Adaptation of a Crystalline Silicon Solar Cell Laboratory to produce Perovskite Solar Devices

INTRODUCTION

ITER continues researching on Solar Cell Fabrication, taking the advantage of the acquired core competences, as well as the available infrastructures, to extend its capabilities on solar cells based on perovskites, aiming to reduce the inherent costs by using the available equipment and procedures as much as possible, and to assess the feasibility of converging this kind of technologies with the standard fabrication of crystalline solar cells.

METHODOLOGY

- Study the state of the art of perovskite solar cell technologies and fabrication processes
- Analysis of the market costs and availability for all the required equipment
- Adaptation of the Solar Cell Laboratory
- Fabrication and characterization of a suitable perovskite solar cell

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CHOSEN TECHNOLOGY

- Planar architecture solar cell
- Methylammonium lead iodide (MAPbI3) as photon absorbing layer
- Transparent conductive substrate (FTO)
- Hole-blocking TiO2 film layer (at the bottom)
- Hole-transport Spiro MeOTAD layer (at the top)

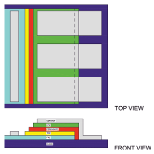

Figure 1: Planar heterojunction architecture of the perovskite device

FACILITIES AND FUNGIBLE

Fabrication process performed in ISO 7 (Class 10,000) clean room.

Substrate preparation

- FTO coated glass cutting
- Laser patterning
- Ultrasonic cleaning

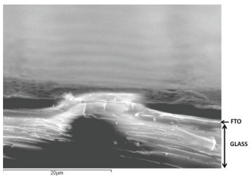

Figure 2: SEM image of a sample section focusing on an area showing the FTO layer ablated.

Solutions synthesis

- Fume hood
- Combined hot-plate magnetic-stirrer
- Precision weighing scales
- Volumetry measurement equipment

Figure 3: View of the fume hood in which a solution synthesis is underway.

Layer depositions

- Spin coating technique
- Chambers and furnaces for drying and Curing process

Figure 4: Spin coating process for the layers deposition

Metallization

- Screen printing technique
- Low temperature curing conductive inks and pastes (< 100°C)
- Short curing periods (10 min)

Characterization

- Chemical nature, quality and uniformity of the deposited layers via X-ray Crystallography and Scanning Electron Microscope imaging
- Capability for quick tests via Spectroscopic ellipsometer
- Photo conversion efficiency test operation values via semiconductor characterization system

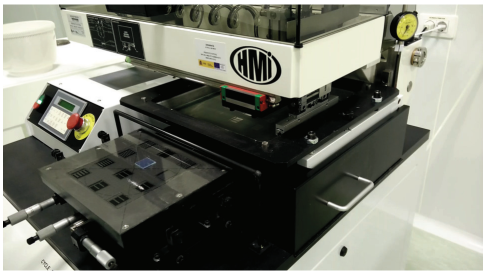

Figure 5: Screen printing process for contact metallization.

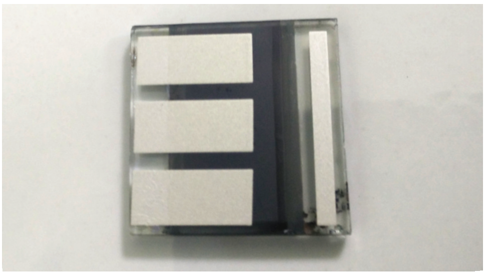

Figure 6: Sample of perovskite solar cell.

COSTS

Table 1: This table shows in detail the cost of the adaptation of a crystalline silicon solar cell laboratory to produce perovskite solar devices.

Process stages	Facilities (€)	Fungible (€)	External service (€)
Substrate preparation	1,172.13	174.50	-
Solutions synthesis	870.81	7,241.21	-
Layer depositions	3,183.00	550.35	-
Metallization	1,663.48	1,177.71	-
Characterisation	7,766.00	-	2,080.50 €
Subtotal	14,655.42	9,143.77	2,080.50
Total			**25,879.69 €**

FIRST RESULTS

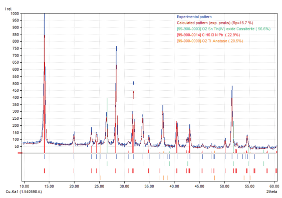

Figure 7: Difractrometer for a sample where TiO2 compact layer and perovskite have been deposited over FTO

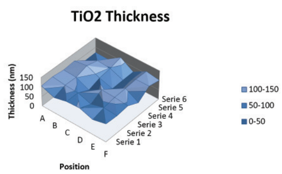

Figure 8: Graph depicting the uniformity thickness of the deposited TiO2 layer with a 0.42 mm resolution.

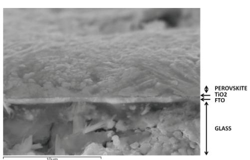

Figure 9: Section view of the left corner of the sample, with an inclination on 7 degree and 600X rise.

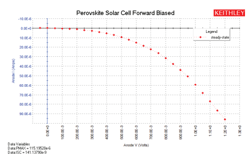

Figure 10: IV Curve for a complete processed device.

CONCLUSION AND DISCUSSION

- IV curve follows the projected shape of a device of this kind of perovskite typology
- Electric parameters were substantially low in relation to the ones mentioned in the available bibliography
- Suggests rather correct fabrication methodology but lacking essential improvements:
  - Strict environment control throughout the whole process,
  - Need to push on quality and uniformity of the layer deposition techniques
  - Avoidance of electric traps
- Objective purpose mostly achieved
- Forecast future research to obtain fully-functional devices

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