Performance of perovskite solar cells with field's metal as an alternative cathode

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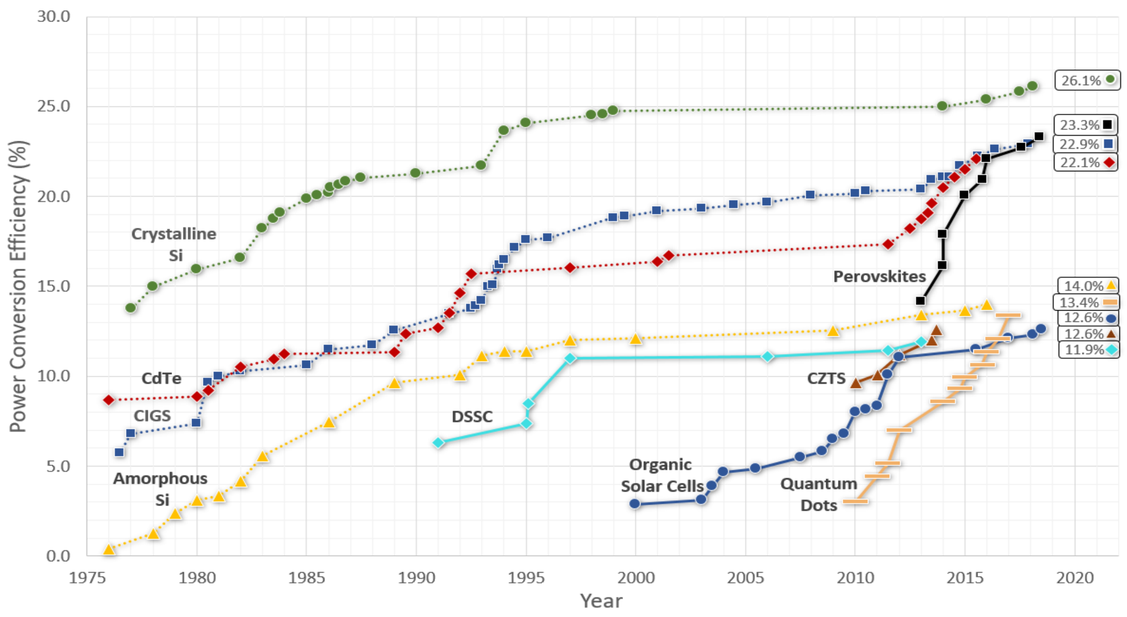
Abstract: In this work, the Field's metal was studied as an alternative cathode in perovskite solar cells (PSC-FM) and their performance was compared to reference cells with Ca/Ag cathodes (PSC-Ca/Ag). The structure of the solar cells was: glass/ITO/PEDOT:PSS/$CH_3NH_3PbI_{3-x}Cl_x$/$PC_{71}BM$/Cathode. An analysis of the interface of the $PC_{71}BM$/cathode was made using SEM, AFM and LBIC. It was found that the interface with FM showed defects such as "empty spaces" that would make a bad physical contact between both surfaces. However, the photovoltaic performance of perovskite solar cells showed comparable efficiencies; for PSC-FM the PCE was 10.2% meanwhile for PSC-Ca/Ag was 10.5%. Therefore it is shown that the eutectic mixture of Field's metal is a good alternative cathode which does not require special conditions to be deposited and it is not expensive to acquire.

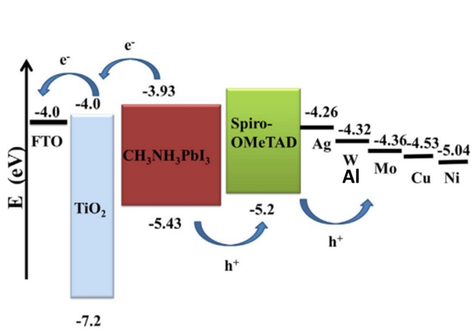
Introduction

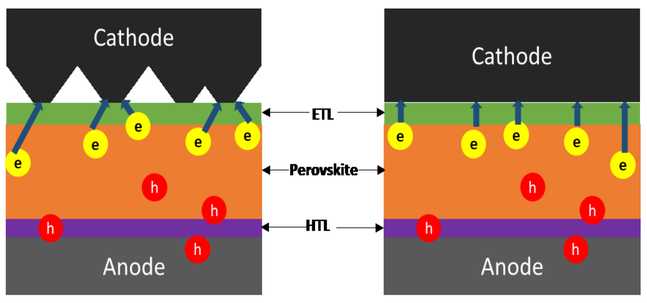
PSCs have been studied by research teams all over the world for their interesting properties such as low band gap, broad absorption spectrum and the electronic properties of the active material.



The most used cathodes are Al, Ag, Ca/Al and Au, with these the PCE above 15% has been reported. However, special conditions are required to deposit such materials making the procedure time consuming and expensive.

Alternatives anodes



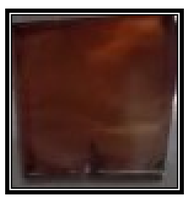


Experimental

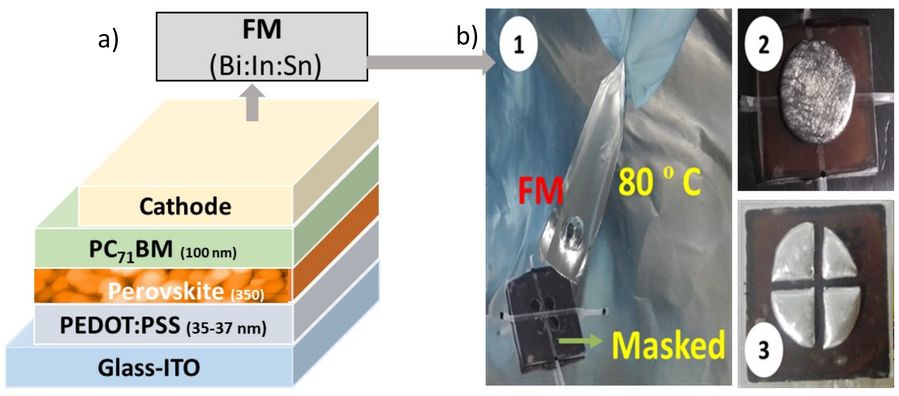
Films deposition

$MAPbI_{3-x}Cl_x$
1:1:4 ($PbCl_2$:PbI_2:MAI)
Ossila

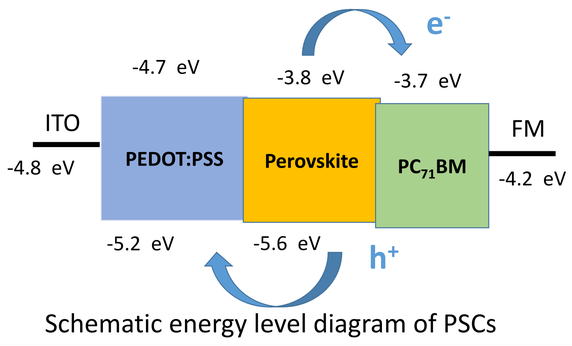
Perovskite film



Device fabrication



a) Schematic representation of perovskite devices (b) masked and deposit of the FM



Schematic energy level diagram of PSCs

References:
[1] Dubey, A.et al.Mater. Chem. A 6, 2406–2431 (2018).
[2] Chouhan, A. et. al. Mater. Lett. 221, 150–153 (2018).
[3] Li, B., et. al. Adv. Mater. Interfaces 5, 1800326 (2018).

Acknowledgements:
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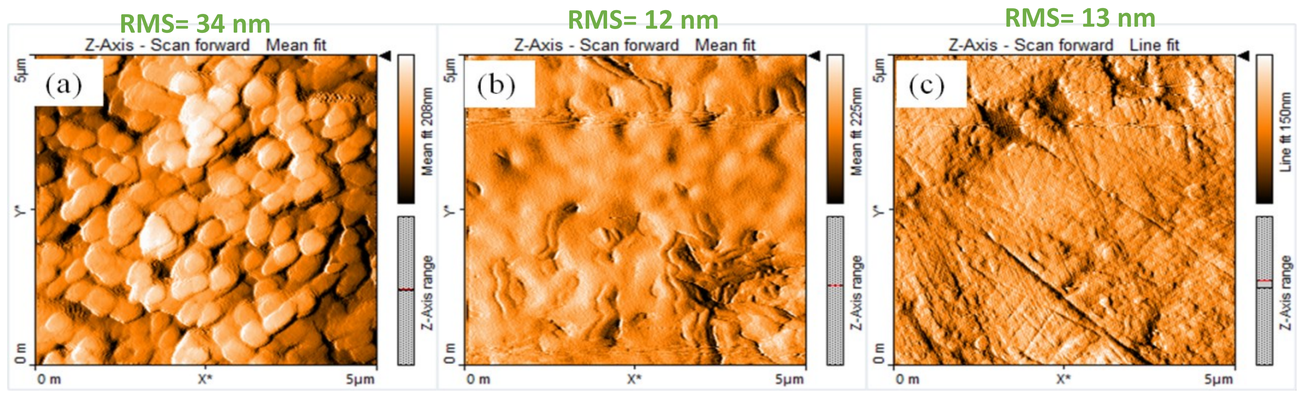
Results

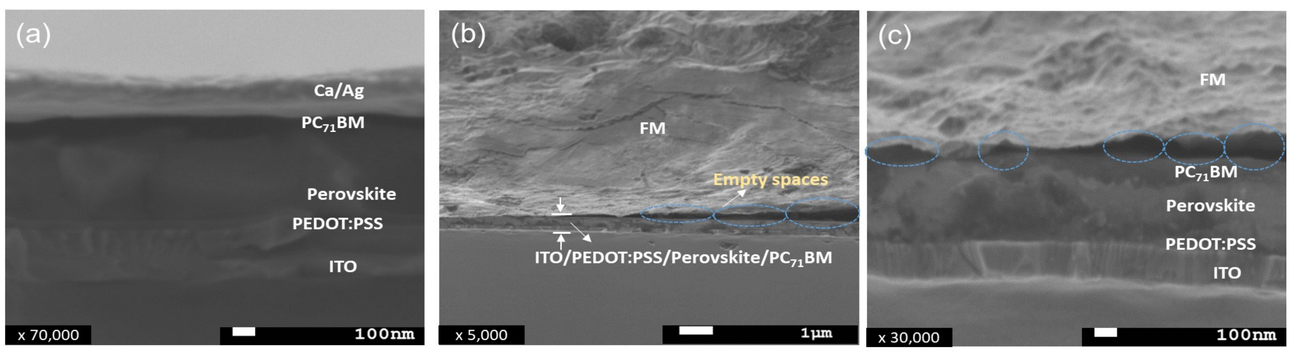
Films characterization

AFM



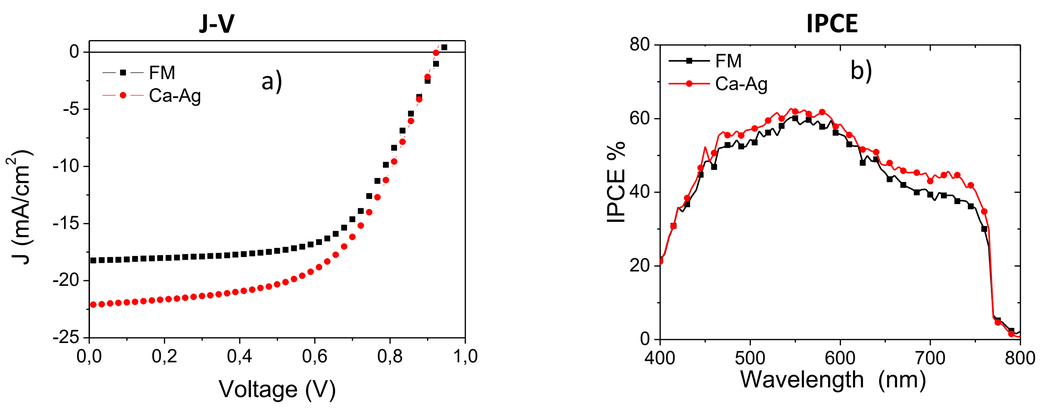
AFM images of films; (a) Perovskite, (b) Perovskite/$PC_{71}BM$ and (c) Field´s Metal (FM) after a rinse with chloroform to remove residues of $PC_{71}BM$

SEM



SEM images for PSCs cross section with (a) Ca/Ag and (b, c) FM and as cathodes

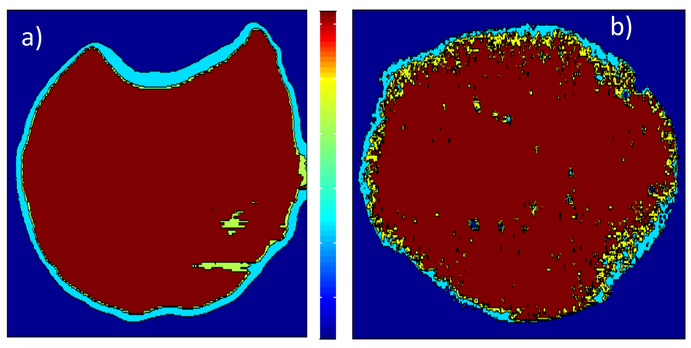
Devices characterization



(a) J-V curves and (b) IPCE of PSCs, with FM or Ca/Ag as cathodes

Cathode	Voc [V]	Jsc[mA/cm²]	FF	PCE [%]
Ca/Ag	0.922	22.14	0.57	11.6 (10.5±0.8)
FM	0.933	18.26	0.62	10.5 (10.2 ± 0.2)

LBIC



LBIC images of photoresponse for PSCs with (a) Ca/Ag and (b) FM as cathodes

Conclusions

The Fields metal as alternative cathode has been used in perovskite solar cells. We studied the $PC_{71}BM$/FM interface and its influence on device performance. The morphological analysis showed several "empty spaces" at the $PC_{71}BM$/FM interface. Despite this issue, the performance for our devices with the FM was comparable with that for devices with Ca/Ag common cathode used as reference. The PCE largest values were 10.5 and 11.6% respectively. The results showed that defects at the cathode interface are not determining charge transfer process; even though the contact area in the interface is smaller, the electrons have been transported correctly towards the FM by the areas of good contact. Therefore this study suggests that the quality of this interface is not so crucial for the overall devices performance. Also, FM is a non expensive material of fast and easy implementation.