## Thin Films

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

**TCO sputter-MOCVD deposition and characterization**

<table>
<thead>
<tr>
<th>Location of the infrastructure</th>
<th>Portici, Naples-Italy</th>
<th><a href="http://www.ene1.portici.enea.it/">http://www.ene1.portici.enea.it/</a></th>
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<tr>
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### Objectives:
Devised and realized high transparency and high conductivity transparent Conductive Oxide as front electrode of thin film solar cells and Silicon HJ

### Main features:
- 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 cm²) by ZnO by LP-CVD.
- Development of plasma treatments on LP-CVD deposited ZnO thin oxide.
- 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 (<6x10^4 Ωcm, transmittance > 82%) by sputtering
- **ii.** Patented MOCVD reactor for in line fabrication of boron doped Zn oxide
- **iii.** 30x30 cm² thin silicon modules based on laser scribed TCO : Voc=33.93 V; Isc=0.300 A; FF 0.67; n=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/µc-Si:H tandem solar cells 11.6% efficiency realised on plasma treated zinc oxide.

Furthermore:
- **vi.** 10^5 ohm cm range resistivity and transparency 60% in the visible range with nanocomposited materials approach.
- **vii.** Preliminary 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.