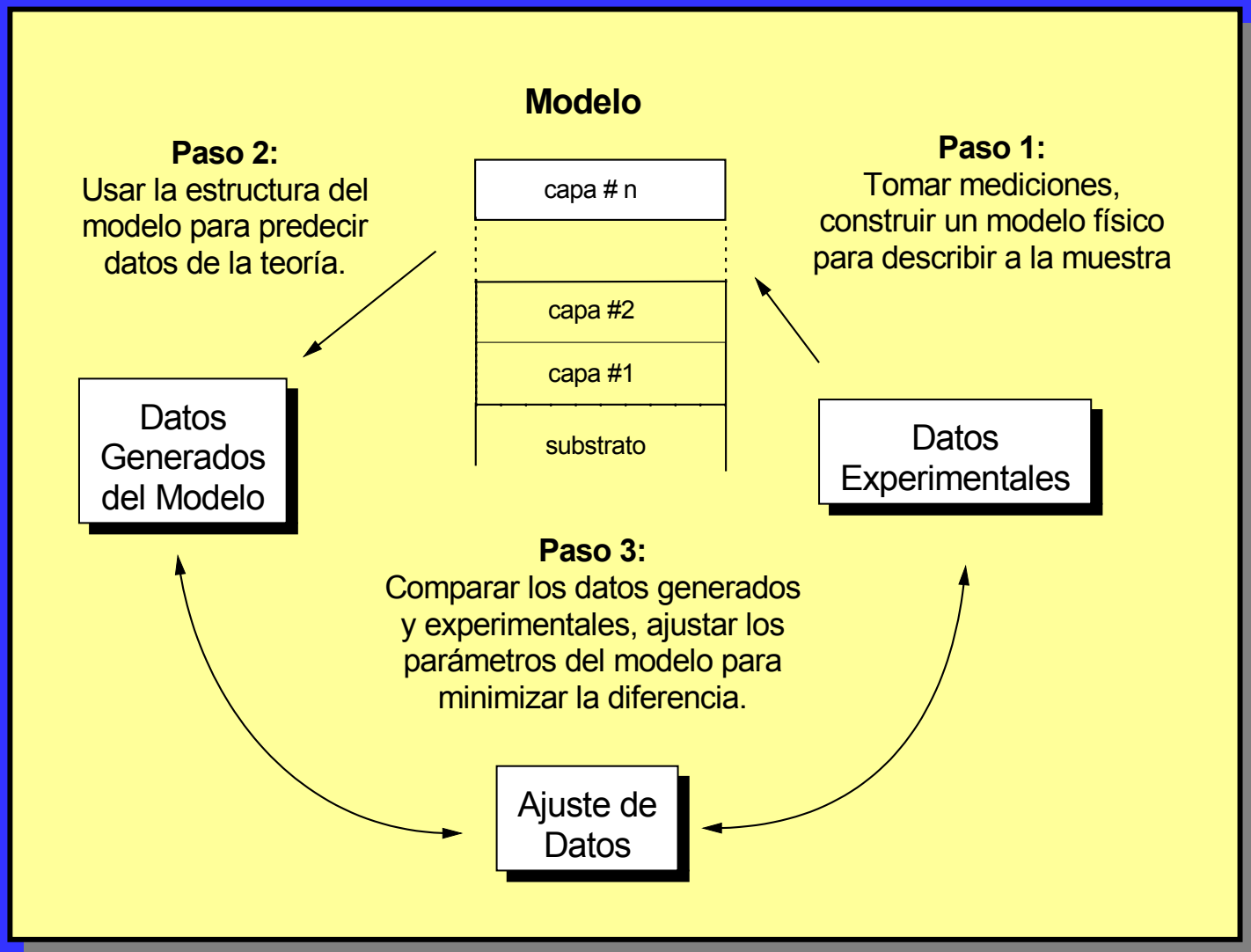
Contenido:

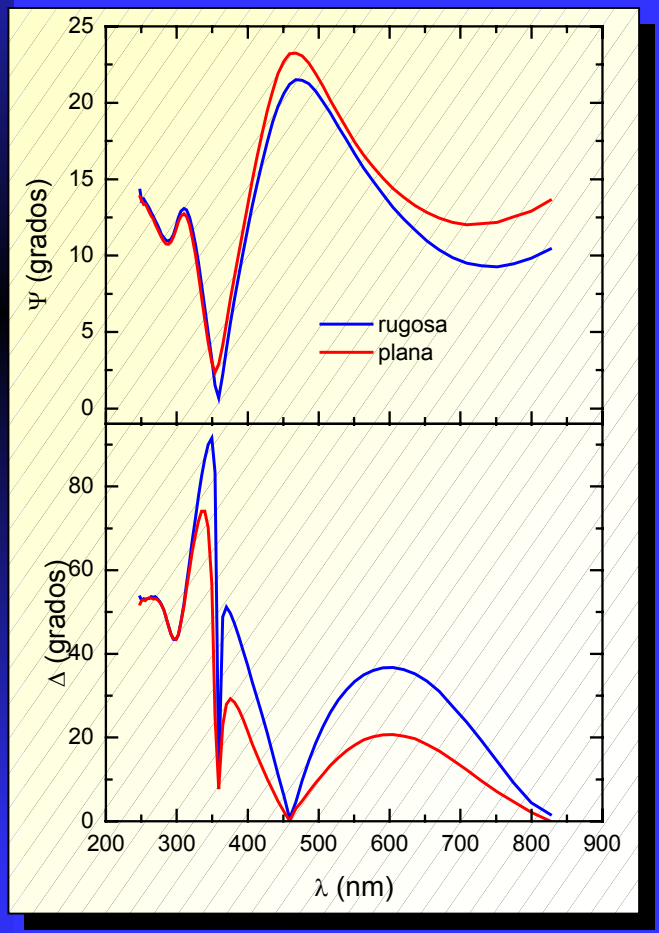
1. **ITO: Efecto de la temperatura de tratamiento.** ***Cuauhtémoc Trejo (M) y Miguel Gracia (IFUAP).***
2. **Co-SiO_2: Efectos de composición y temperatura de tratamiento.** ***Alicia Ramos (M) y Hugo Tototzintle (M).***
3. **Ni-SiO_2: Efectos de composición y temperatura de tratamiento.** ***Julián Hernández (D).***
4. **Oxidación de Ni.** ***Ana María López (D).***

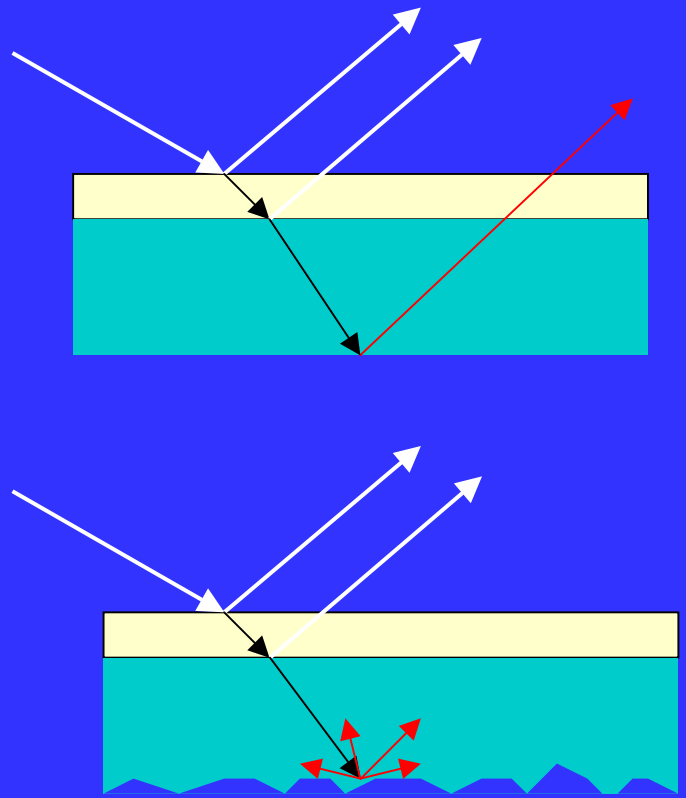
Análisis de Datos



Ejemplos: Efecto de reflexiones en la cara posterior del substrato sobre las mediciones elipsomètricas.

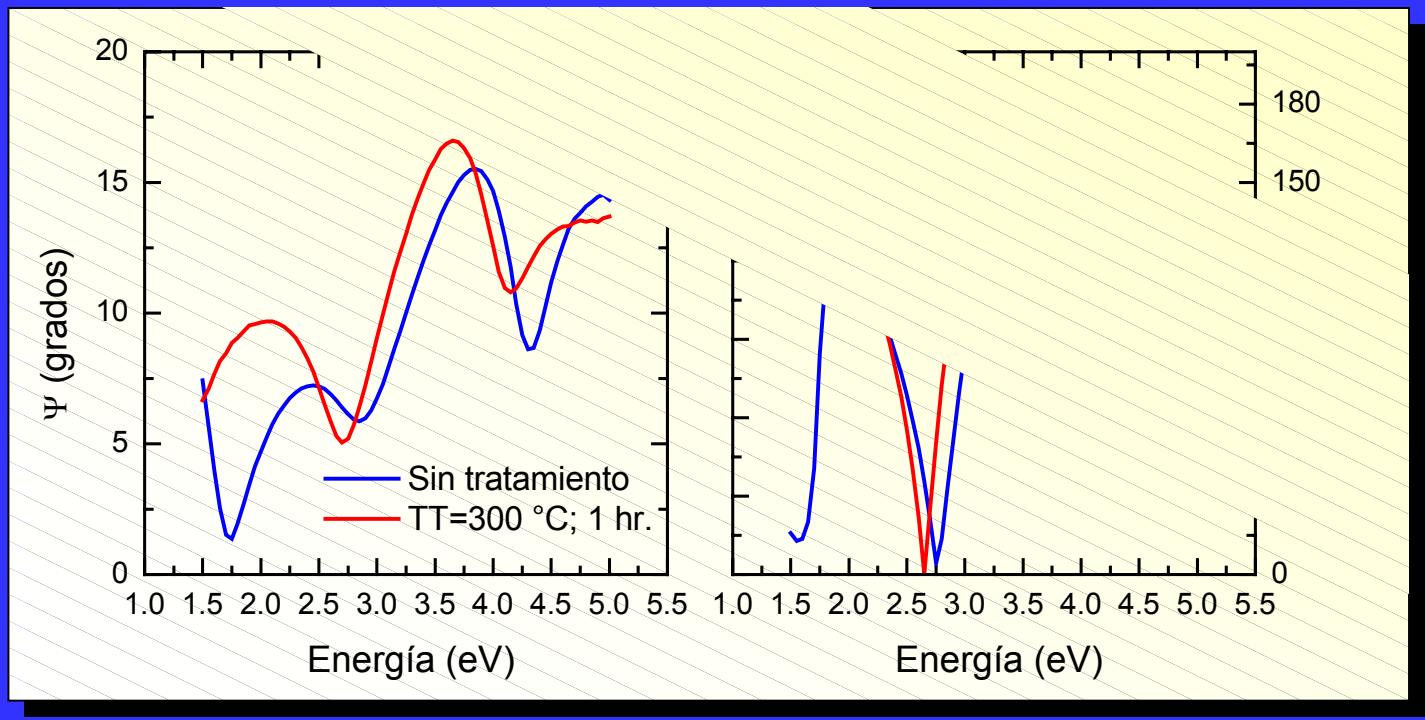
- **Óxido de indio estaño (ITO) sobre vidrio**



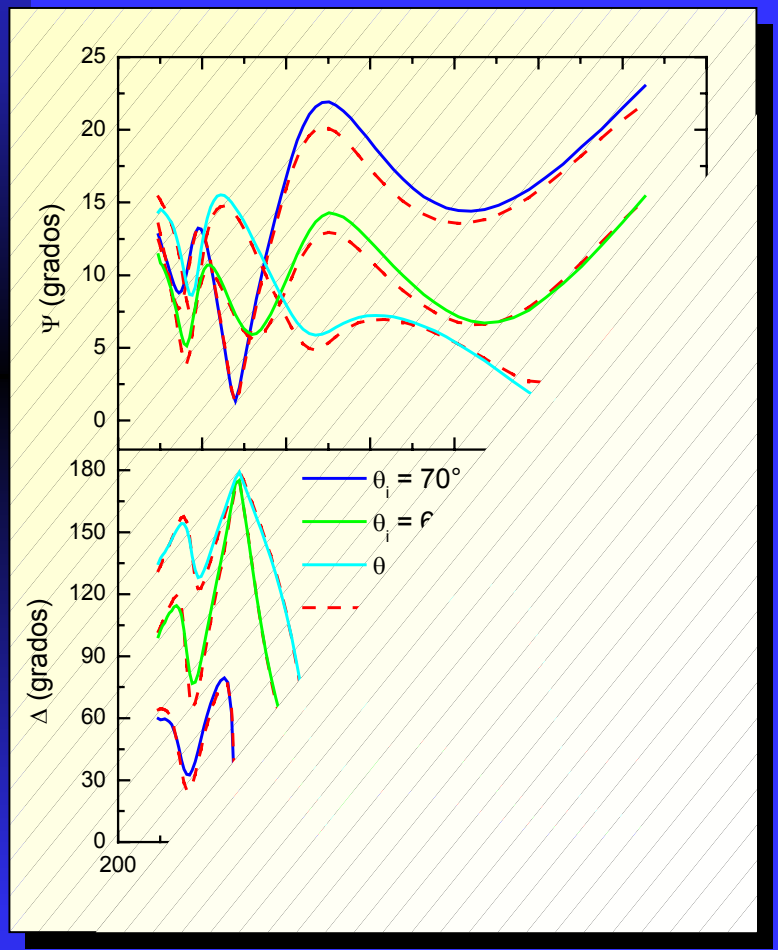


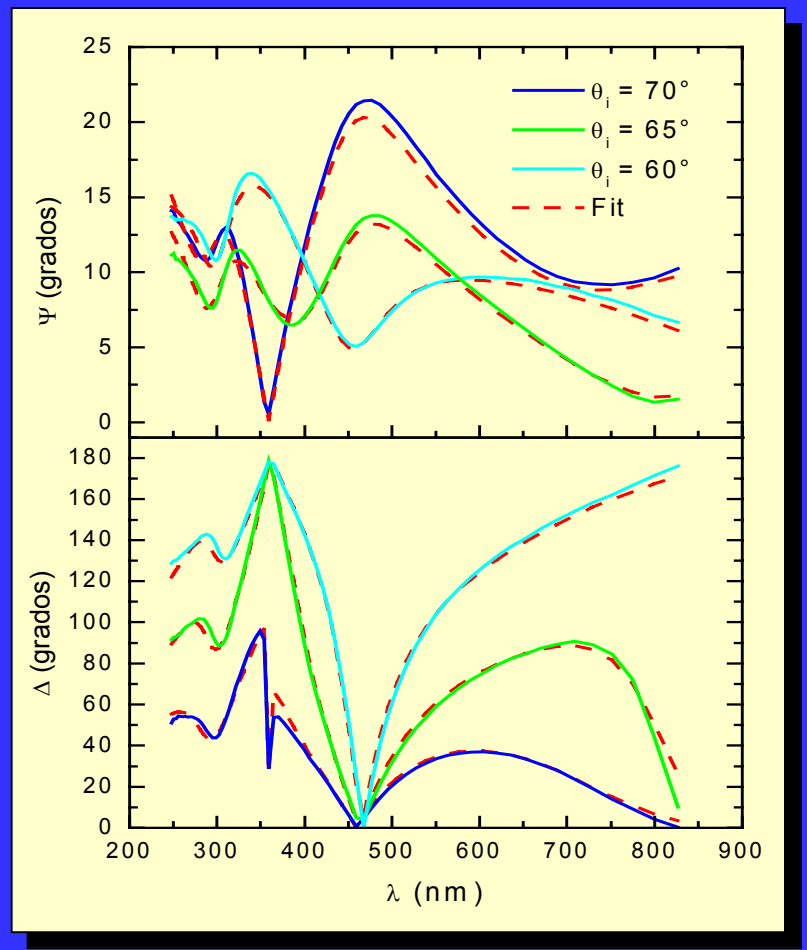
Ejemplos: ITO sobre vidrio

Datos experimentales



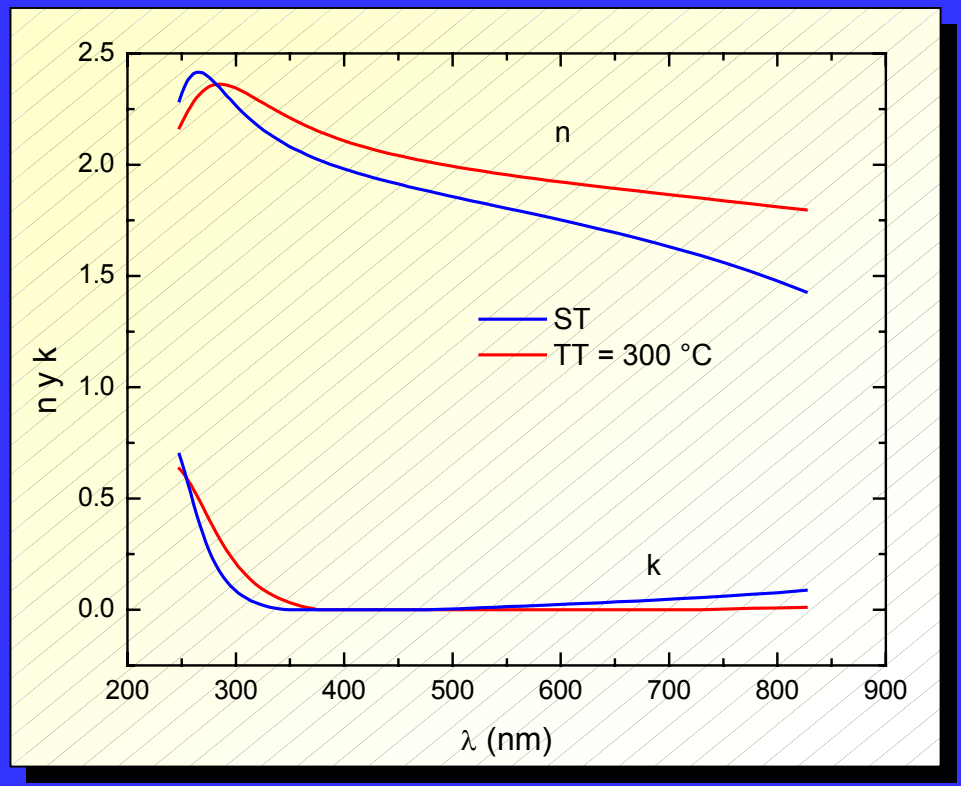
Ajustes para tres ángulos de incidencia





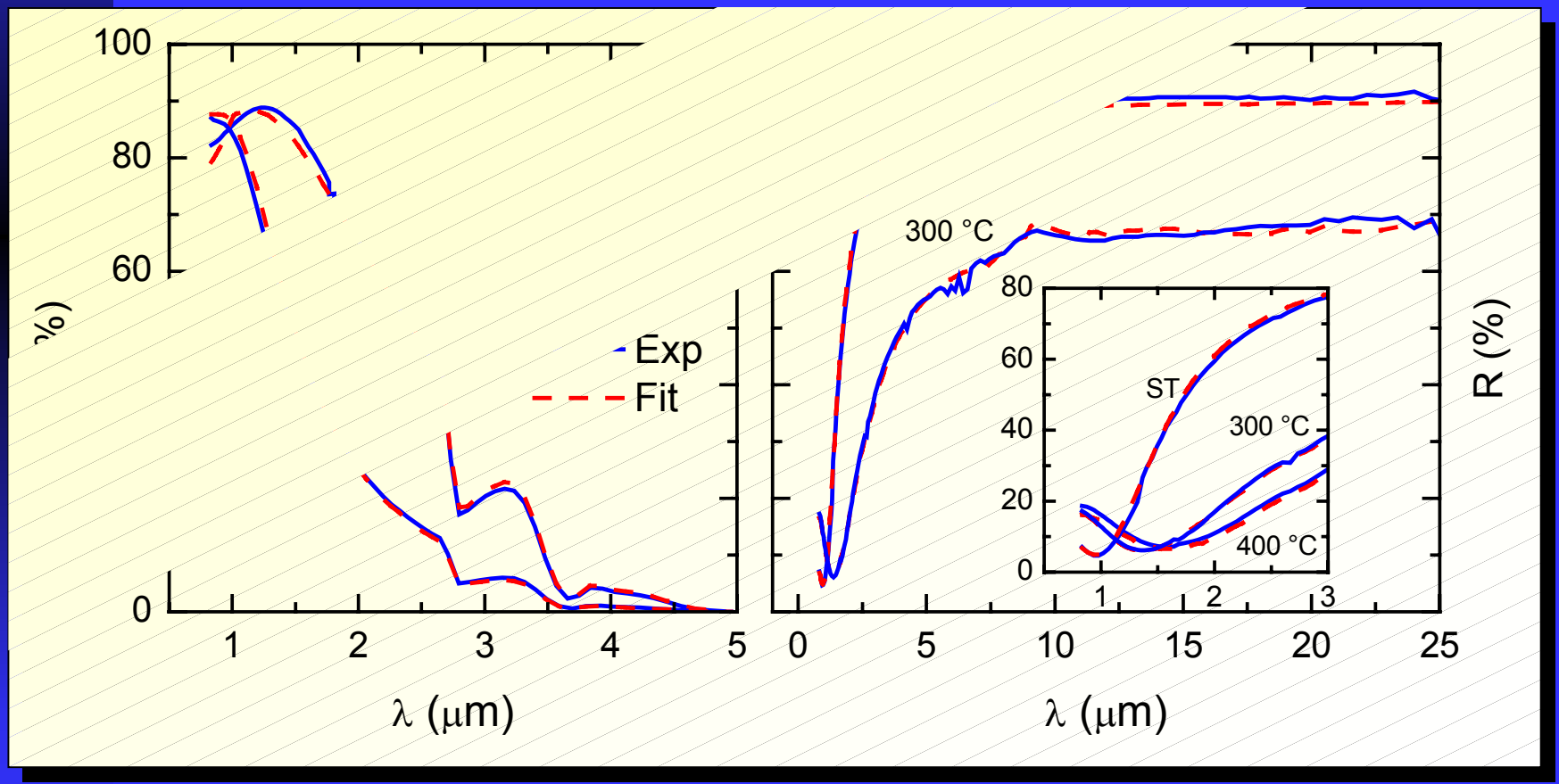
Efecto sobre las constantes ópticas del ITO

Oscilador de Lorentz generalizado

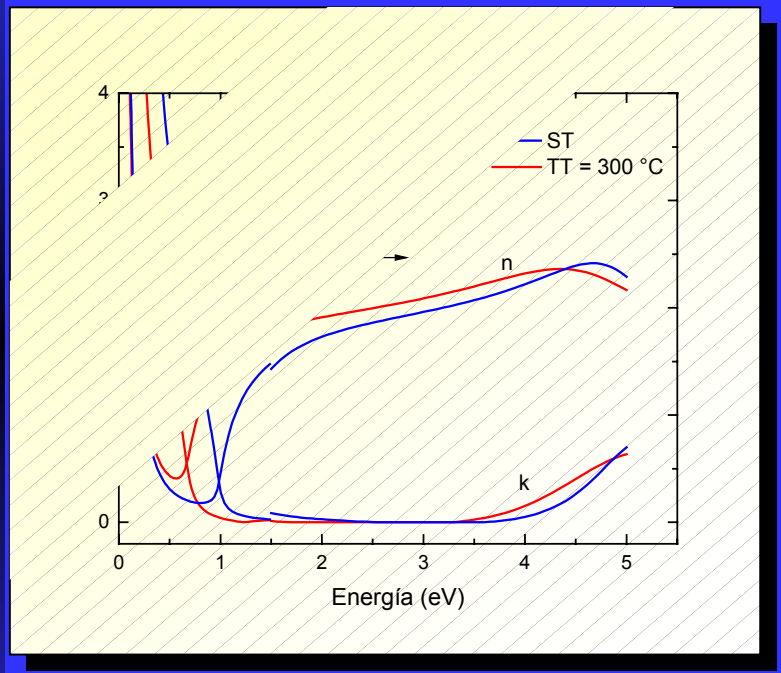


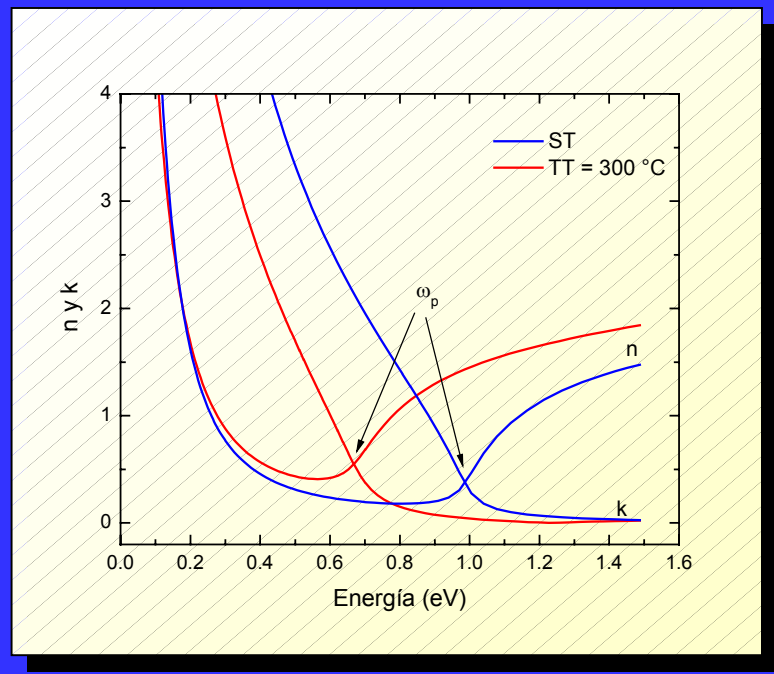
Ajustes de R y T en el infrarrojo

$$\varepsilon(\omega) = \varepsilon_\infty - \frac{\varepsilon_\infty \omega_p^2}{\omega(\omega + i\nu)}; \quad \sigma_{IR} = \frac{\varepsilon_0 \varepsilon_\infty \omega_p^2}{\hbar \nu},$$



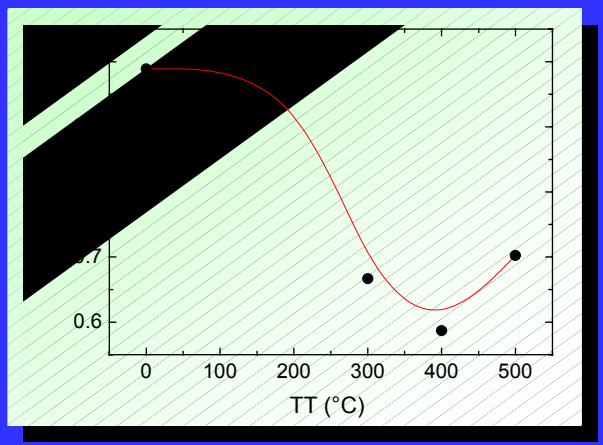
Constantes ópticas del ITO y frecuencia de plasma

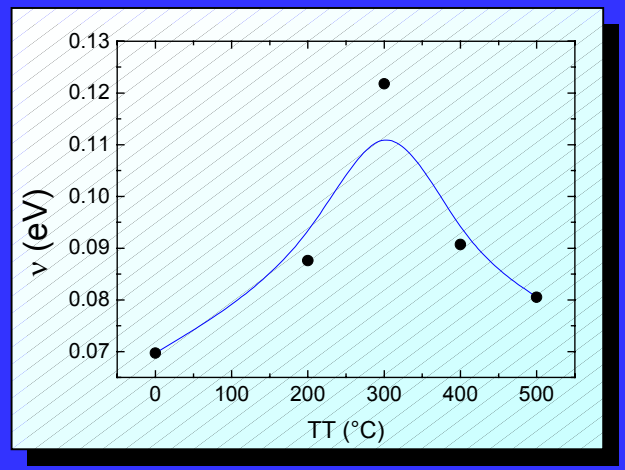


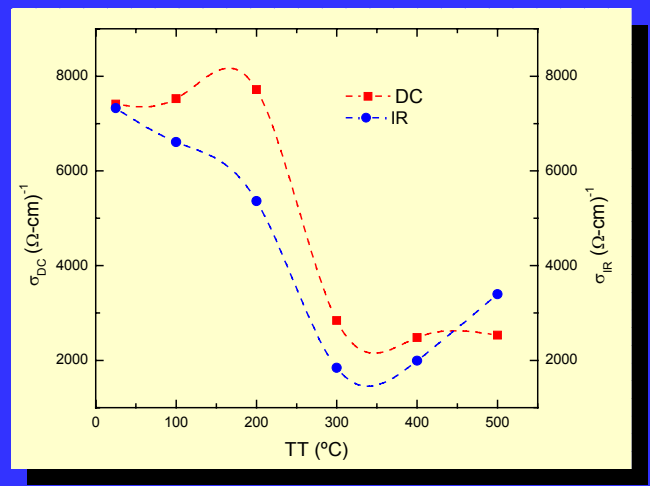


Parámetros de ajuste y conductividad eléctrica

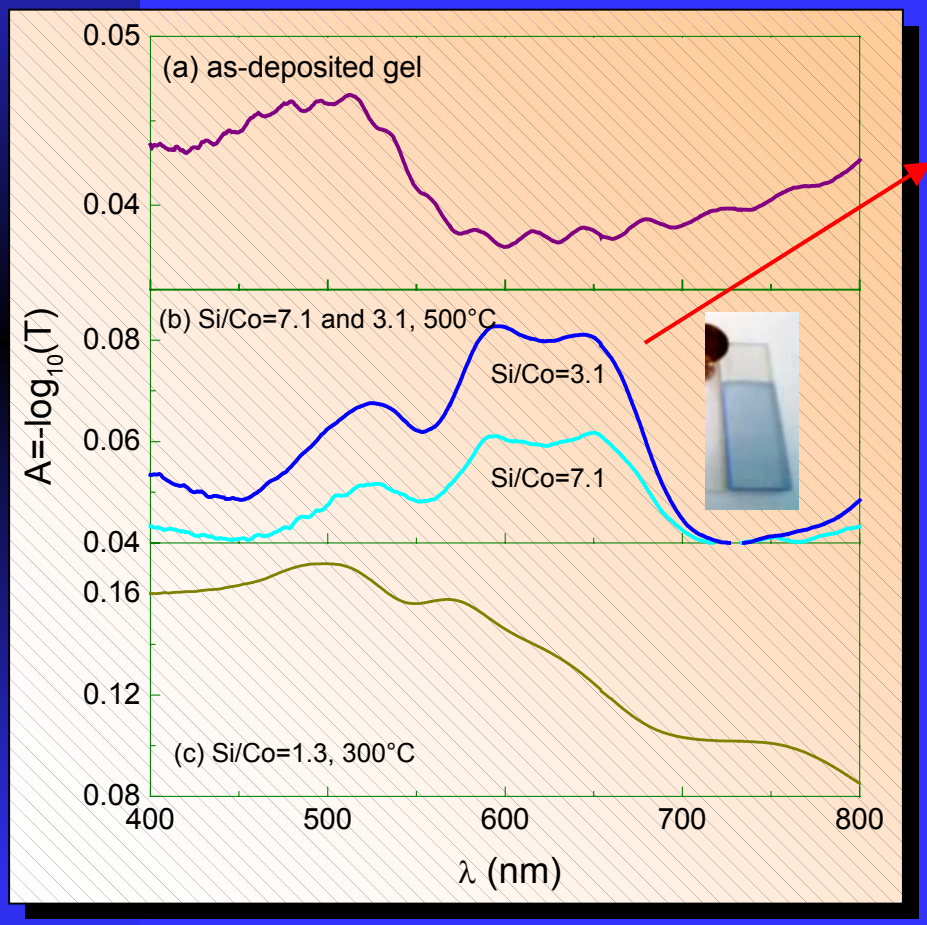
$$\varepsilon(\omega) = \varepsilon_\infty - \frac{\varepsilon_\infty \omega_p^2}{\omega(\omega + i\nu)}; \quad \sigma_{IR} = \frac{\varepsilon_0 \varepsilon_\infty \omega_p^2}{\hbar \nu},$$



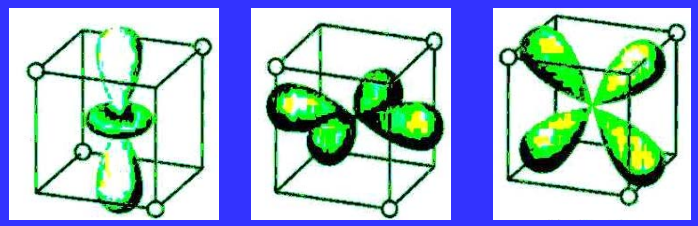




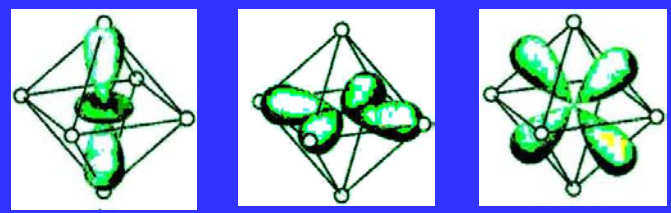
Películas compuestas Co-SiO_2



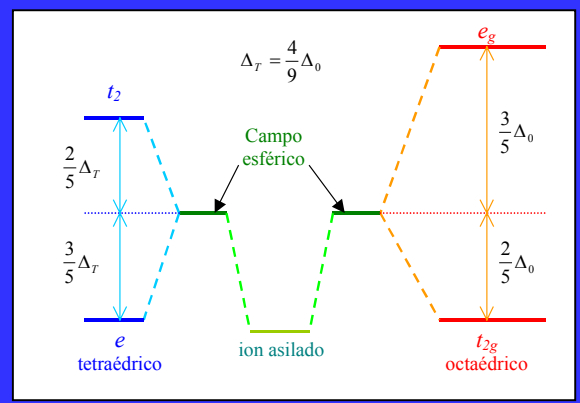
Sitios tetraédricos y octaédricos



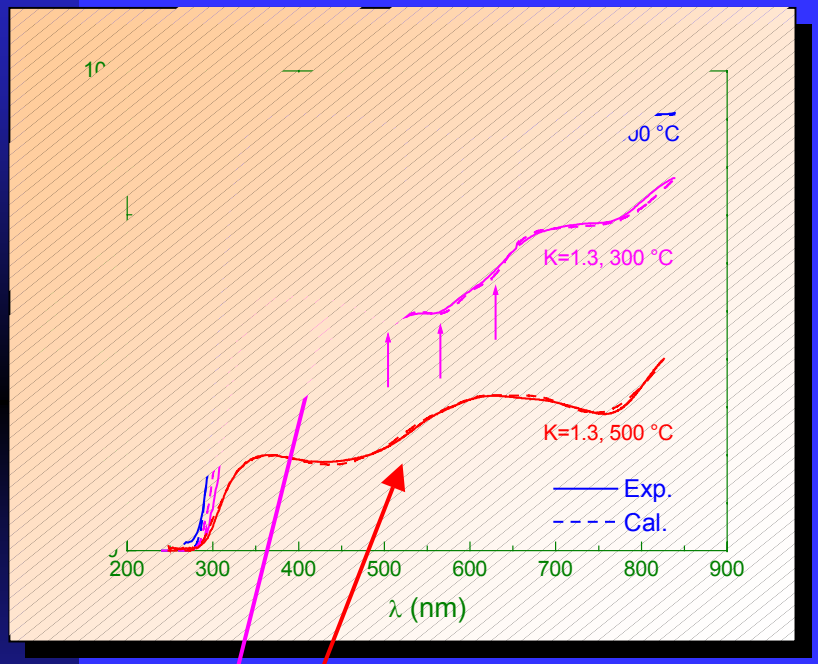
T

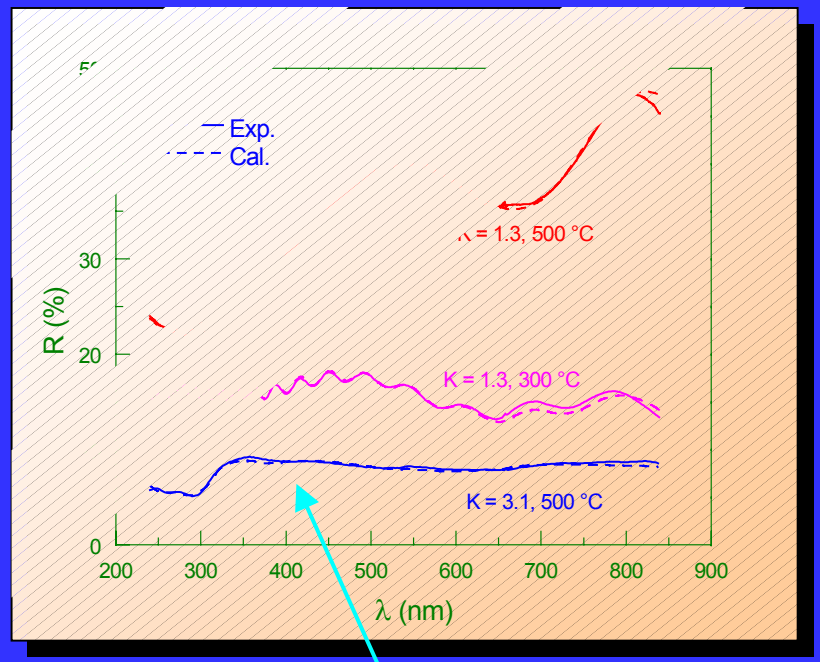


O



Películas compuestas Co-SiO_2

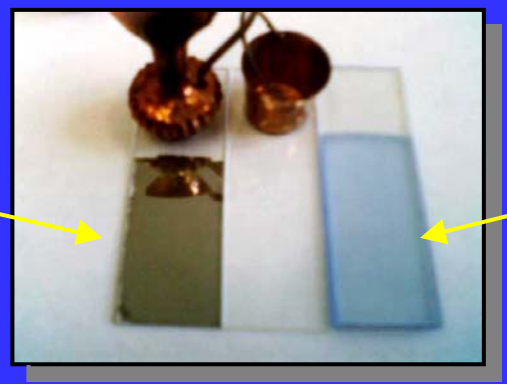




Co_3O_4

SiO_2:Co^{2+}

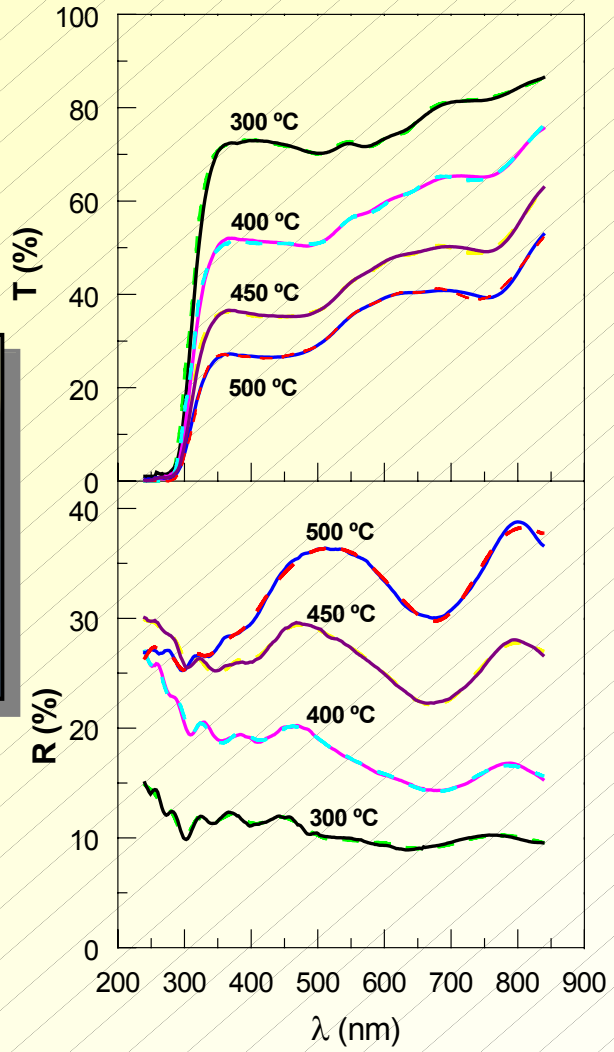
vidrio

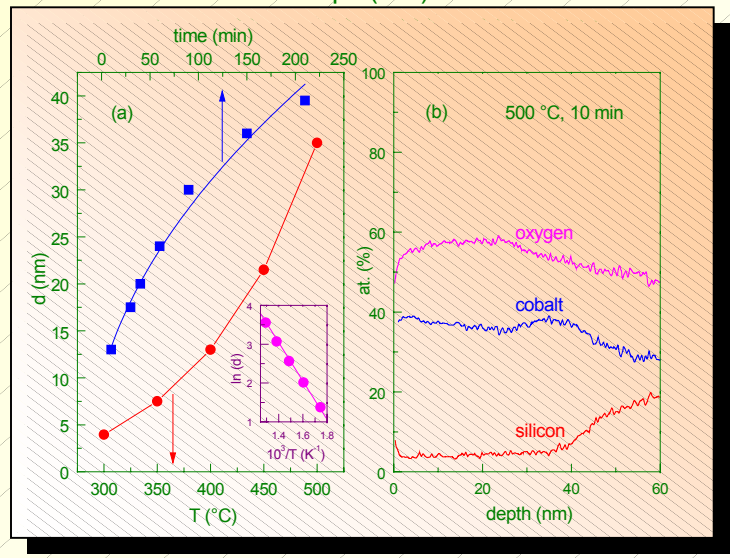


SiO_2:Co^{2+}

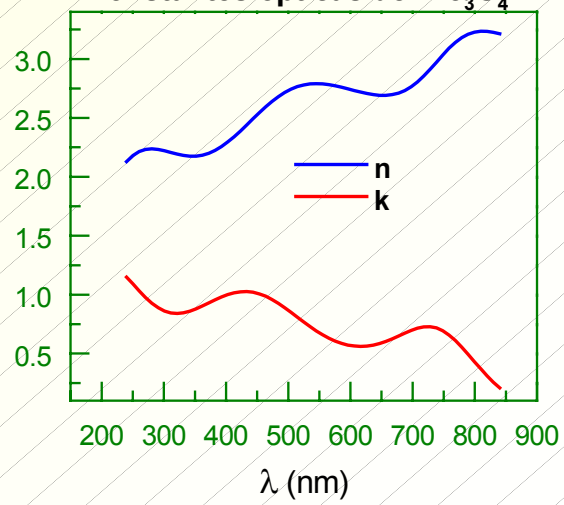
vidrio

Formación de Co_3O_4 sobre SiO_2

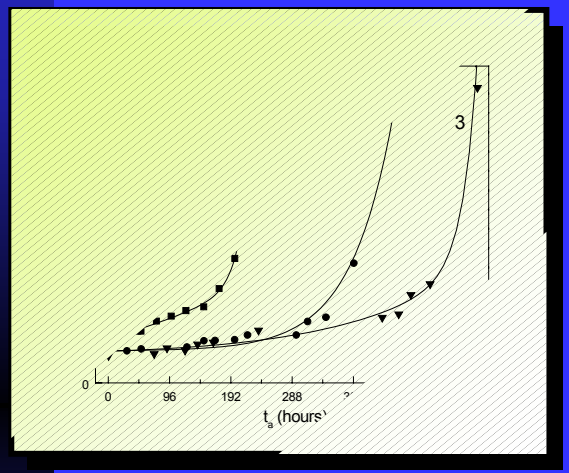




Constantes ópticas del Co_3O_4



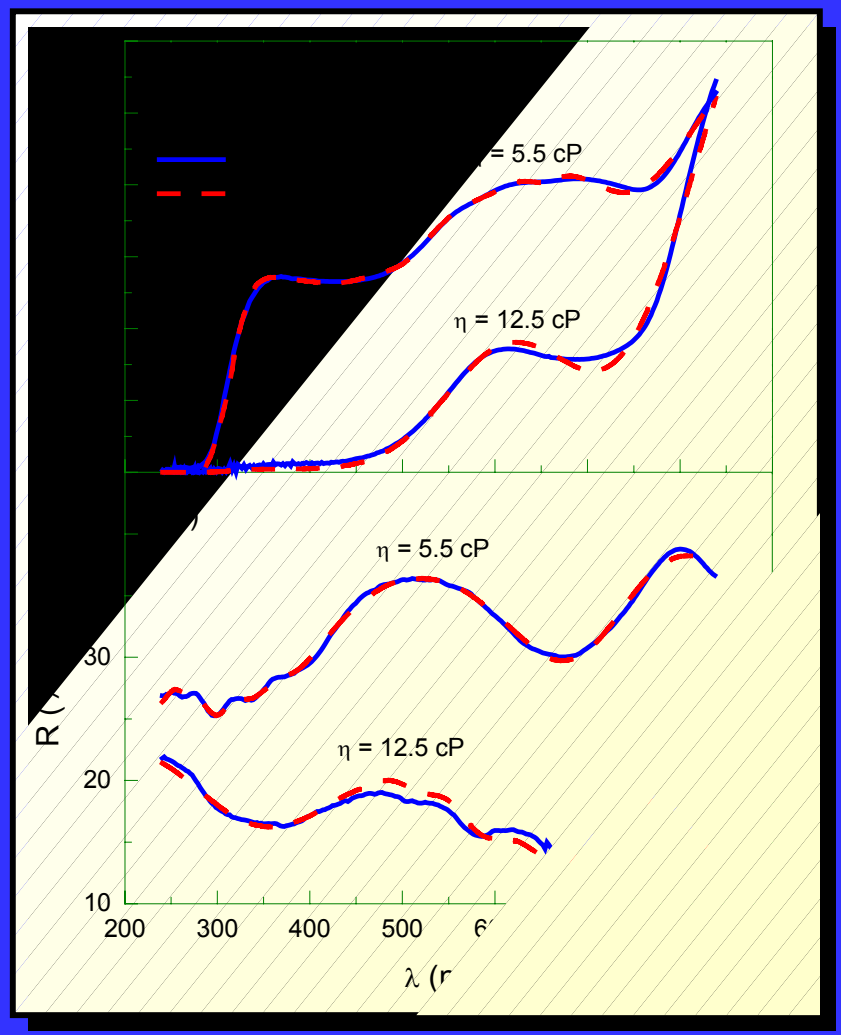
Efecto de la viscosidad de la solución precursora. Formación de Co_3O_4 en la superficie y en el volumen de SiO_2.



Co_3O_4
SiO_2:Co^{2+}
vidrio

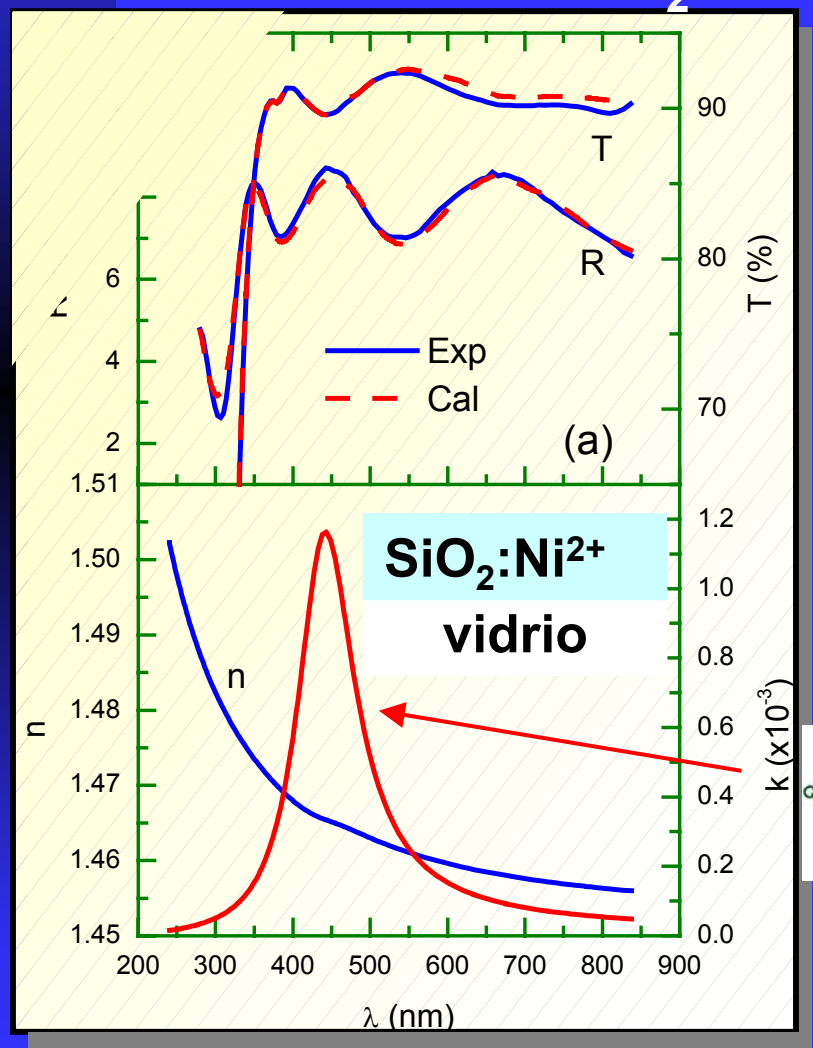
SiO_2
vidrio

$$\frac{\varepsilon - \varepsilon_{SiO_2}}{\varepsilon + 2\varepsilon_{SiO_2}} = f_{Co_3O_4} \frac{\varepsilon_{Co_3O_4} - \varepsilon_{SiO_2}}{\varepsilon_{Co_3O_4} + 2\varepsilon_{SiO_2}}$$

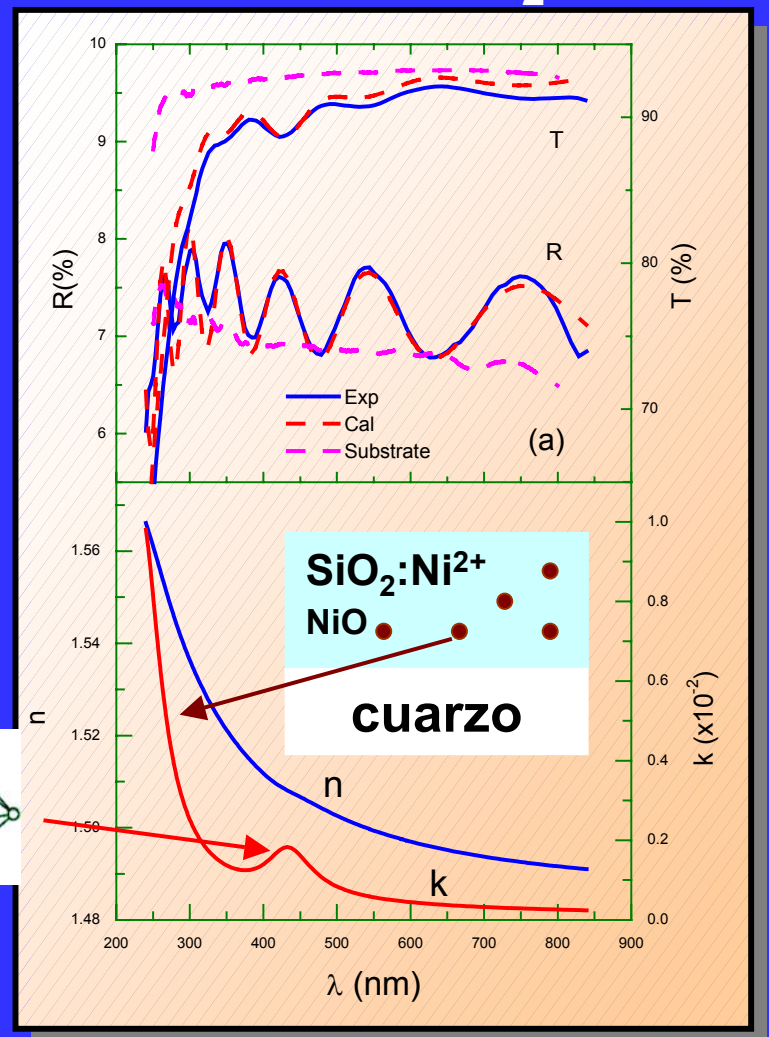


Compuestos Ni-SiO_2

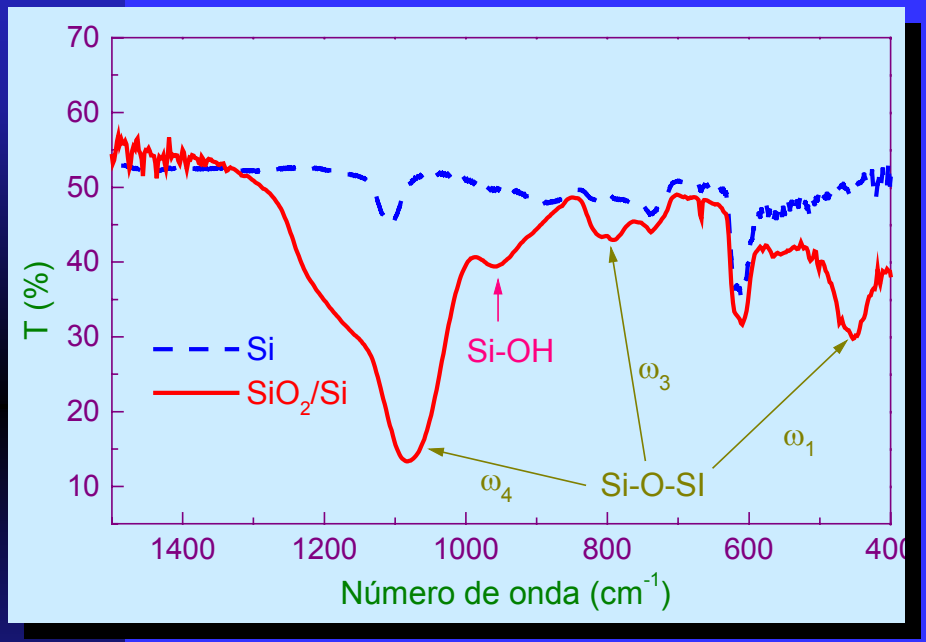
$10NiO+90SiO_2$

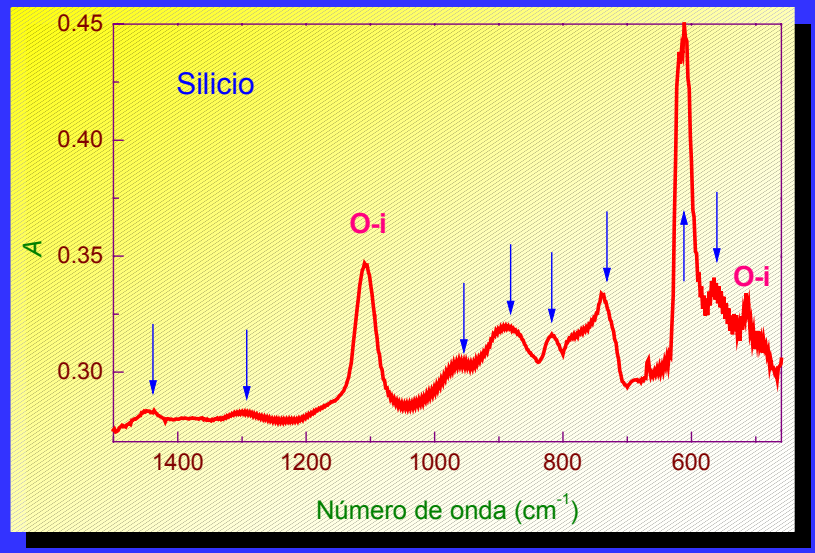


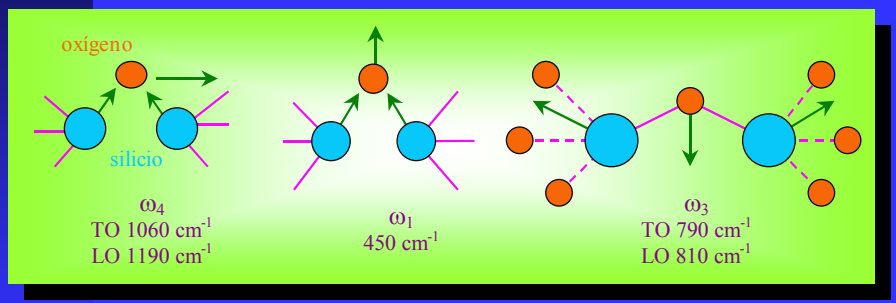
$20NiO+80SiO_2$

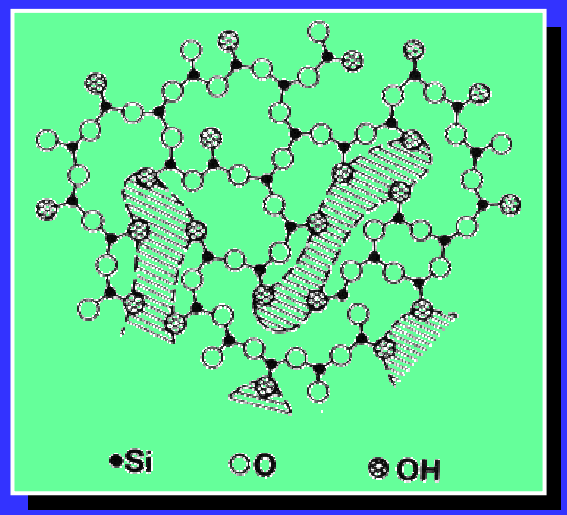


Infrarrojo: SiO_2 sobre Si



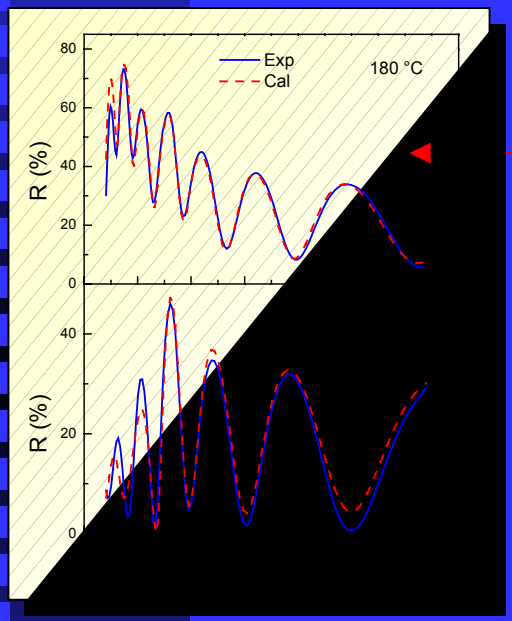


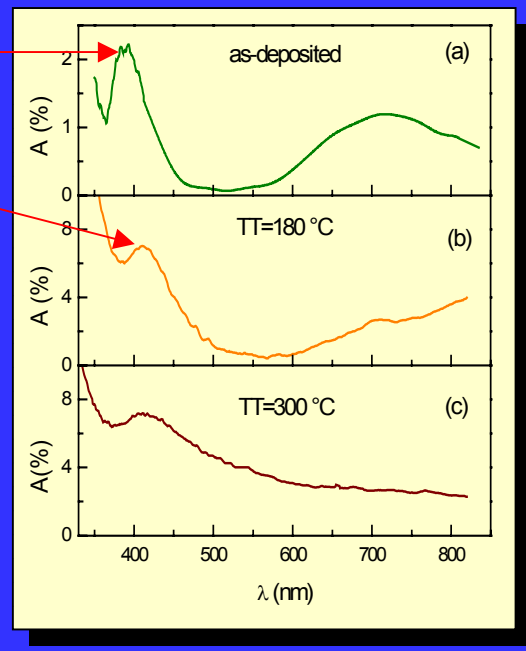


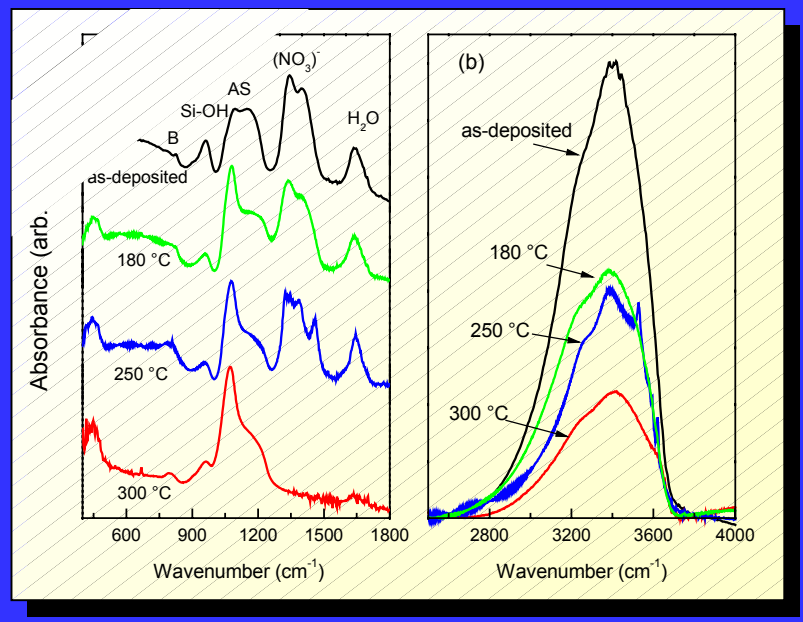


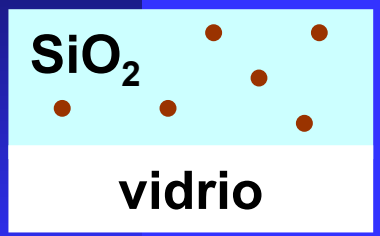
Compuestos Ni-SiO_2

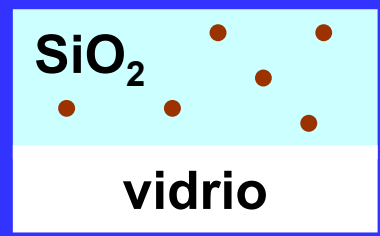
40NiO+60SiO_2



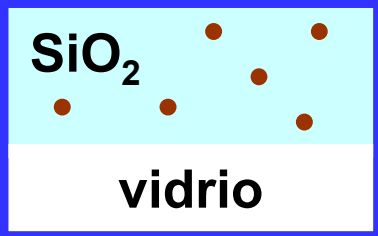


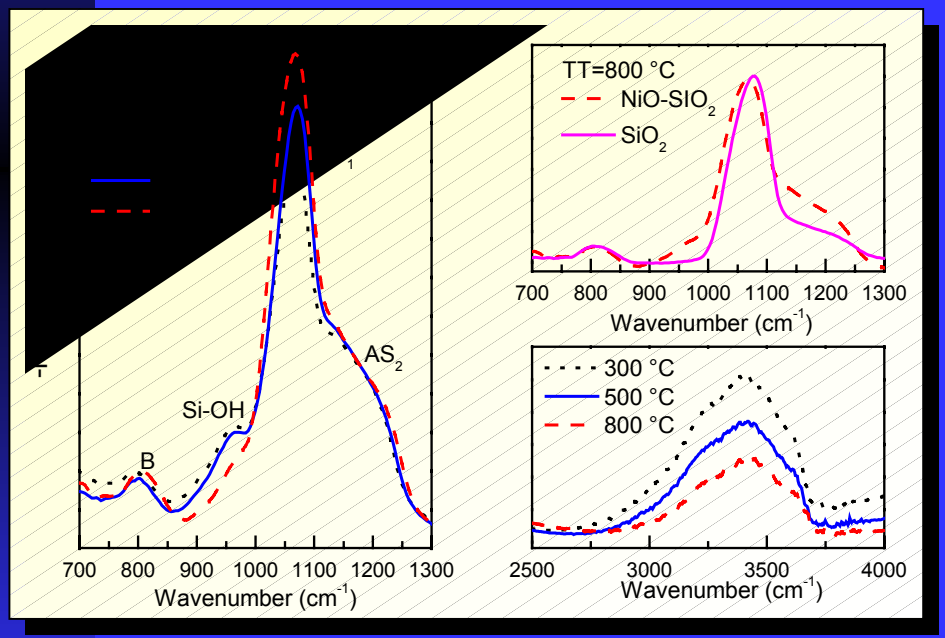


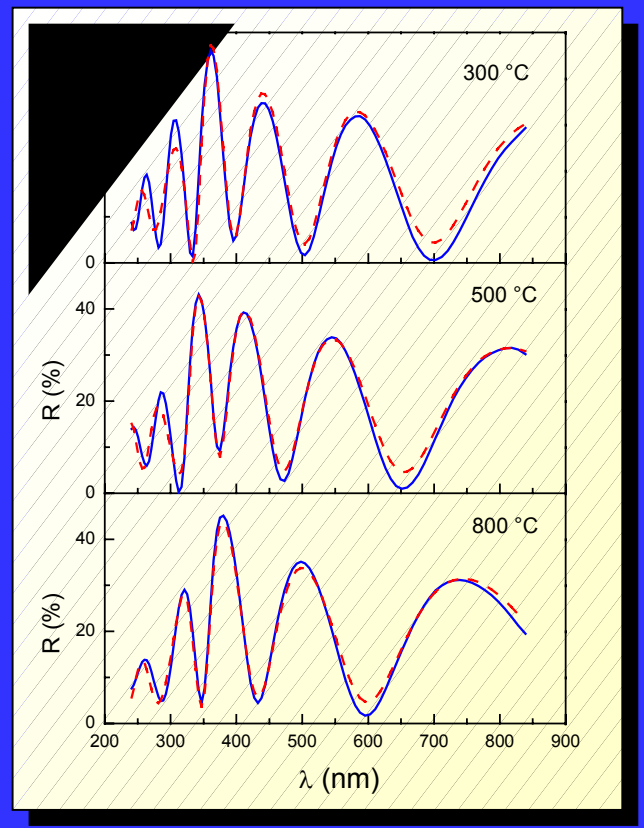




Formación de partículas de NiO en SiO_2

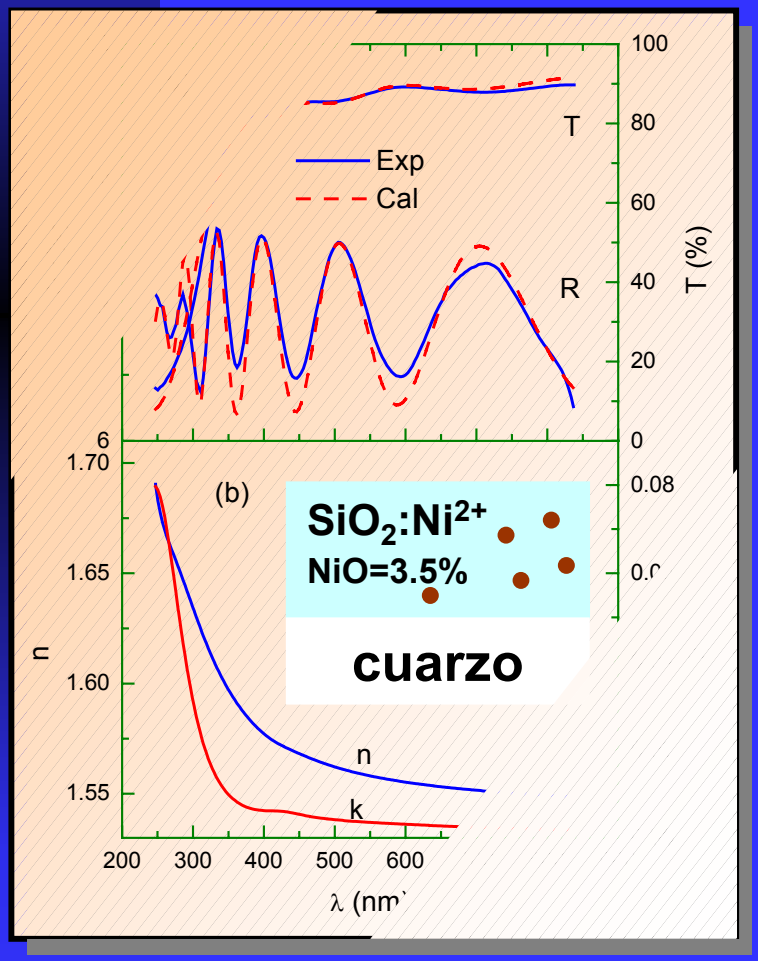




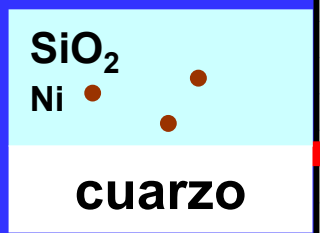


Transformación de partículas de NiO en partículas de Ni.

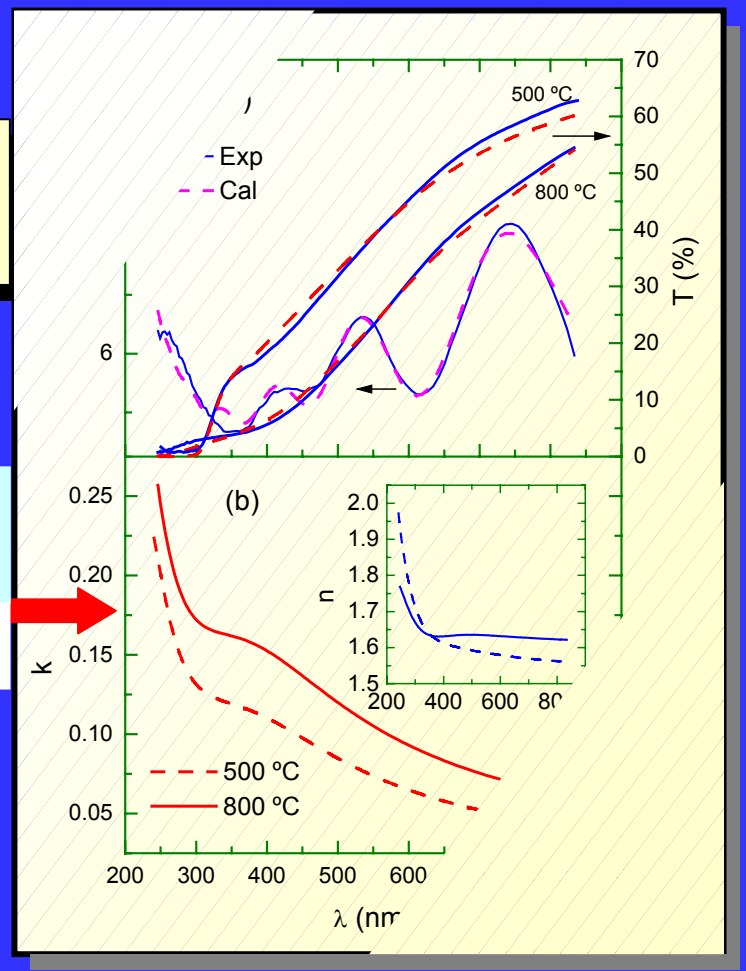
Tratamiento en aire a 500ºC



f =5nm

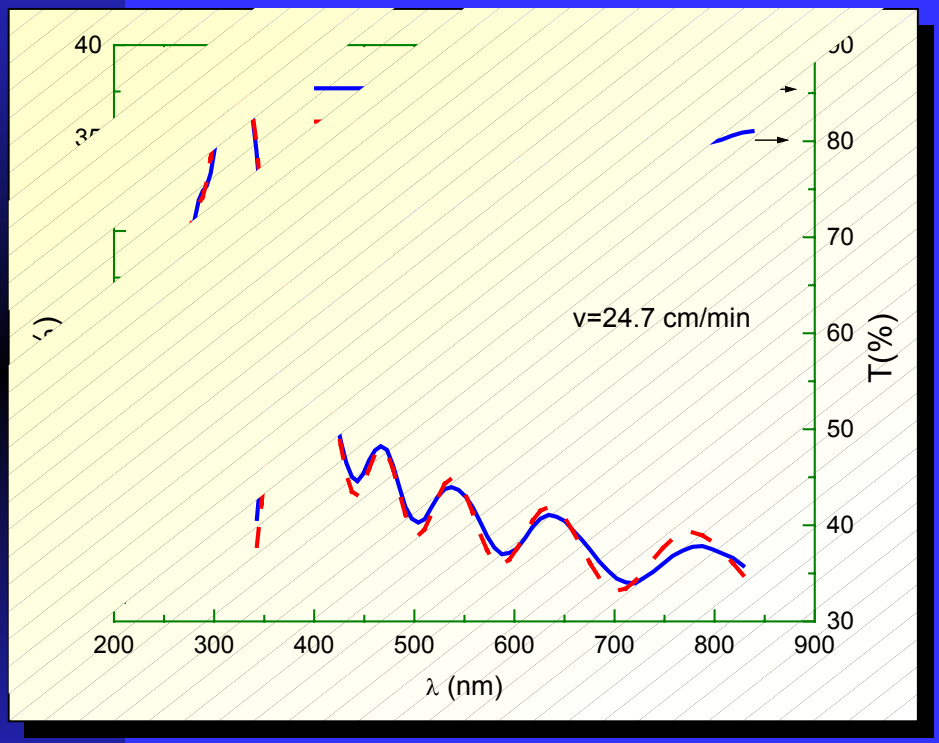


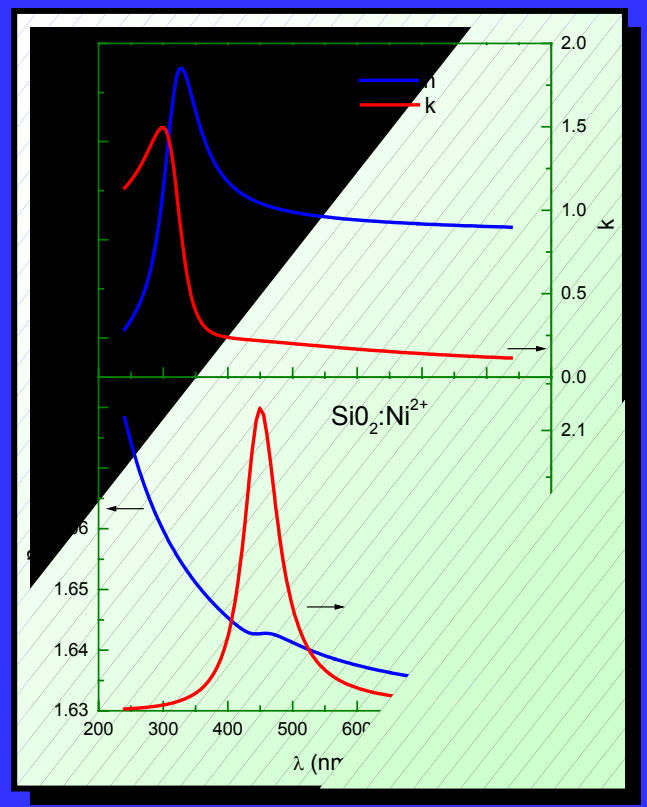
Tratamiento en H_2/N_2



Formación de una capa superficial de NiO

NiO, 22 nm
$SiO_2:Ni^{2+}$,1036 nm
vidrio





Oxidación de Níquel

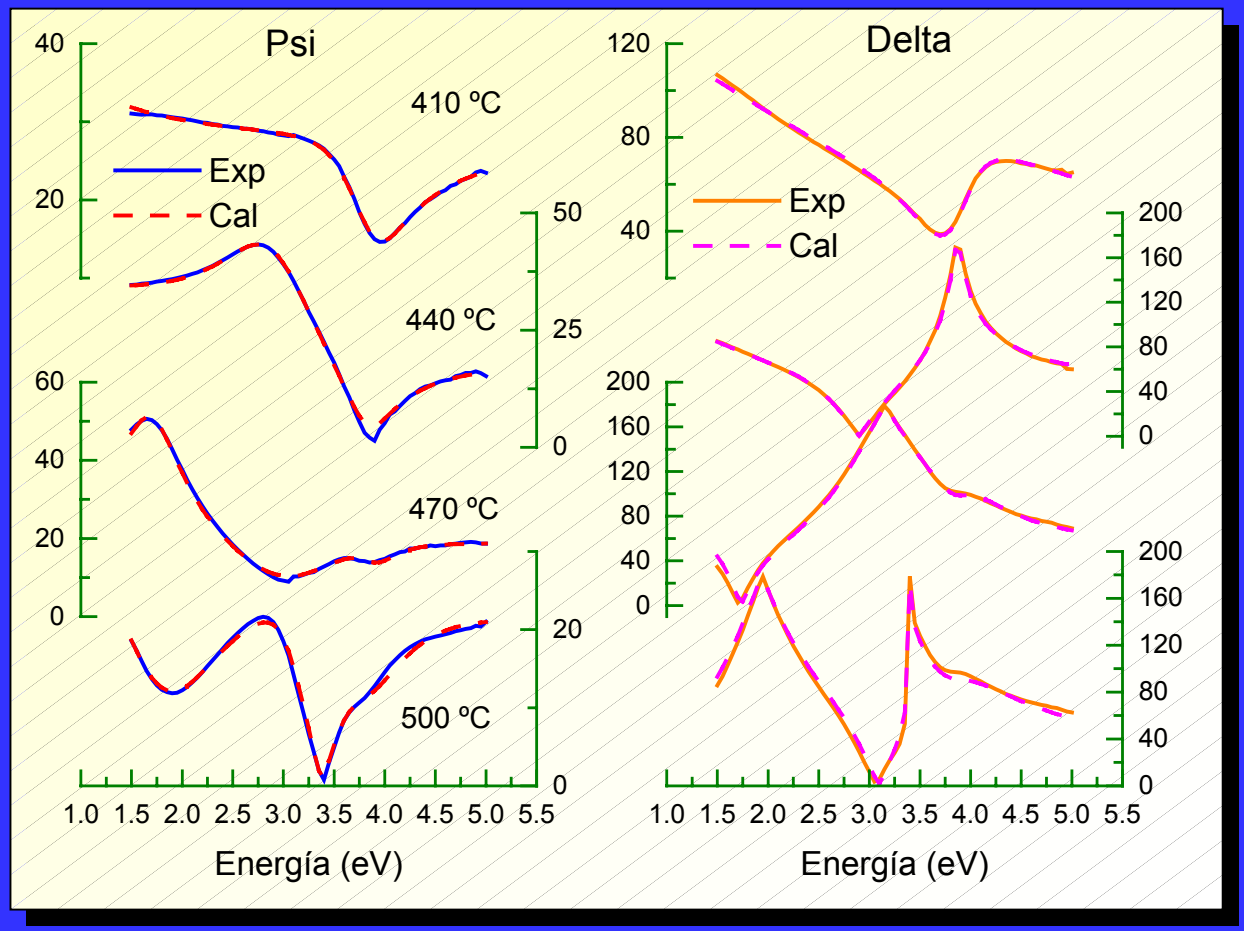
Ni:125 nm

vidrio

NiO: $d_{ox}(T,t)$

Ni: $d_{Ni}(T,t)$

vidrio



Oxidación de Níquel

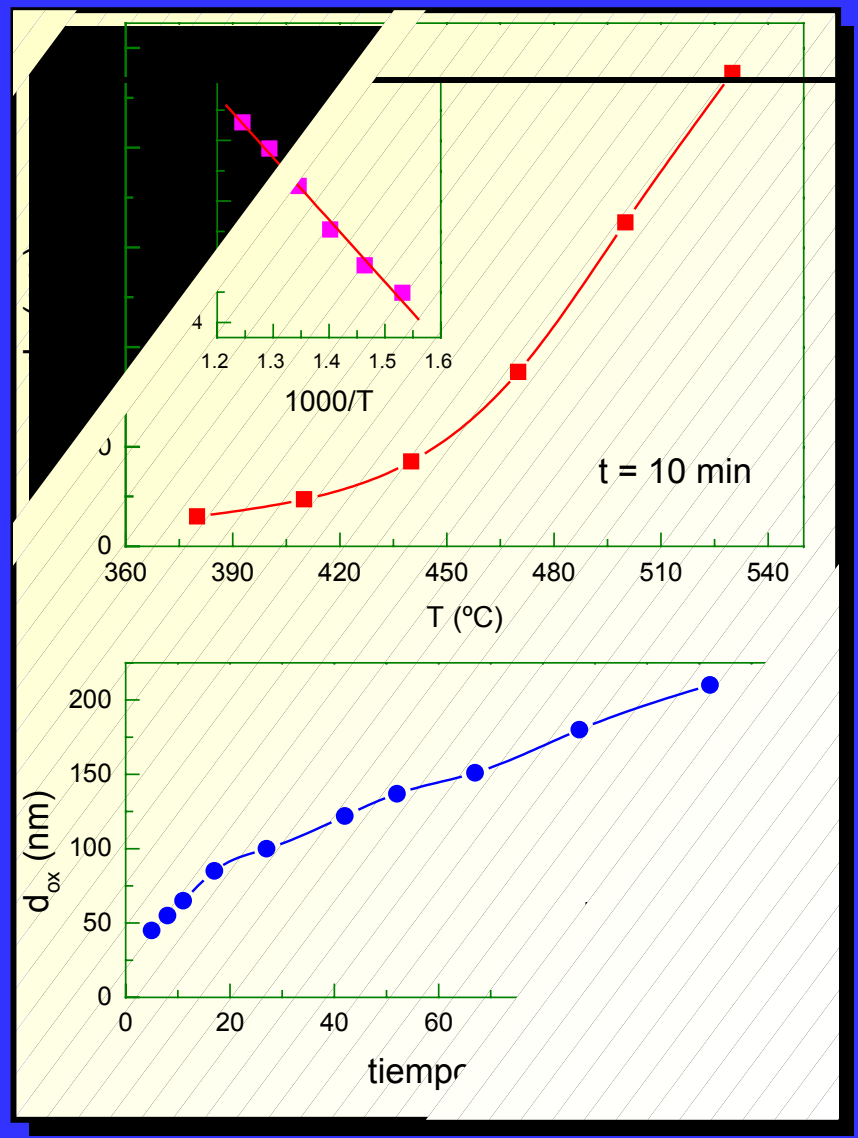
Ni:125 nm

vidrio

NiO: $d_{ox}(T,t)$

Ni: d_{Ni} (T,t)

vidrio

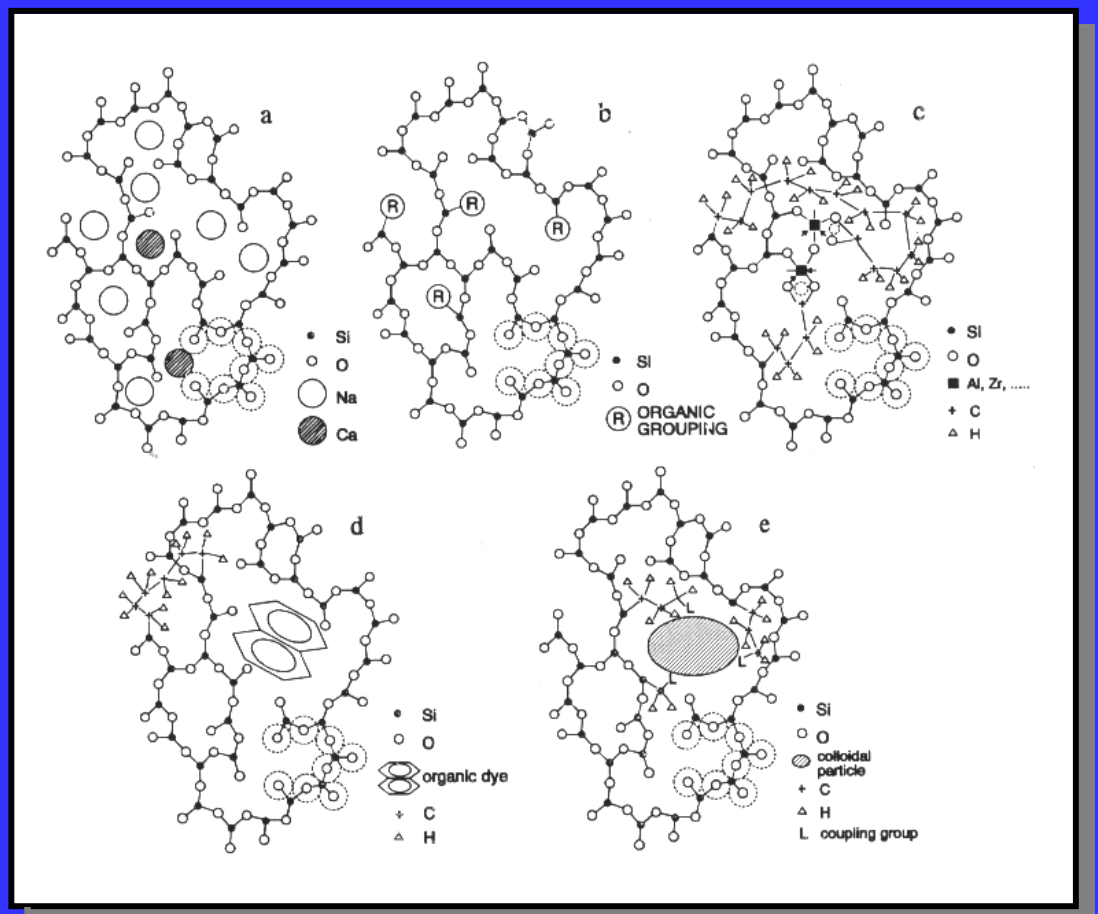


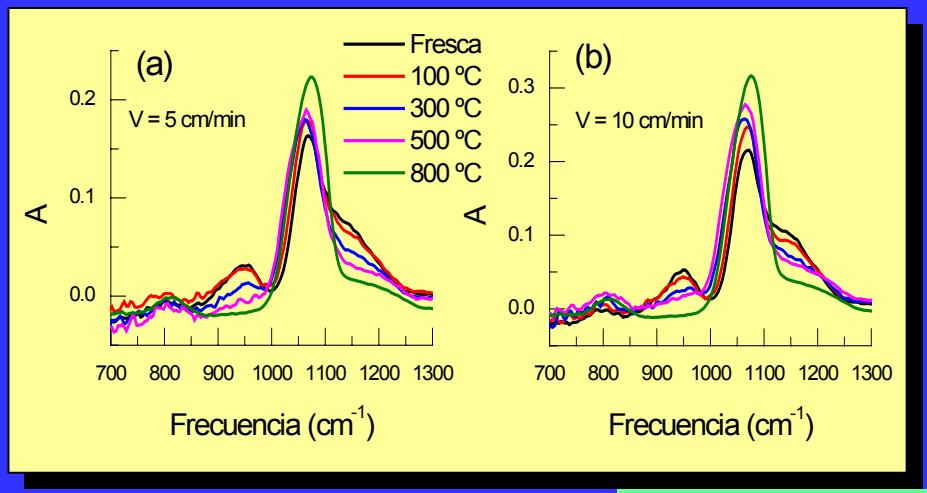
Sumario

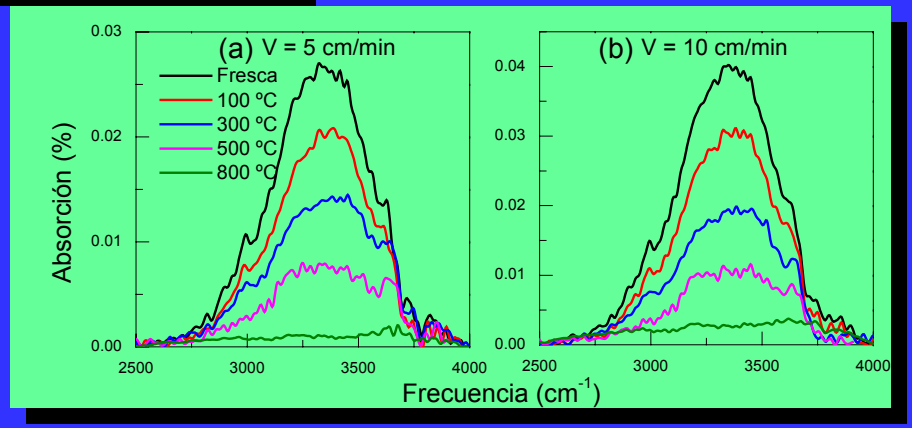
El análisis de datos ópticos sobre un intervalo amplio de longitudes de onda permite determinar diferentes parámetros ópticos y microestructurales de la muestra.

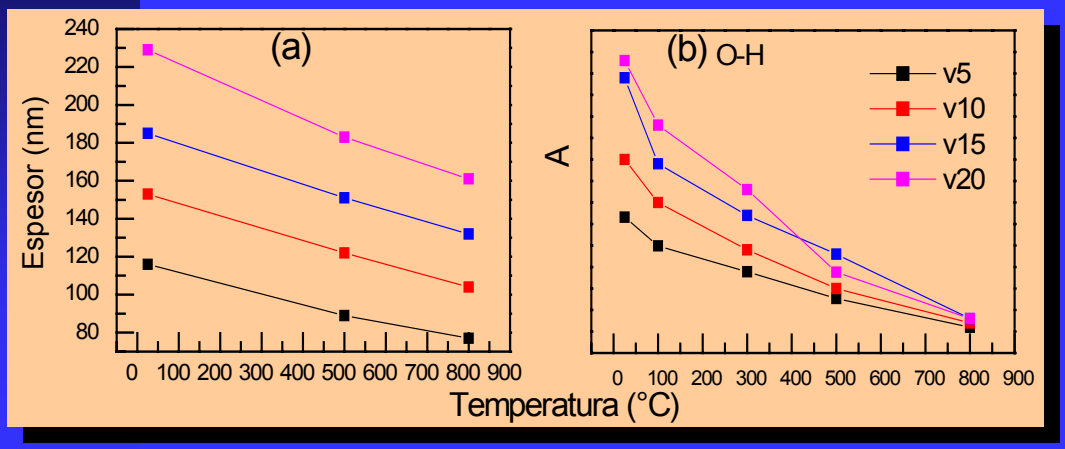
Con lo anterior es posible estudiar el efecto de las variables del procesamiento sobre las cantidades de interés.

Incorporación de diferentes especies en los poros del SiO_2




(a)
V = 5 cm/min
(b)
V = 10 cm/min
Fresca
100 ºC
300 ºC
500 ºC
800 ºC
A
Frecuencia (cm-1)


(a) V = 5 cm/min
(b) V = 10 cm/min
Fresca
100 ºC
300 ºC
500 ºC
800 ºC
Absorción (%)
Frecuencia (cm-1)


(a)
(b) O-H
v5
v10
v15
v20
Espesor (nm)
A
Temperatura (°C)