



Thin Films

ENEA - Italian National Agency for New Technologies, Energy and Sustainable Economic Development.

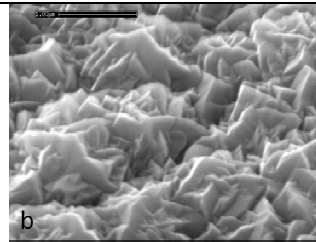
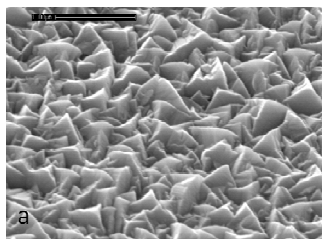
### TCO sputter-MOCVD deposition and characterization

**Location of the infrastructure :** Portici, Naples-Italy <http://www.ene1.portici.enea.it/>

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**Objectives :** Develop and realize high transparency and high conductivity transparent Conductive Oxide as front electrode of thin film solar cells and Silicon HJ

**Main features :**



Surface morphology of ZnO: B films :  
(a) pyramidal structure and  
(b) double textured

- Development and realization of high transparency and high conductivity boron doped zinc oxide thin films deposited by Low Pressure Chemical Vapour Deposition (LP-MOCVD).
- Optimisation of the properties uniformity on large area substrate (30 x 30 cm<sup>2</sup>) by ZnO by LP-CVD.
- Development of plasma treatments on LP-CVD deposited ZnO thin films.
- Development of thin film silicon based solar cells on LP-CVD zinc oxide.
- Use a wider range of characterization methods (SEM, AFM, XRD, Hall effect, and models to analyze films, crystals)
- interfaces mechanical tests, functional properties, definition of fabrication process.

The main achieved results concern

- i. ZnO (<math>6 \cdot 10^{-4}</math>  $\Omega\text{cm}$ , transmittance > 82%) by sputtering
- ii. Patented MOCVD reactor for in line fabrication of boron doped Zn oxide
- iii. 30x30 cm<sup>2</sup> thin silicon modules based on laser scribed TCO : Voc=33.93 V; Isc=0.300 A; FF 0.67  $\eta_{\text{nit}}$ =9.1%(NREL Certified)
- iv. a-Si:H thin film solar cells . 9.2 % efficiency realised on argon plasma etched zinc oxide
- v. micromorph a-Si:H/ $\mu\text{c-Si:H}$  tandem solar cells 11.6 % efficiency realised on plasma treated zinc oxide.

Furthermore

- vi.  $10^{-3}$  ohm cm range resistivity and transparency 60 % in the visible range with nanocomposited materials approach.
- vii. preliminar studies on p-type TCO
- viii. TCO materials including carbon-based and ultrathin materials, devoted to flexible devices

**Limitations or constraints :**

The access will be allowed with technical and scientific assistance from Enea.

**Typical services or results :**

Experimental work on realization and optimization of TCO

**Examples of research projects :**

The facility has been used for many national and FP EU funded research projects including 7FP project HETSI on Silicon HJ.