PELICULAS DELGADAS DE NUEVOS MATERIALES PARA CELDAS SOLARES CdTe/CdS

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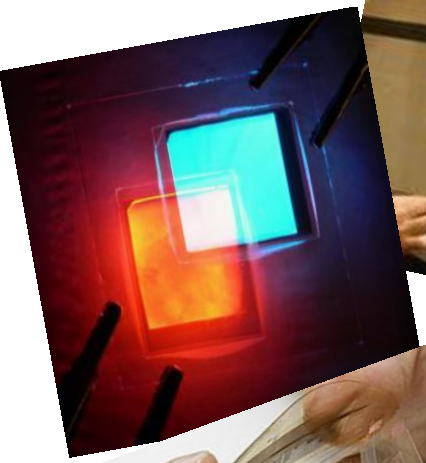


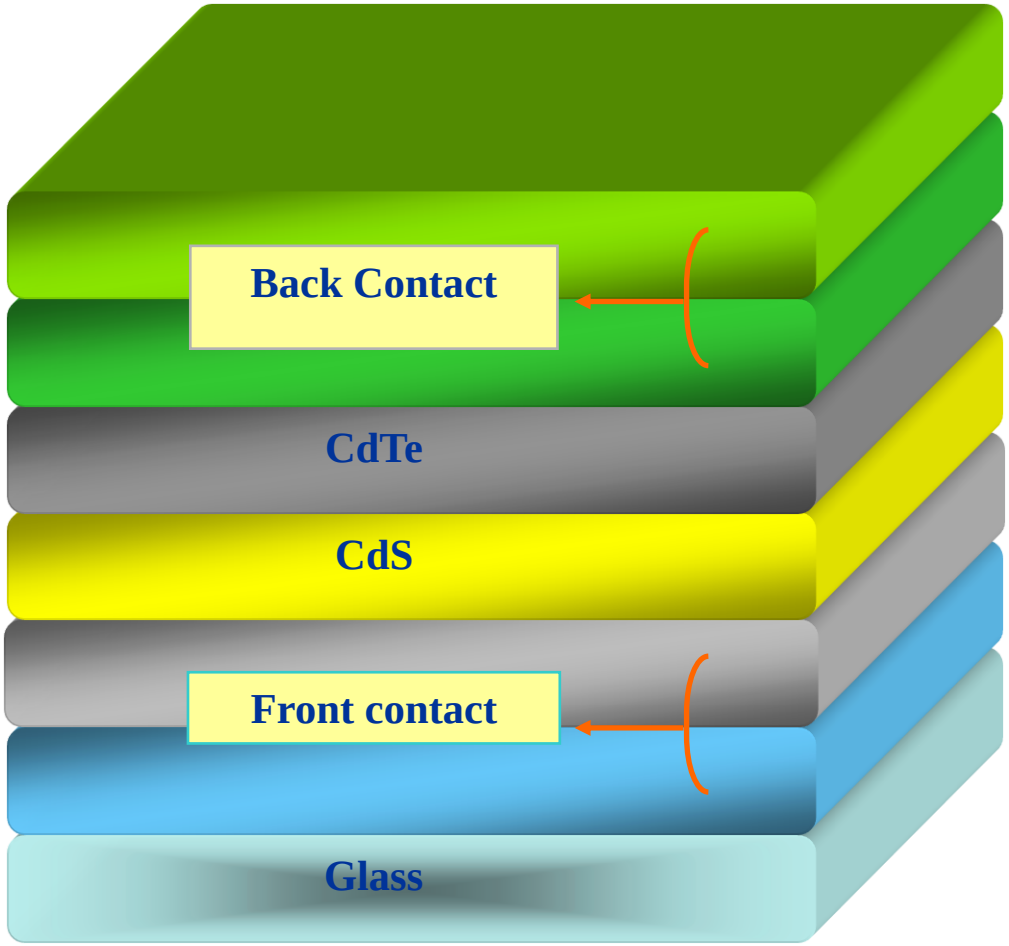

Potential Applications


Diferentes celdas solares en el mundo
Y su estado de comercialización
Celda Solar
Silicio
Comp. III-V
Comp. II-VI
Otros comp
otros
Si-monocristalino
Si-multicristalino
Si-listón
SI-amorfo (pel. Delg.)
SI-microcrist (pel. delg)
Si-esférico
GaAs
InP
CdTe
CuInSe2
CuInGaSe2 , CuInS2
Tintes / Orgánico
Gran escala de producción
Gran escala de producción
Mediana escala de producción
Mediana escala de producción
Pequeña escala de producción
I&D o Producción piloto
Espacial, concentración
Espacial
Mediana escala de Producción
Pequeña escala de producción
I&D Producción piloto

Estructura de una Celda Solar CdS/CdTe

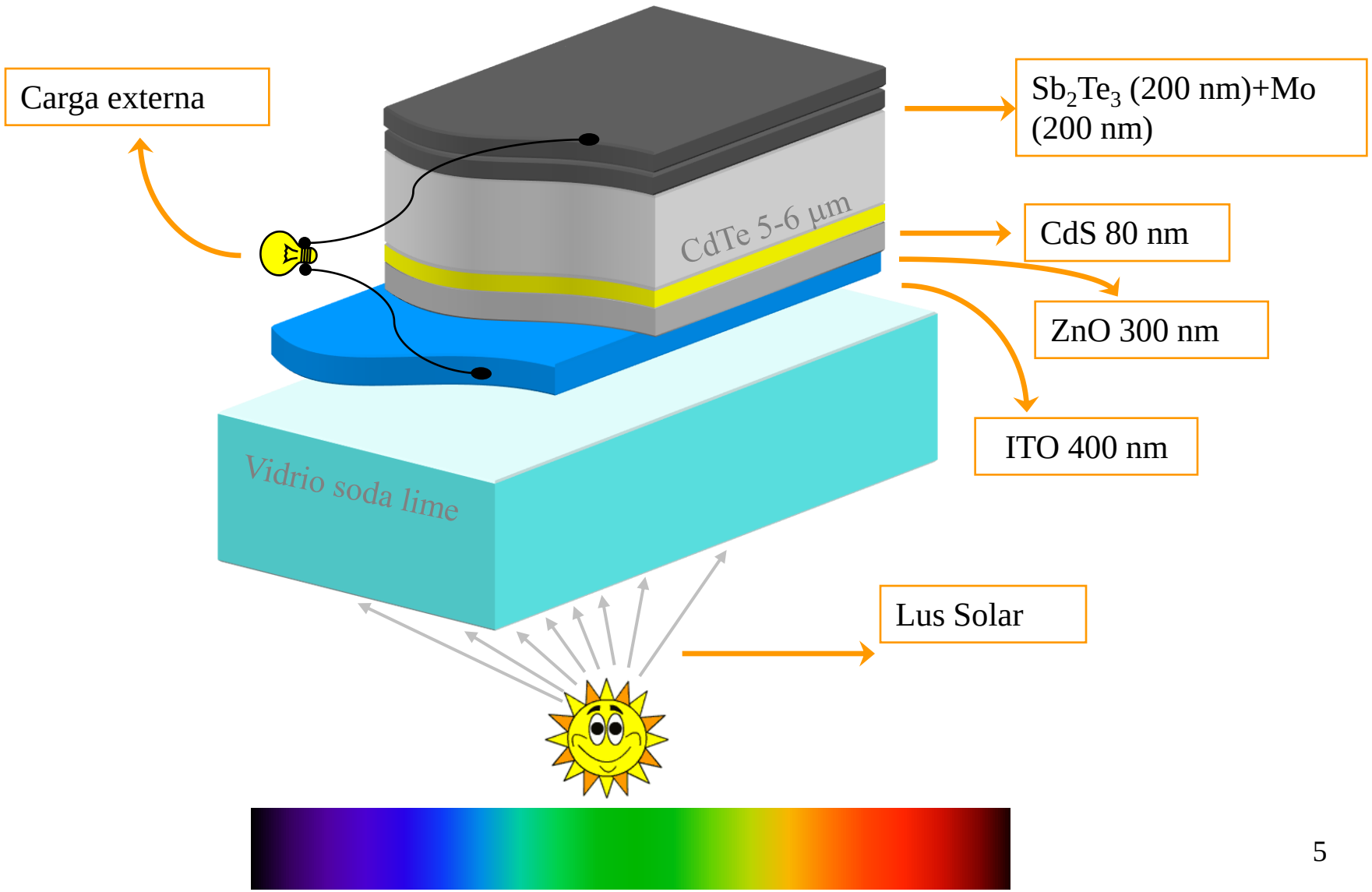
The cell is composed of four layers:

- *The front contact*
- *CdS*
- *CdTe*
- *The back contact*



Both front and back contact are composed of 2 sublayers

Como funciona una celda Solar CdS/CdTe

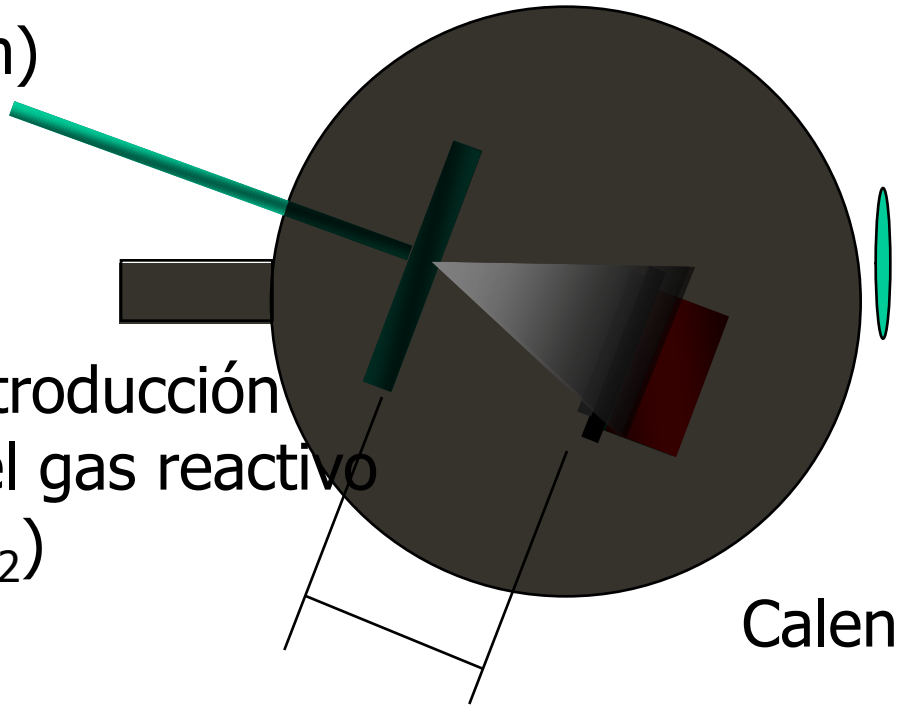


Detalles experimentales

¿Qué es PLD?

Rotación del Target (5 rpm)

Vacío de la cámara 10^{-6} Torr



Pulsos Láser Nd:YAG

λ=1064 nm

~2 J/(cm²) por disparo

5 Hz

Introducción Del gas reactivo (O_2)

Número de disparos: 2000

Calentamiento

Target:

- **Polvo de in2O3 embebido en estaño metálico**

Distancia target-sustrato **40 mm**

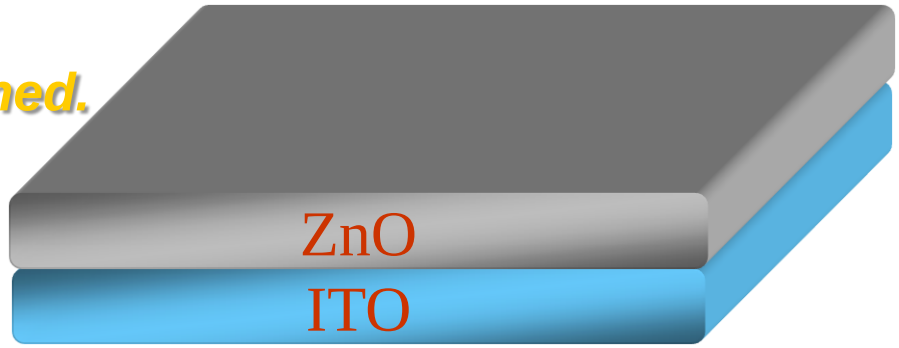
Substrato **Vidrio Corning No. 7059** **12x12 mm²**

The single layers: Front Contact

- **ITO: This layer is deposited at 400 °C substrate temperature with a Deposition Rate greater than 40 Å/sec by D.C. sputtering using a ceramic target.**

With a thickness of 400 nm,

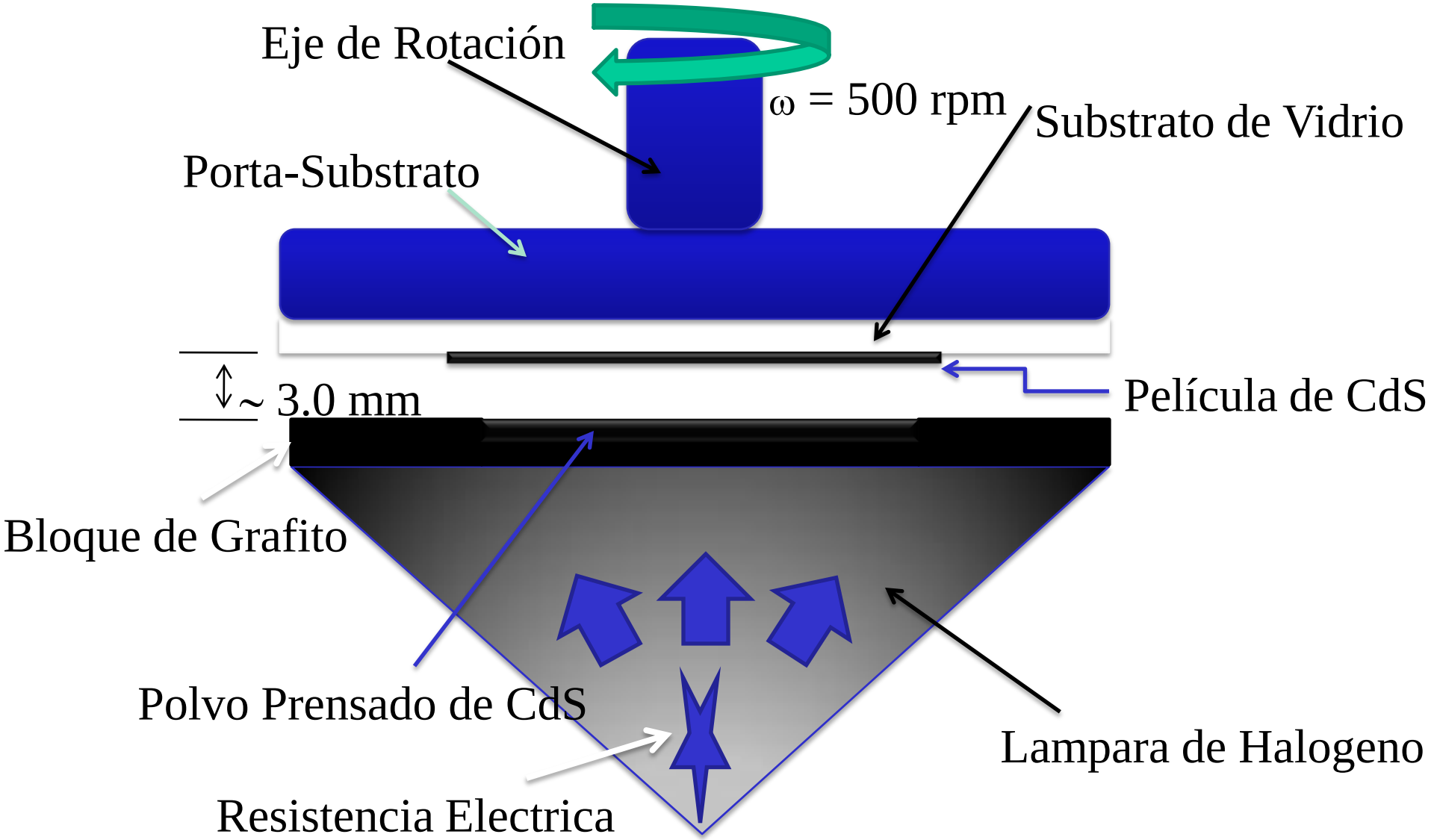
a sheet resistance of ~5 Ω/sq is obtained.



- **ZnO: on top of the ITO layer 100-150 nm of ZnO are deposited by D.C. reactive sputtering in an atmosphere of Ar containing 20% of O_2 with a deposition rate greater than 30 Å/sec using a Zn target.**

Resistivity of ZnO is ~10^3 Ω-cm .

The role of ZnO layer is both to hinder the In diffusion from ITO and to separate CdS from ITO in order to limit the effect of eventual pinholes that could be present in CdS, since this layer is very thin (80-100 nm).



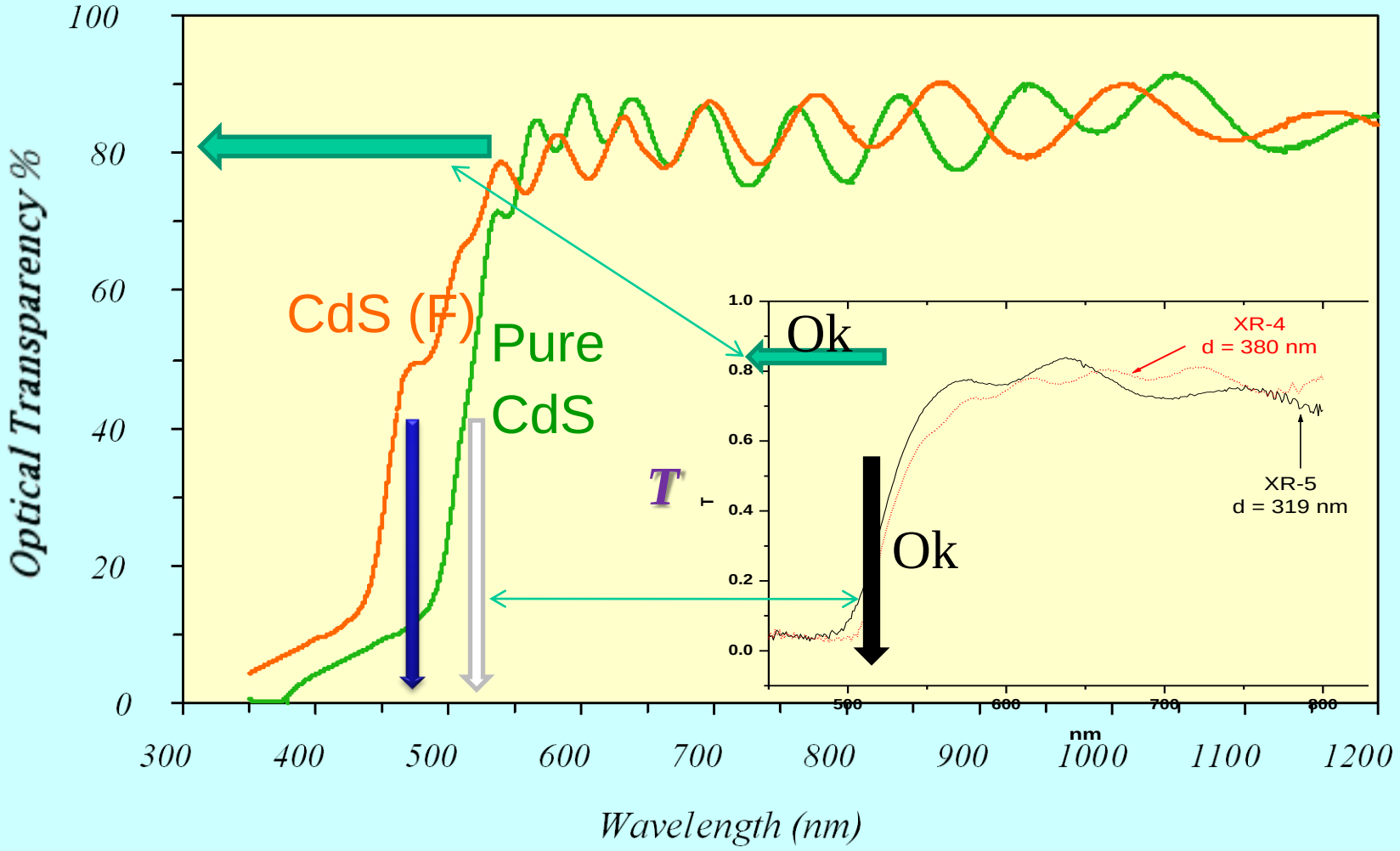
Visión esquemático de la Técnica CSS con giro de substrato

The single layers: The window CdS layer

CdS is deposited at 250 °C substrate temperature by R.F. sputtering with a deposition rate greater than 20 Å/sec in an Ar atmosphere containing 5% of CHF_3.

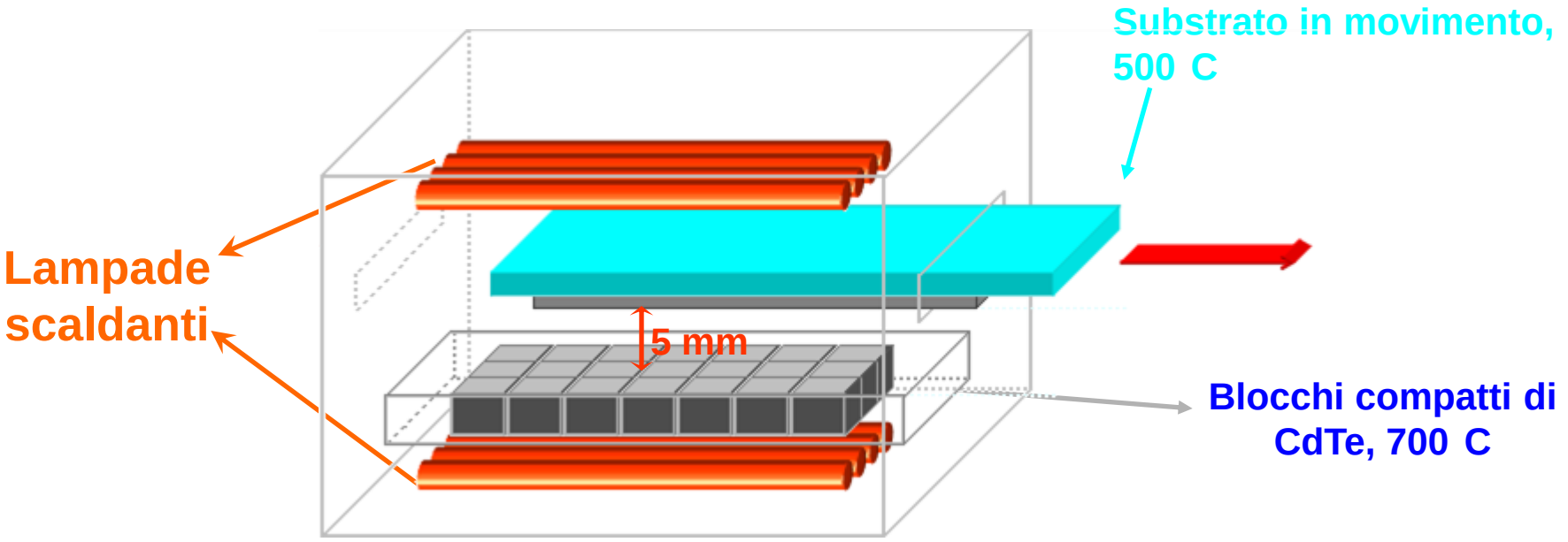
Normally, good CdS films are obtained also by CSS. However, due to the small thickness of the CdS layer (80 nm) is preferred to use sputtering since it allows a better thickness control.

CdS CSS_rotación vs CdS rf_sputtering

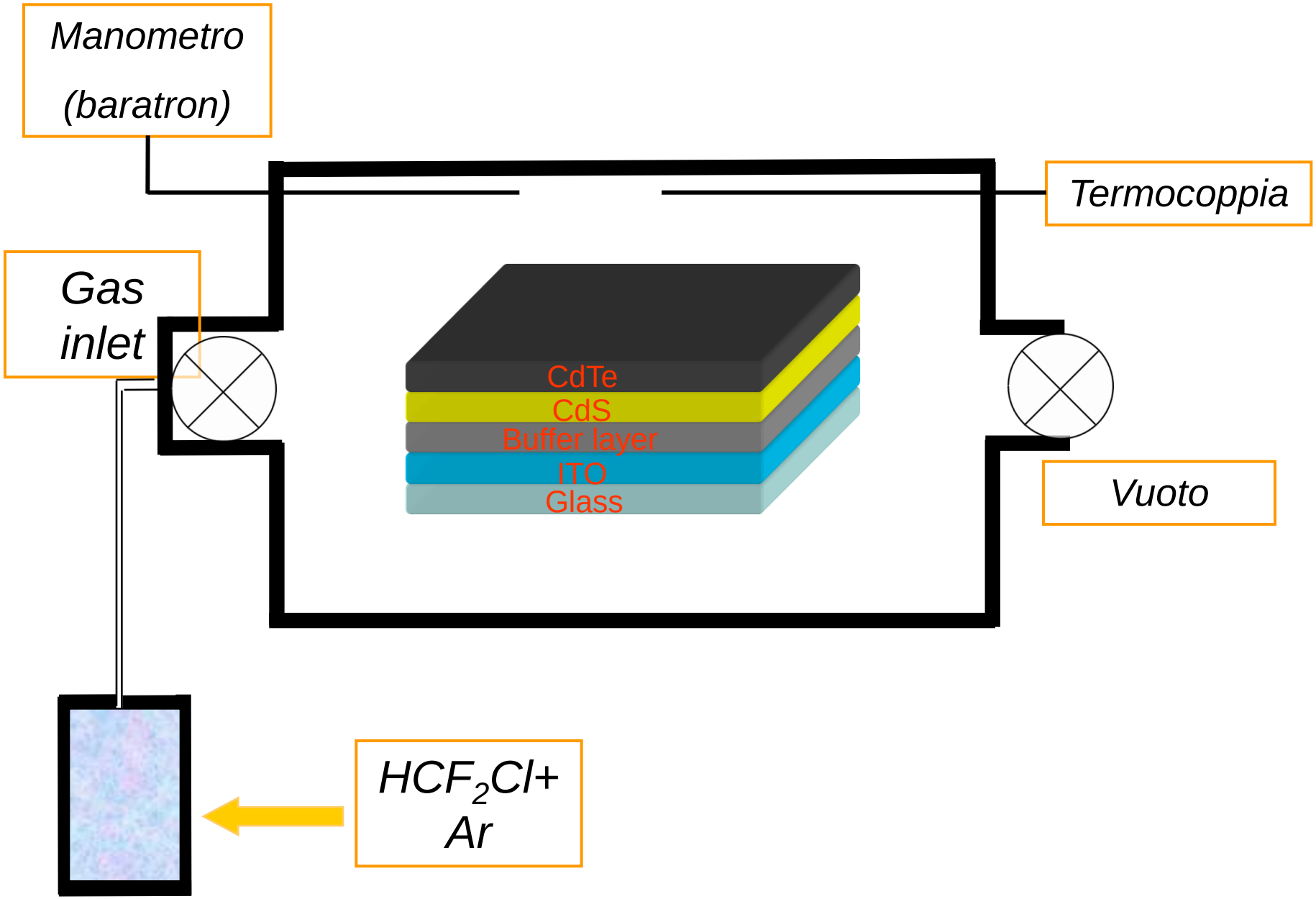


Tecniche usate per la deposizione: Sublimazione a distanza ravvicinata (CSS)

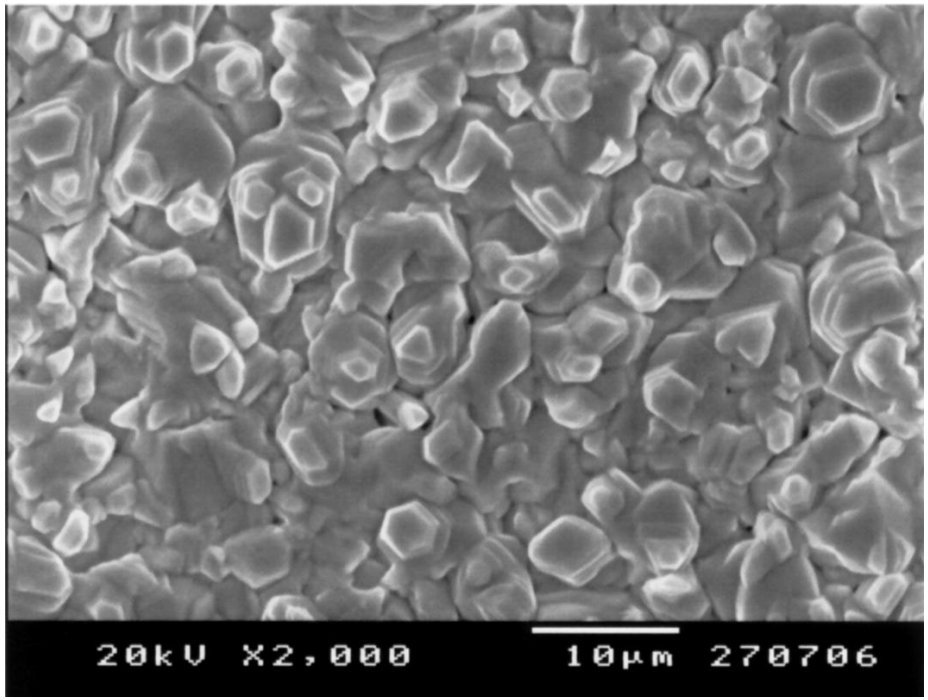
La "sublimazione a distanza ravvicinata" viene usata dall'Antec Solar. Non è una tecnica commerciale, ma può essere facilmente costruita e non ha dimostrato problemi di scalabilità



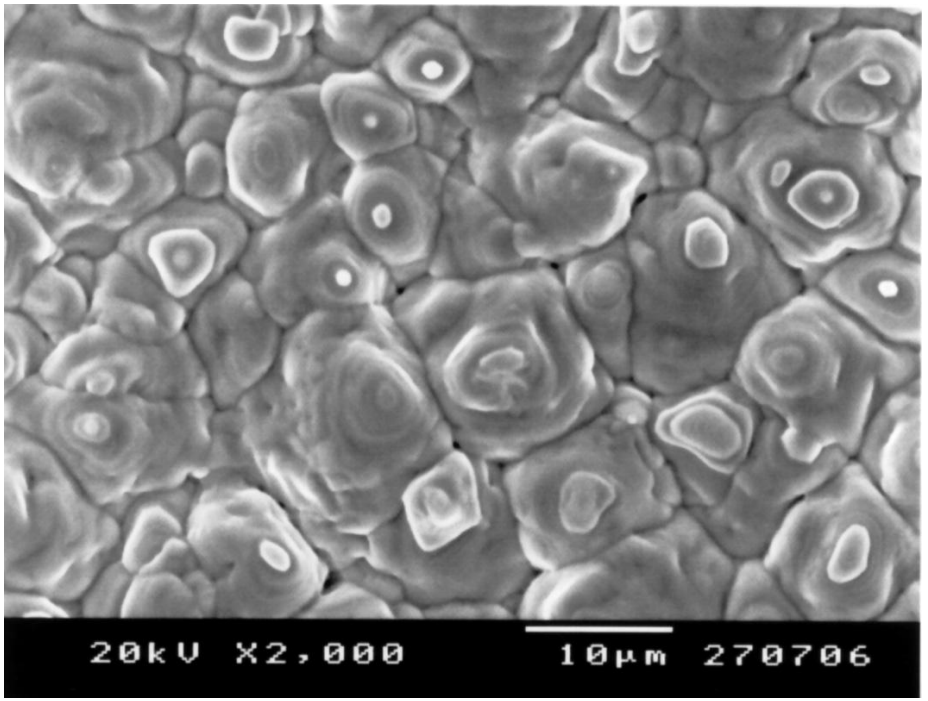
Procedura trattamento HCF2Cl + Ar



I singoli strati: il CdTe

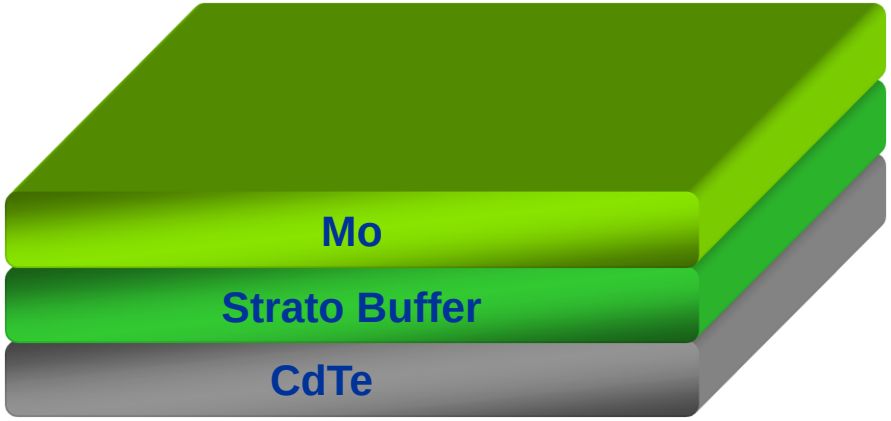


Morfologia superficiale di un film di CdTe depositato per CSS e non trattato.



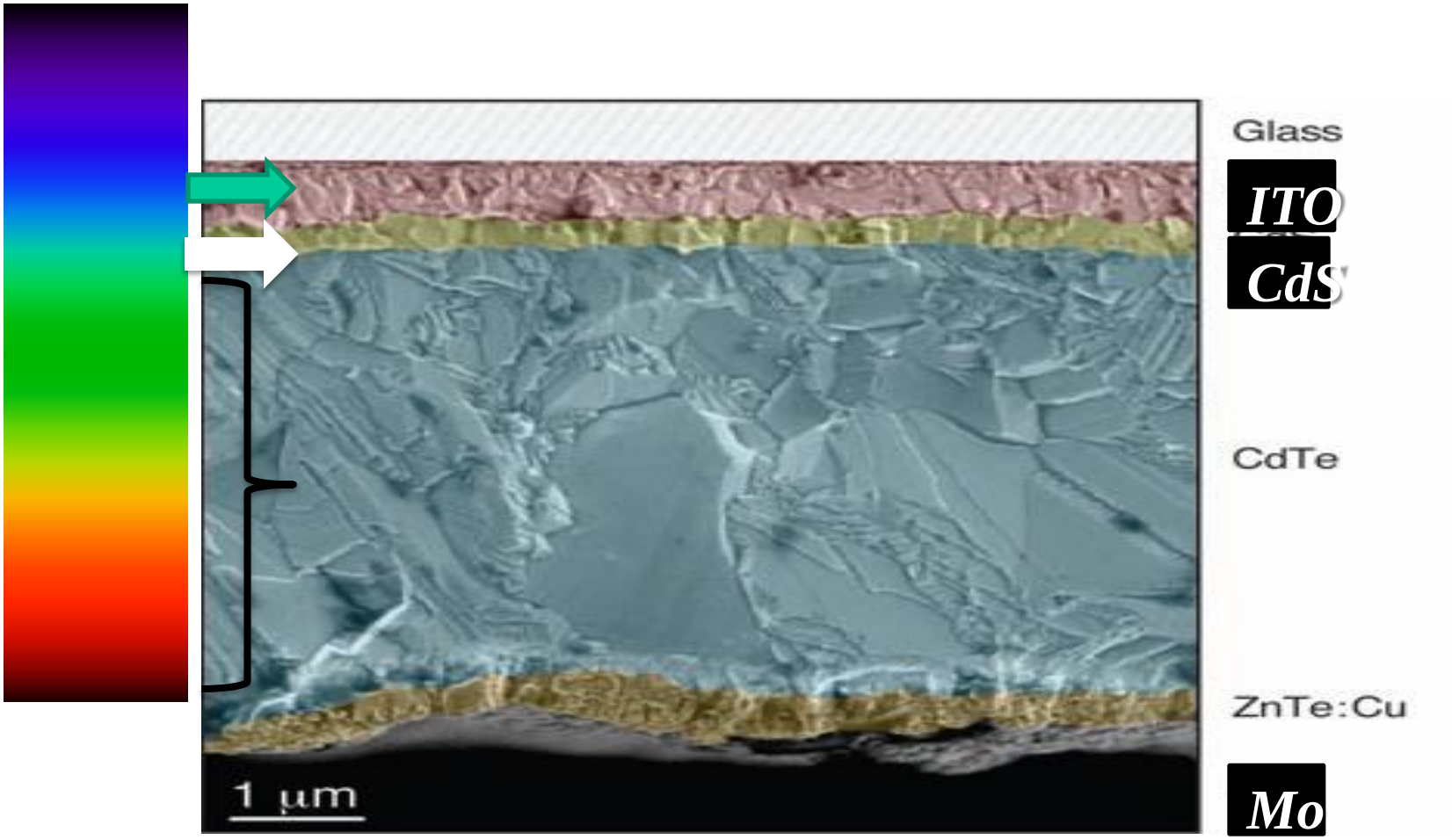
Morfologia superficiale dello stesso campione dopo il trattamento termico in atmosfera di $Ar+HCF_2Cl$.

I singoli strati: il contatto posteriore



Sul CdTe è depositato uno strato buffer per sputtering ad una temperatura del substrato di 250 C, senza alcun etching sulla superficie del CdTe.

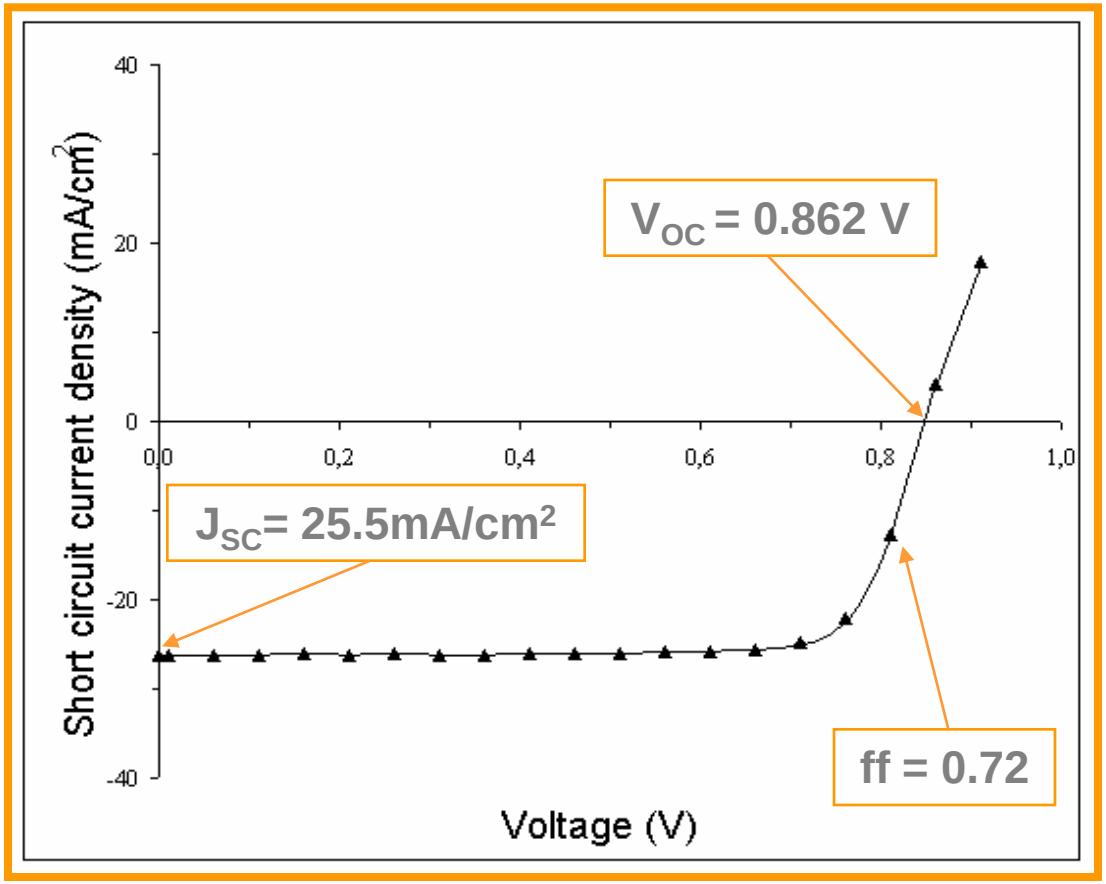
Infine, sullo strato buffer vengono depositati 150 nm di Mo per sputtering in corrente continua con una velocità di deposizione di 60 Å/sec.



Corte de una sección transversal real de una celda solar CdTe\CdS

Laboratory results:

Efficiencies larger than 14% are routinely obtained with this process on an 1 inch² soda-lime glass substrate.



Best efficiency is 15.8% with:

- ***V_{OC} = 0.862 V***
- ***J_{SC}= 25.5mA/cm²***
- ***ff = 0.72***
- ***Area= 1cm²***

The parameters of the cell have been measured under AM 1.5, 100 mW/cm² simulated solar light.

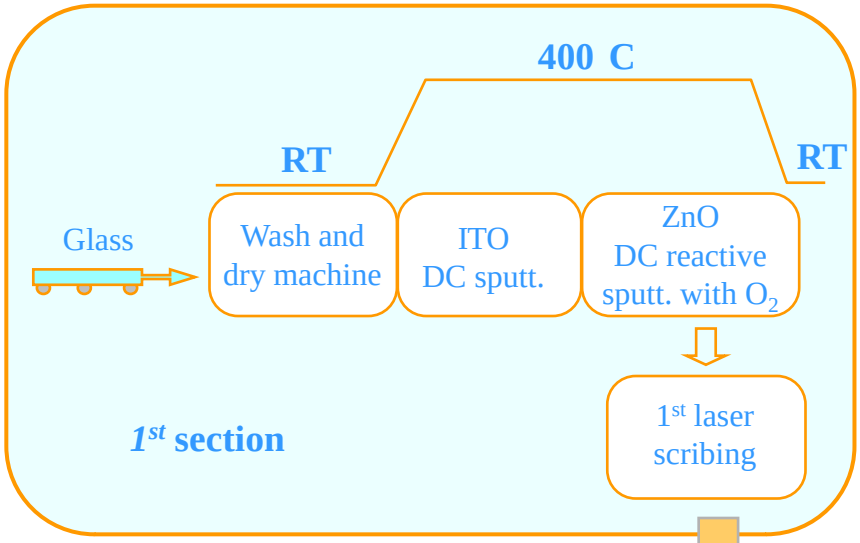
Towards the Industrial Production of CdTe/CdS Thin Film Modules

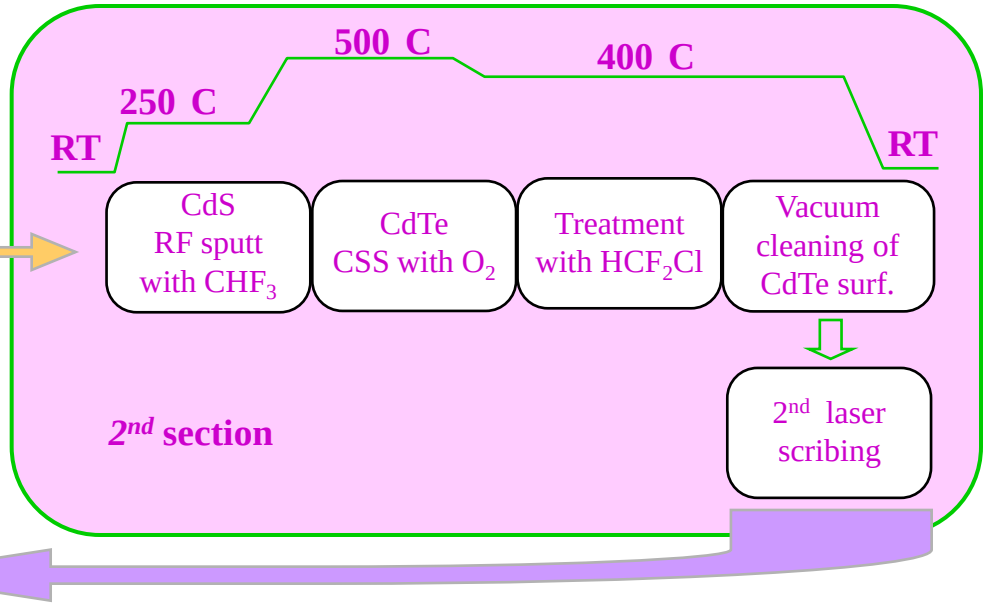
The process which we will use to produce CdTe/CdS thin film modules is quite simplified in many aspects such as:

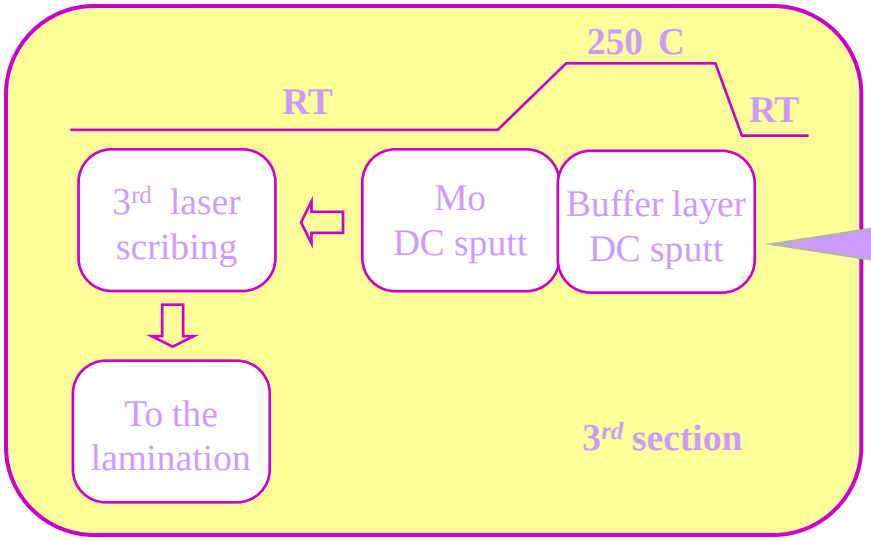
- ***The CdS film is done by RF sputtering and a much better control of its thickness is obtained.***
- ***Treatment of CdTe is done by using a gas that is inert and non toxic at room temperature. The step of $CdCl_2$ deposition has been removed.***
- ***CdTe is not etched before back contact deposition.***
- ***The buffer layer in the back contact renders the cells much more stable without affecting their efficiency.***

The in-line process

The technology to fabricate CdTe/CdS thin film solar cells can be considered mature for a large scale production of CdTe-based modules. A stable efficiency of 15.8% has been demonstrated for 1 cm^2 laboratory cell and it is expected that an efficiency of 12% can be obtained for 0.6×1.2m^2 modules.







A fully automated in-line process could produce 1 module every 2 minutes at a cost substantially less than 1€/W.

MUCHAS GRACIAS