Micromorph™ Technology

HelioSphera S.A., Greece
February 2012

HelioSphera S.A.

Introduction

- Greek company founded in 2007
  - €189m committed capital to date
- **60MW** thin film solar module production line, Tripoli, Greece
- Swiss Technology
  - Oerlikon Solar Micromorph™ Technology
- Biggest micromorph thin film plant in Europe
  - 500.000 modules/year
- Team of 200 people with international backgrounds
  - PhD or Post-Doctoral level: 16
  - Postgraduate level: 15
- Production started in Q4 2009 and the ramp up was completed in Q3 2010
- 30 MW sales
  - New markets: Middle East

Production Facility, Tripoli Greece

The Choice of Micromorph™

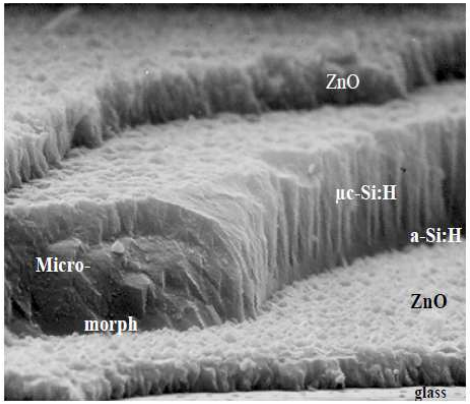
Benefits

Features	Benefits
Micromorph technology	❖ Improved spectral response ❖ Good performance with diffuse light ❖ Better performance than c-Si under partial shading ❖ Higher energy yield in hot and sunny climates (Arizona, Middle East) due to low temperature coefficient
Usage of non-toxic and abundant materials	❖ Unlimited supply of raw material ❖ No hazardous compounds inside module ❖ No worries for disposal at the end of module lifetime
Minimum usage of materials and low process temperatures	❖ Energy Payback Time (EPT) of only 1.5 years
Monolithic series connection of cells (laser scribing)	❖ High reliability ❖ Best in class biased damp heat stability
Frameless glass-glass module	❖ Easy & faster installation (Module Mounting Interface) ❖ Applicable for BIPV

Tandem Solar Cell Structure

Tandem Features

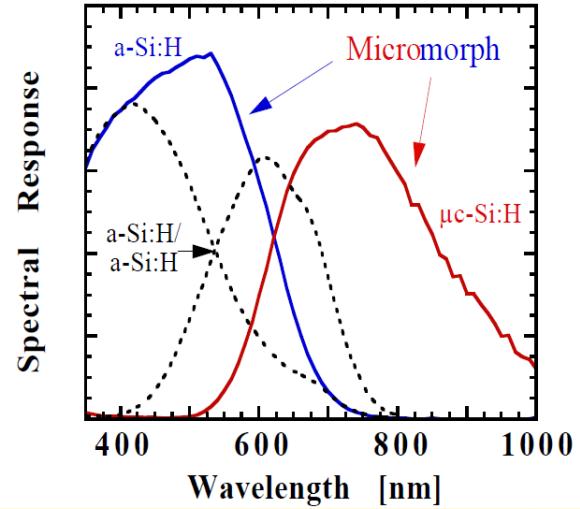
• Wide band gap material for top cell (a-Si:H): short wavelength absorption
• Low gap material for bottom cell (eg. mc-Si:H): long wavelength absorption
• Absorption of low energy photons in bottom cell, which would not be absorbed in single top cell



Tandem solar cell structure

Advantages

• Better utilization of solar spectrum compared to single junction cells (e.g. a-Si)
• Lower temperature coefficient compared to c-Si results to positive influence of yearly energy yield
• Wide spectral sensitivity for each component cell due to combination of two different semiconductor materials

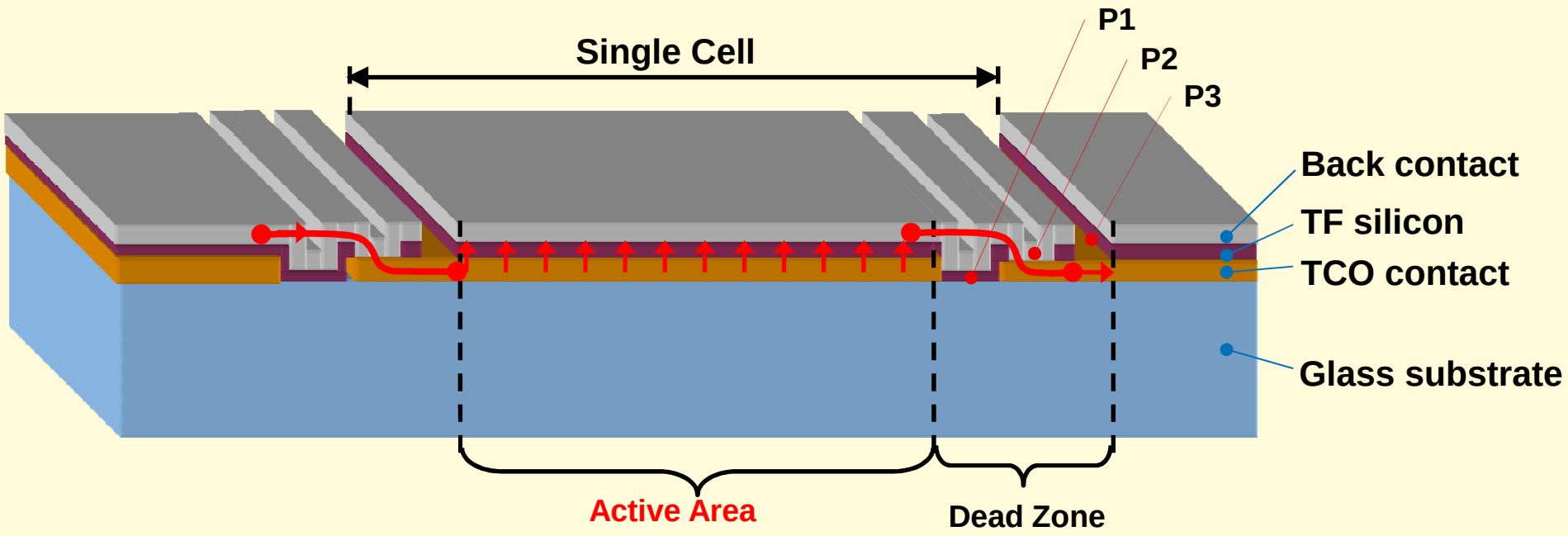


Micromorph™ Technology

Production Process Steps

HelioSphera

Clean → TCO → Laser → PECVD → Laser → Back Contact → Laser → Assembly



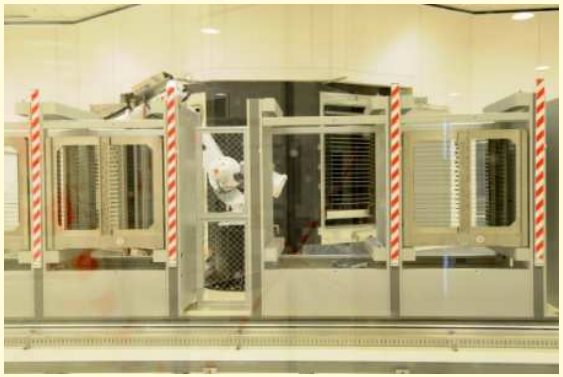
Production Equipment

OPTICAL INSPECTION

FRONT GLASS CLEANER

TCO TOOL

LINE AUTOMATION



LAMINATION TOOL

SILICON DEPOSITION TOOL

LASER TOOL

HelioSphera R&D Projects

HelioSphera's R&D Department is exploring new areas to achieve higher efficiency modules in cost effective mass production. Few of the innovations are listed below:

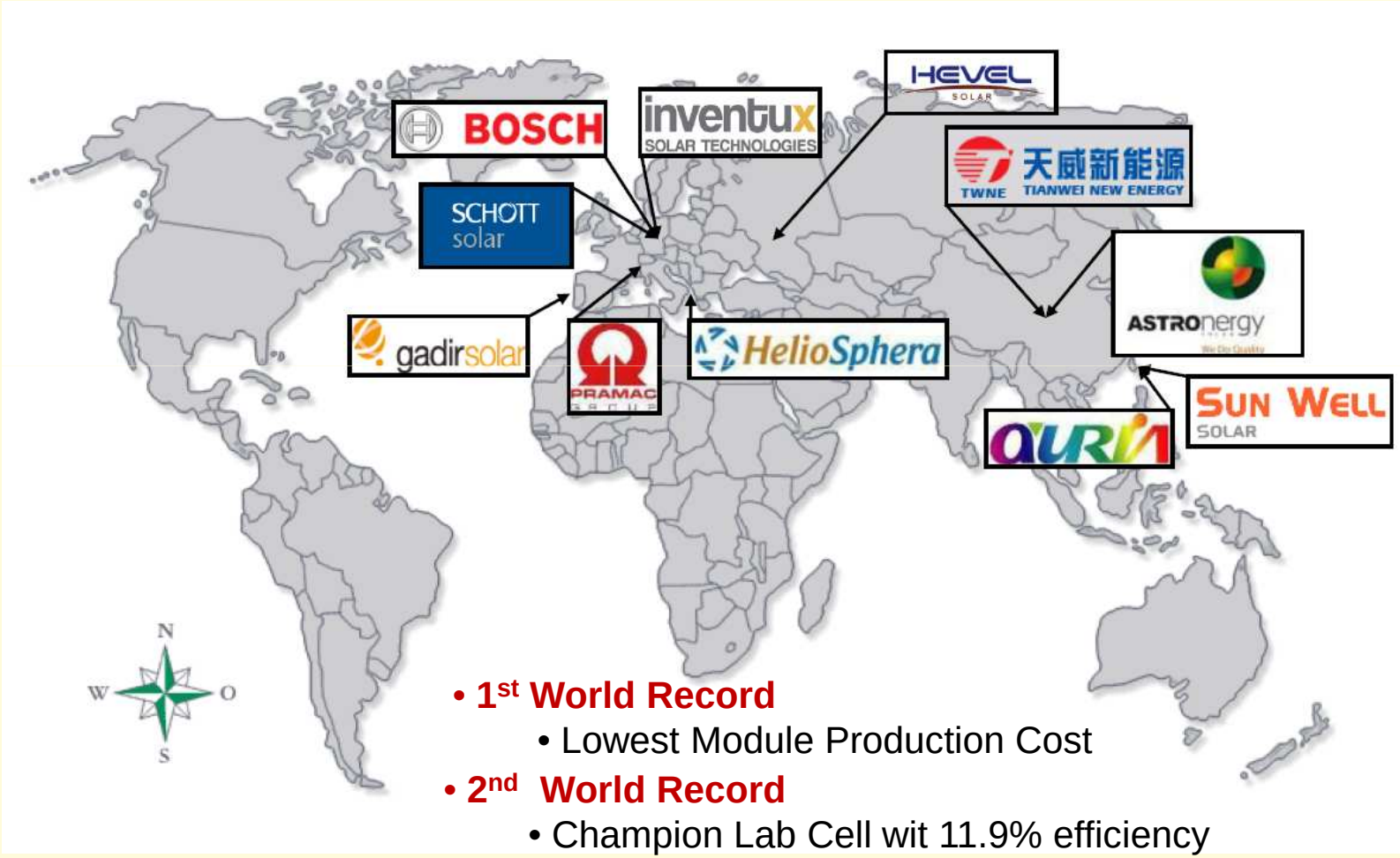
- **Absorber layer (a-Si:H and mc-Si:H) optimization**
  - Material structure development by deposition parameters optimization
- **TCO layer optimization**
  - Light trapping and transmittance improvement in combination with doping optimization will result in power gain
- **Intermediate reflector**
  - The use of an intermediate reflector will improve cell current
- **Active area maximization**
  - Dead zone reductions
- **New module design**
  - Innovative cell design
- **Novel materials for improved light trapping**
  - Textured glass, polymeric foil

HelioSphera Research Collaborations

- **3% of Production is dedicated to R&D Projects**
- **FP7 European Project PEPPER**
  - Research project coordinated by the European Commission/DG Energy
  - Target:157W stabilized power
- **SYNERGASIA 2009 project in collaboration with National Centre of Scientific Research "Demokritos" (Department of MicroElectronics)**
  - Light management improvement (ZnO Nanowires)
  - Process optimization (a-Si Laser Annealing)
- **Democritus University of Thrace (DUTH), Electrical Engineering Department**
  - Optical and structural material characterization
- **Future Projects (Proposals submitted)**
  - *Synergasia 2011 Proposals*
    - *N-GeneSiS:* In collaboration with DuPont/AirLiquide/CRES/DUTH/University of Patras
      - Innovative cost effective materials for module assembly and new mounting
      - Higher deposition rates for increase line throughput
    - OGYGIA: Development of an innovative hybrid power system in collaboration with PPCR (Public Power Corporation Renewable)
  - *Hybrid Organic-Silicon Solar Cells* (Si Nanowires) FP7-ENERGY-2012-1
  - Plasma Cleaning Process Optimization FP7-ENERGY-2012-1
  - *Hellenic Photonics Cluster (H-PHOS)- Laser development*
  - *PV STERN*

Oerlikon Solar Customers

More than 500MW capacity



- 1st World Record
  - Lowest Module Production Cost
- 2nd World Record
  - Champion Lab Cell wit 11.9% efficiency

Certificates

ISO 9001:2008
Quality Management System

Qualified IEC-61646
Safety Tested IEC-61730
Periodic Inspection

PV0069

PHOTOVOLTAIC MODULE
4CM6


Thank you