

# A Breakthrough in Plating for Solar Cell Metallization

M. Balucani<sup>1,2</sup> S. Quaranta<sup>1</sup>

<sup>1</sup> DIET-Sapienza University of Rome, Via Eudossiana, 18 - 00184 Roma (ITALY),

<sup>2</sup> Rise Technolgy S.r.l., Lung.re P. Toscanelli 170 – 00121 Roma (ITALY),

# Agenda / Outline / Overview

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## Introduction

- Solar cell and cost pressure

## History and State of the art

- Plating Techniques
- Technology Key Issues of Plating in Solar Cell
- Localized Plating

## Our Approach (A Breakthrough in Plating for Solar Cell Metallization)

- DLD/DLM
  - Main results achieved
  - On going work (H2020 AMPERE Project)

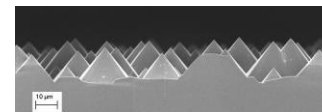
## Acknowledgement

## Conclusions

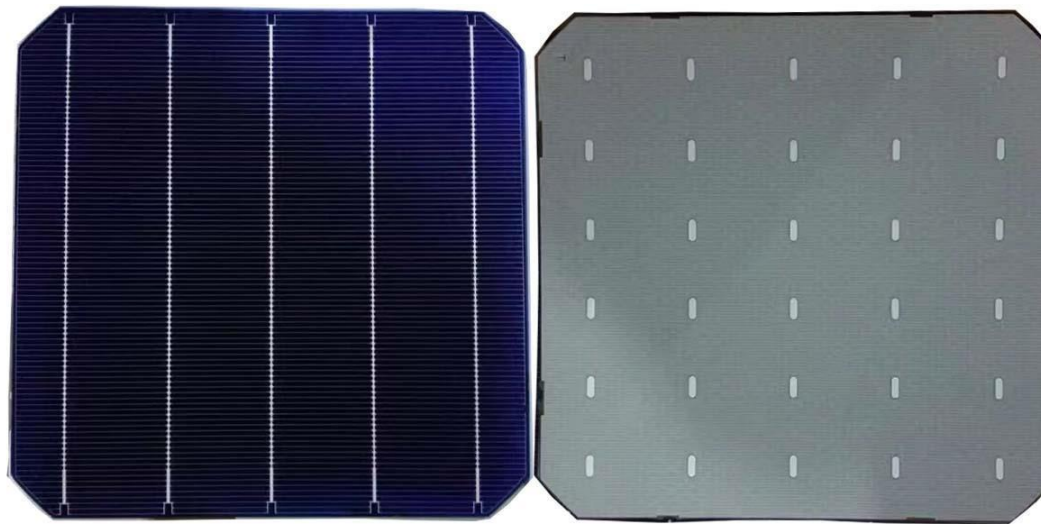
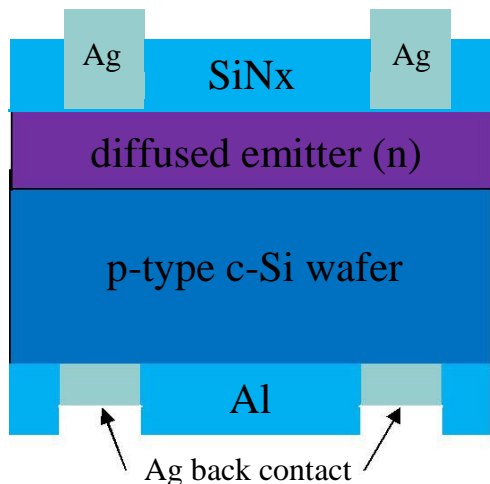
# Introduction

## Solar Cell

World wide production capacity > 110GW



A solar cell, or photovoltaic cell, is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect, which is a physical and chemical phenomenon. It is a form of photoelectric cell, defined as a device whose electrical characteristics, such as current, voltage, or resistance, vary when exposed to light.



ITRPV 2018

Al-BSF

75%

$16.0 < \eta < 20.0\%$

- (2028 ~ 7%)

Market Share

Efficiency

trend for such technologies

PERC/PERL/PERT

22%

$19.0 < \eta < 22.5\%$

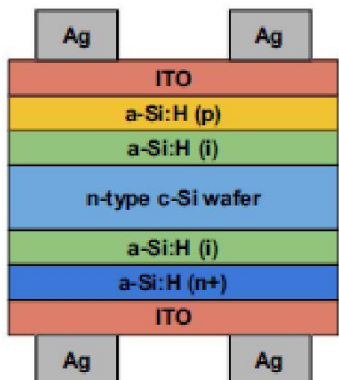
+ (2028 ~ 60%)

# Introduction

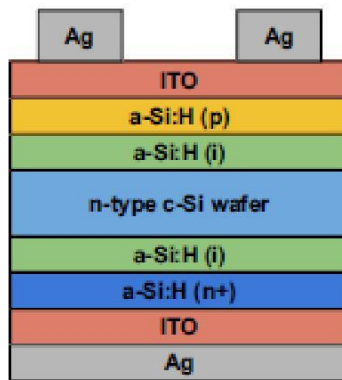
## Silicon HeteroJunction (SHJ) Solar Cell

$\eta > 22.0\%$

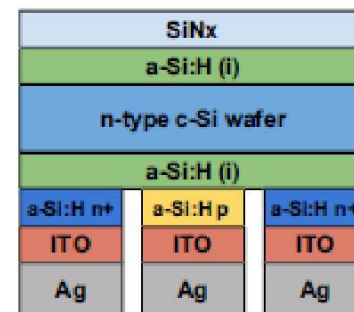
Ref. SHJ  
 $\eta \geq 22.4\%$



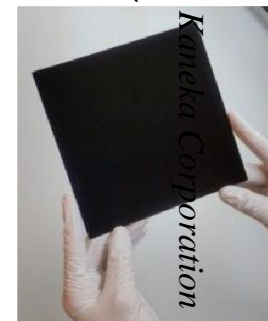
PVD SHJ  
 $\eta \geq 22.7\%$



IBC SHJ  
 $\eta \geq 23.3\%$



$\eta_{record} = 26.63\%$   
size (180 cm<sup>2</sup>)



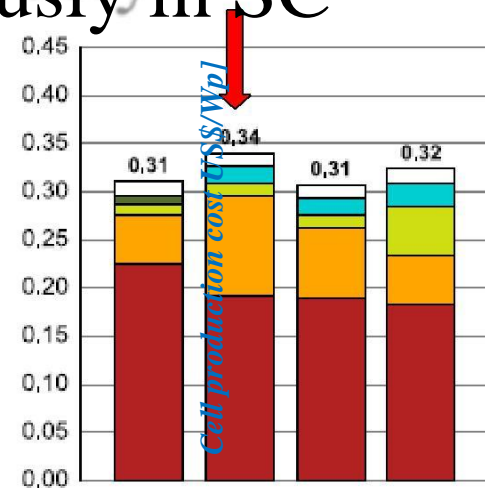
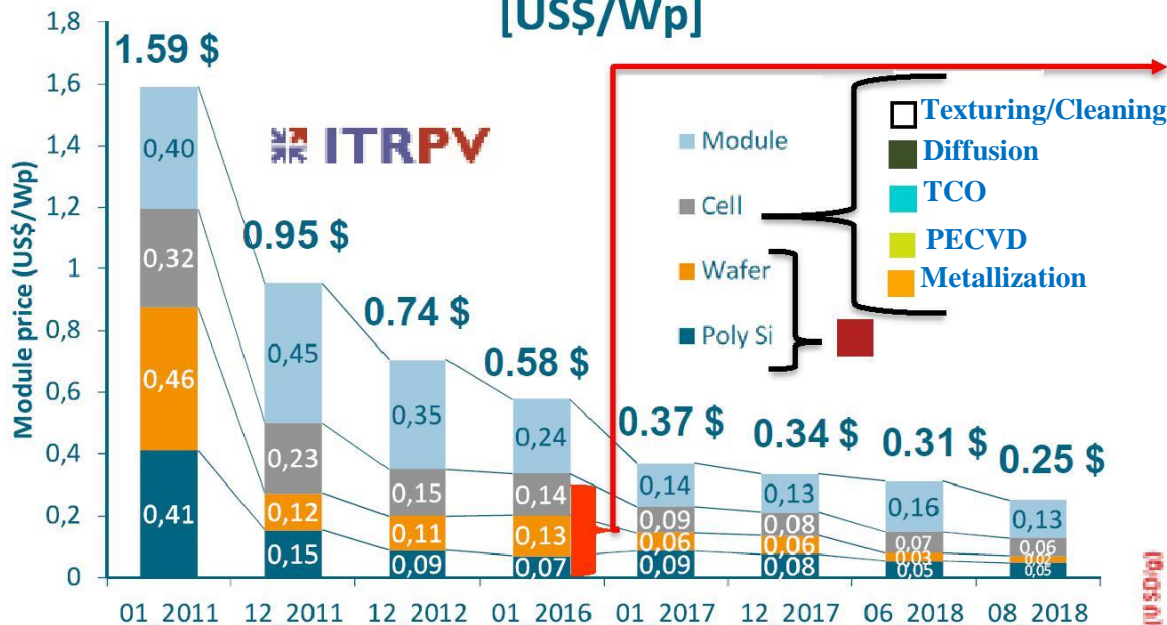
April 2020  $\eta = 22.5\%$  bifacial cell  
at industrial level full scaled automated cell line 100MW

Look to solutions for  $\eta = 23.5\%$

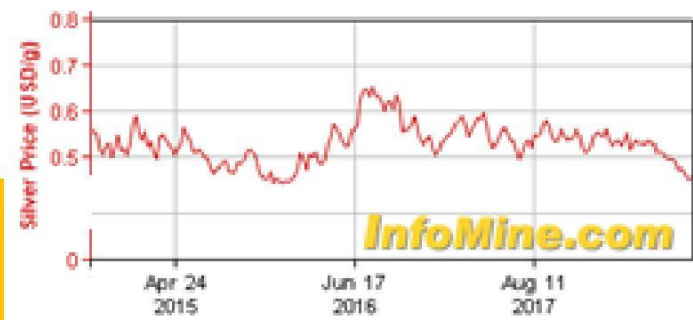
# Introduction

## Cost Pressure Increasing Tremendously in SC

Module price break down [US\$/Wp]



Ref. SHJ 22.4%  
 PVD SHJ 22.7%  
 IBC c-Si 23.3%

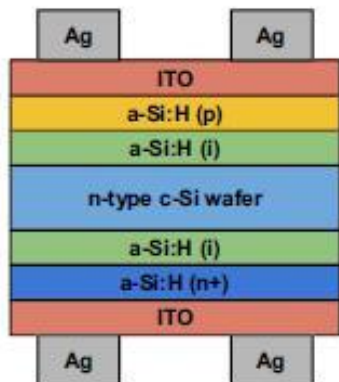


15% < Metallization influence cost (\$/Wp) <  
 30% on Solar cell production cost

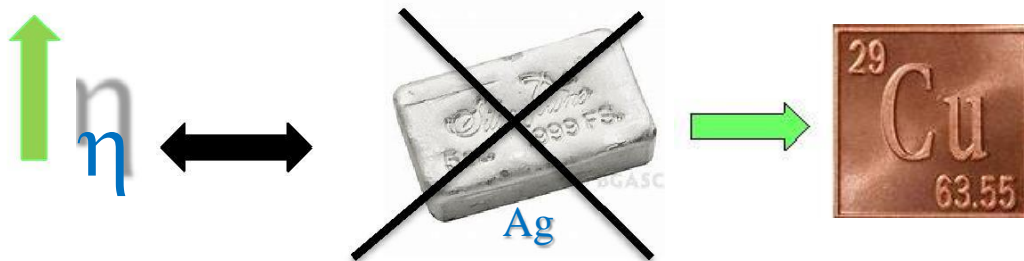


# Introduction

Ag \$/g influences Tremendously solar cell cost



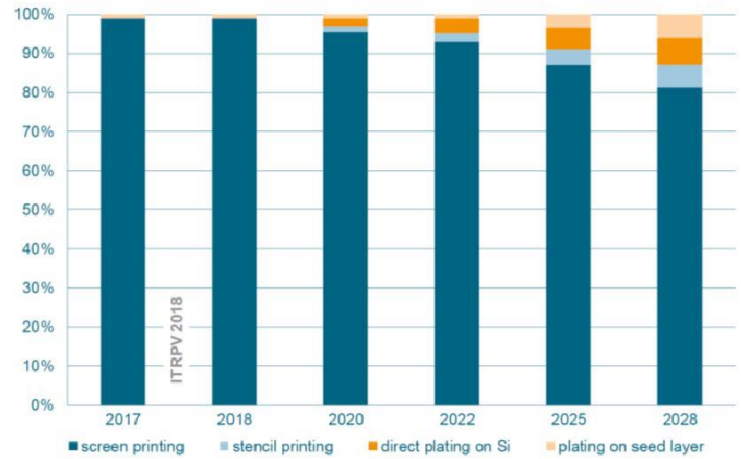
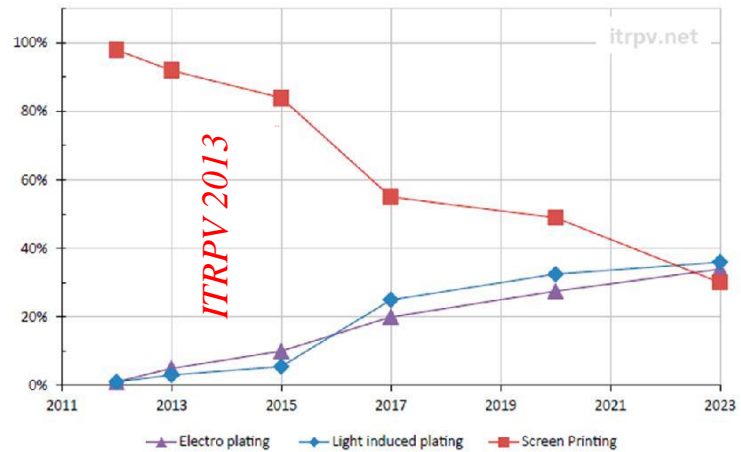
Bi-facial SHJ Ag/cell (5BB)  $\cong$  0.2g  $\rightarrow$  0.14\$/cell  $\xrightarrow{22.5\%}$   $\rightarrow$  0.073 \$/Wp  $\xrightarrow{22.5\%}$   $\rightarrow$  0.34\$/Wp  $\rightarrow$  21.4%



# History and State of the art

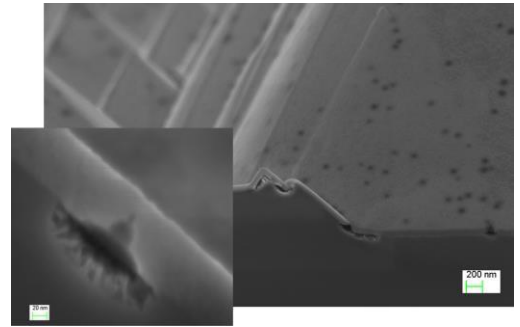
## Plating Technique in Solar Cell

Before the introduction of alternative metallization techniques, technical issues in reliability and adhesion have to be solved. Appropriate equipment also needs to be available. **(ITRPV)**



## Plating key issues

- Copper not directly in contact with silicon!!!! → Need Barrier Layer
- Pin-holes and Scratches
- Adhesion (> 1 N/mm)
- Speed of Plating → Throughput, Space floor and Chemical quantities
- Drag-out → Reduce additive consumption



# State of the art

## Industrial Plating for Solar Cell

- LIP or LAP

BE Semiconductor Industries N.V.



**Meco Direct Plating Line (DPL)**  
([www.besi.com/products-technology/productgroup/plating/com](http://www.besi.com/products-technology/productgroup/plating/com))



**R | E | N | A |**

**InCellPlate Cu**  
[www.rena.com](http://www.rena.com)



# State of the art

## Industrial Plating for Solar Cell

- Plating seed layer



Meco CPL - Plating on seed layer  
<https://www.besi.com/products-technology/product-details/product/meco-cpl/>

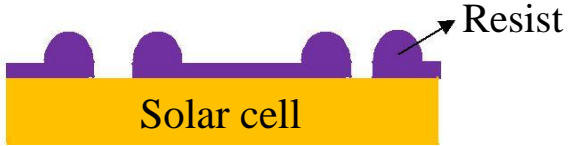
Whatever plating industrial technique you use is necessary to use Protective MASK



PIXDRO JETx P

Inkjet printing equipment for solar cell fabrication

Alternative to printing:  
Apply a film and open it by laser



# State of the art

## Plating Issues

- Mask + Plating  $\approx$  Ag
- Adhesion ....to silicon .....to TCO
- Speed of plating.....

Industrial line for 100MWp is:

$\approx$  30 – 45 m long !!! HUGE FLOOR SPACE!!!!!!

Solution make-up is >1500 liter

!!!!!!



# Acknowledge



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 745601.  
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M. Balucani et al.