Paving the Way for Fully Printable Perovskite Solar Cells

S. CASTRO-HERMOSA[1,3,4], I. BICALHO[1], L. de Q. CORRÊA[1], L.W. de MENEZES[1], R. VILAÇA[1], E. MORGADO [2], T.M. BROWN[3], D. BAGNIS[1,*]
[1]CSEM Brasil, Avenida José Cândido da Silveira, 2000, Belo Horizonte, Brazil
[2]PETROBRAS/CENPES, Av. Horácio Macedo, 950, Rio de Janeiro , Brazil
[3]CHOSE, University of Rome Tor Vergata, Via del Politecnico 1, Rome, Italy
[4]GHIDA, Universidad Surcolombiana, Neiva, Colombia

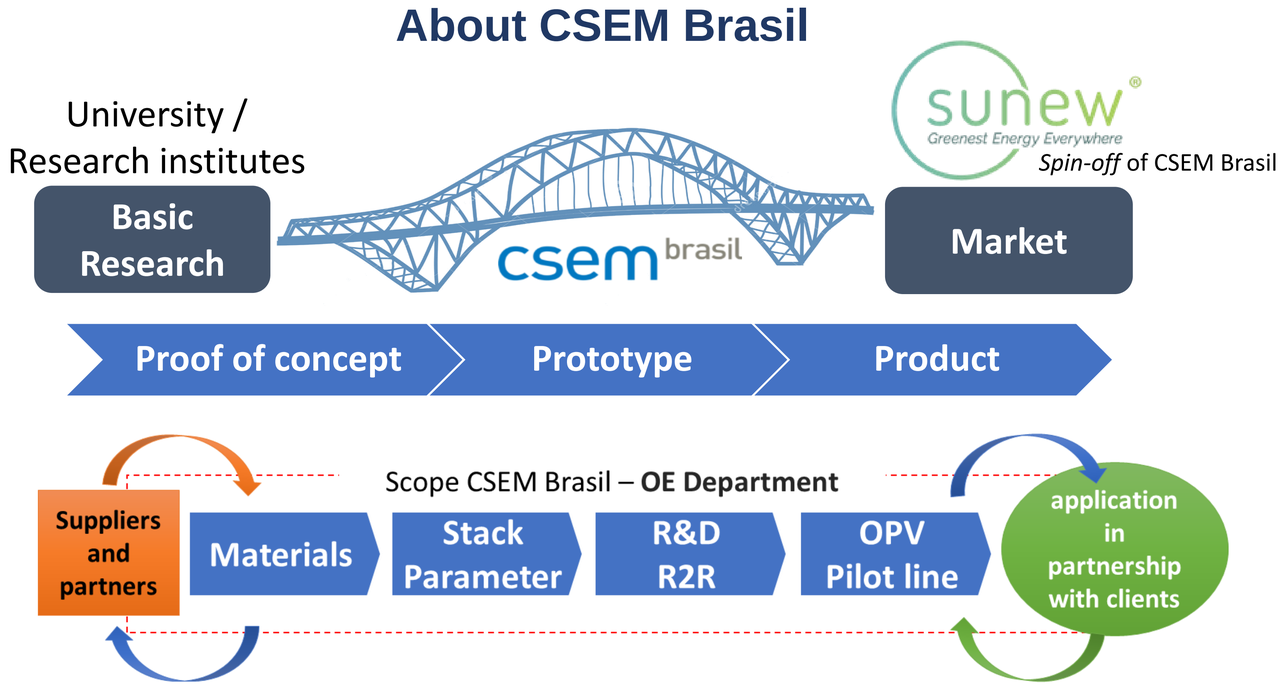
https://csembrasil.com.br/

Abstract

We present a p-i-n perovskite solar cell (PSC) fully printed in air (except for the electrodes) incorporating an ultra-thin Bathocuproine (BCP) buffer interlayer which was deposited for the first time by blade coating. The p-i-n PSC delivered a maximum power conversion efficiency (PCE) of 14.9% over an active area of 0.5 cm^2 under standard test conditions (STC). The buffer improved the PCE of the PSCs by reducing the charge recombination at the PCBM/Ag interface.

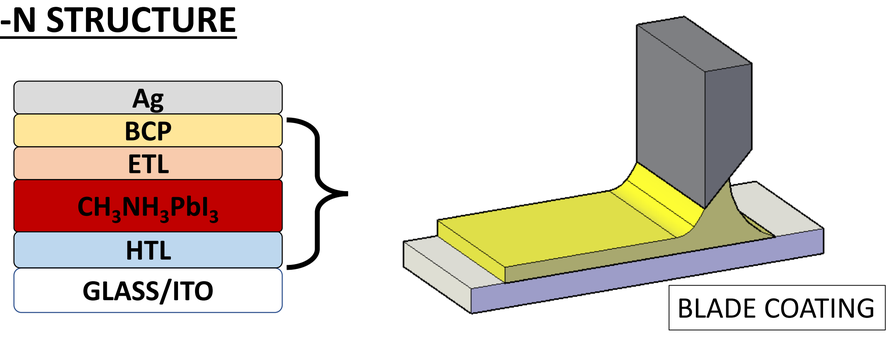
Also, an Ag electrode was screen printed on top of PSC with n-i-p structure reaching a PCE of ~5% over an area of 0.5cm^2. These results highlight important factors which will help those developing printable PSC with either inverted or regular structure.

About CSEM Brasil



Experimental Details

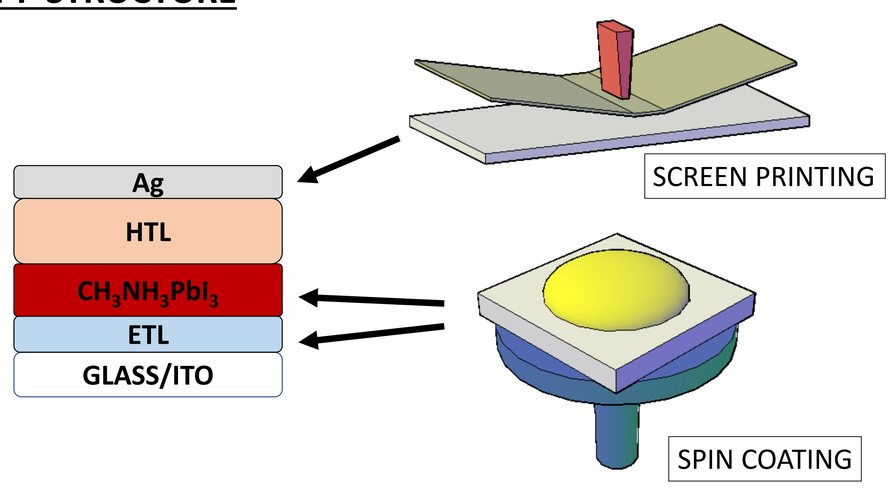
- **P-I-N STRUCTURE**



Layer deposited in air with relative humidity less than 40%.

Electrode by thermal evaporation

- **N-I-P STRUCTURE**



HTL layer deposited by blade coating.

Perovskite by solvent engineering.

All process in air.

Results

- **PRINTED ULTRA-THIN BUFFER LAYER**

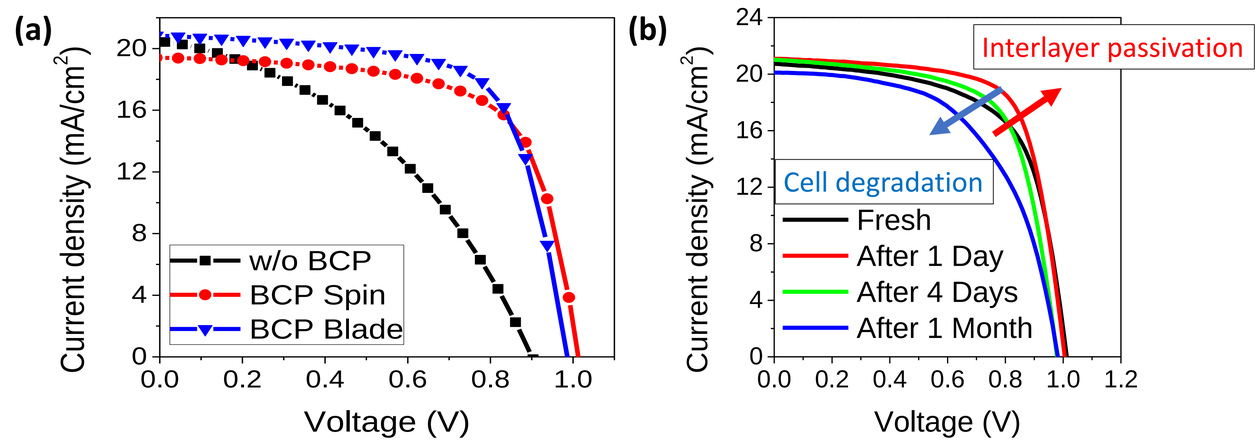


FIGURE 1. J-V curves of fully printed PSCs. (a) PSCs without a buffer layer and including a buffer layer deposited by either spin or blade coating. (b) Performance of PSCs with a blade coated BCP film after 1 month without encapsulation.

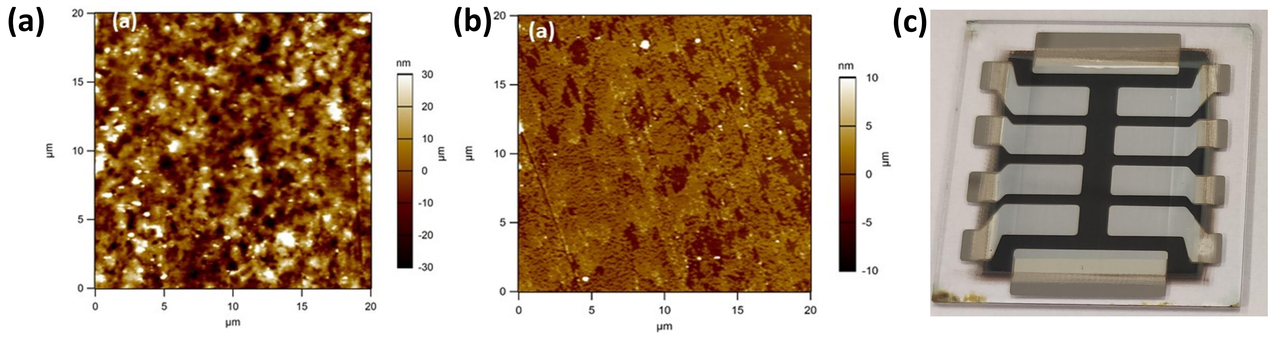


FIGURE 2. AFM height-contrast images of BCP film on perovskite. BCP deposited by (a) spin coating or (b) blade coating. (c) Photograph of a full printed PSC (except for the electrodes) on a 5x5 cm^2 substrate (Active area = 0.5 cm^2).

- **PRINTED ELECTRODE ON N-I-P PSC**

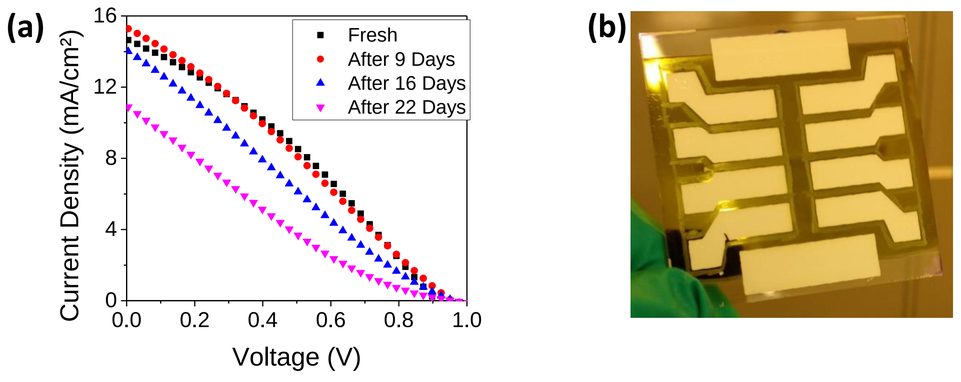


FIGURE 3. (a) J-V curve of PSCs with a screen-printed silver electrode through time. (b) Photograph of a PSC with printed electrode.

Conclusions

- We have demonstrated different process to fabricate fully printed PSCs including ultra-thin buffer layers and back electrodes.
- PSCs with p-i-n architecture delivered a maximum PCE of 14.9%. The ultra-thin BCP interlayer was successfully deposited for the first time via blade coating. PSCs with blade coated BCP delivered a 10% higher PCE than their counterpart with spun BCP making the ultra-thin BCP interlayer compatible with R2R deposition in air.
- The screen-printed silver electrodes are a suitable alternative to the thermal evaporate ones., being stable after 16 days. These electrodes are low cost and compatible with R2R process.

Acknowledgment

The authors thank Jair Rodrigues for the preparation of printed electrodes. Thank to Petrobras project to be the main funder of this work. S.C.H thanks to Departamento del Huila's Scholarship No. 677 for funding. Thank to the Centro de Microscopia of Universidade Federal de Minas Gerais (CM-UFMG) for AFM microscopies.

Sergio Castro-Hermosa
Sergio.castro@csembrasil.com.br
sacastroh
https://linkedin.com/in/sacastroh

Funding

PETROBRAS

References

1. S. Castro-Hermosa et al. **PEROVSKITE SOLAR CELLS WITH AN ULTRATHIN PRINTED BATHOCUPROINE LAYER . 2019 .** In preparation