IOCN 2020

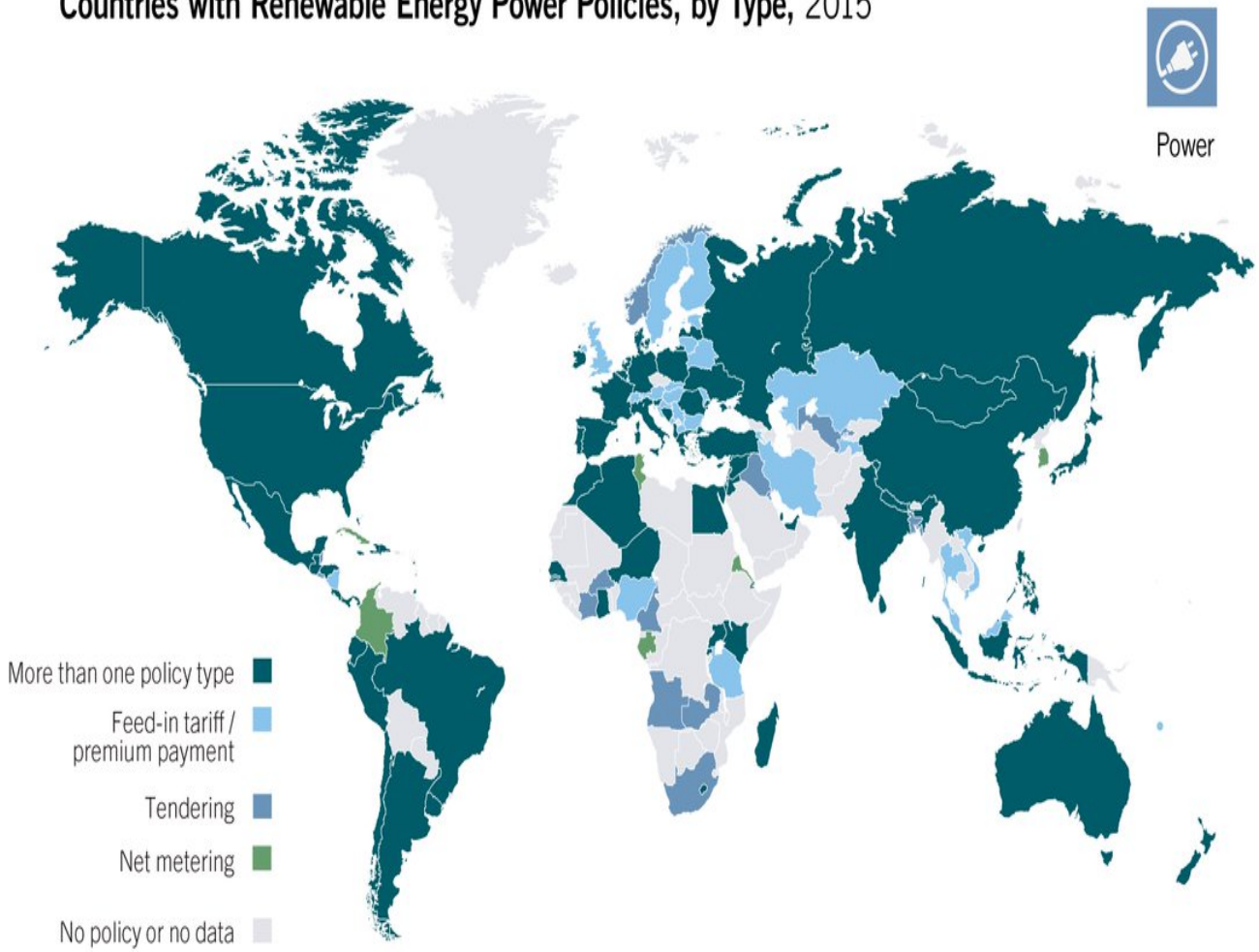
Enhanced Efficiency of Inverted Perovskite Solar Cells by Passivating Hole Transport Layer with POSS

ment of Chemical and Materials Engineering, National Yunlin University of Science and Tech

Bo-Tau Liu, Hong-Ru Lin

15-30 NOV. 2020

Countries with Renewable Energy Power Policies, by Type, 2015

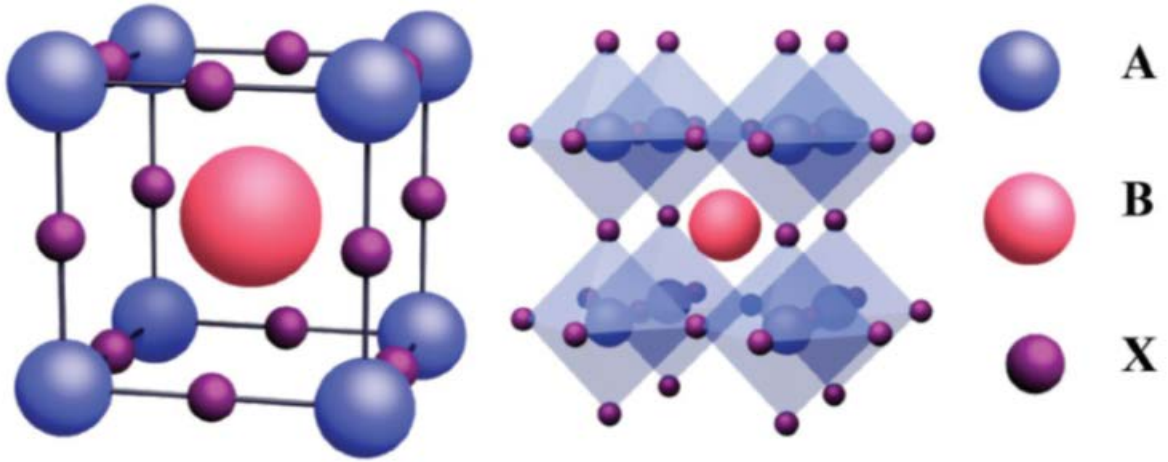


Note: Countries are considered to have policies when at least one national or state/provincial-level policy is in place.

REN21 *Renewables 2016 Global Status Report*

Source: REN21 Policy Database

ABX_3



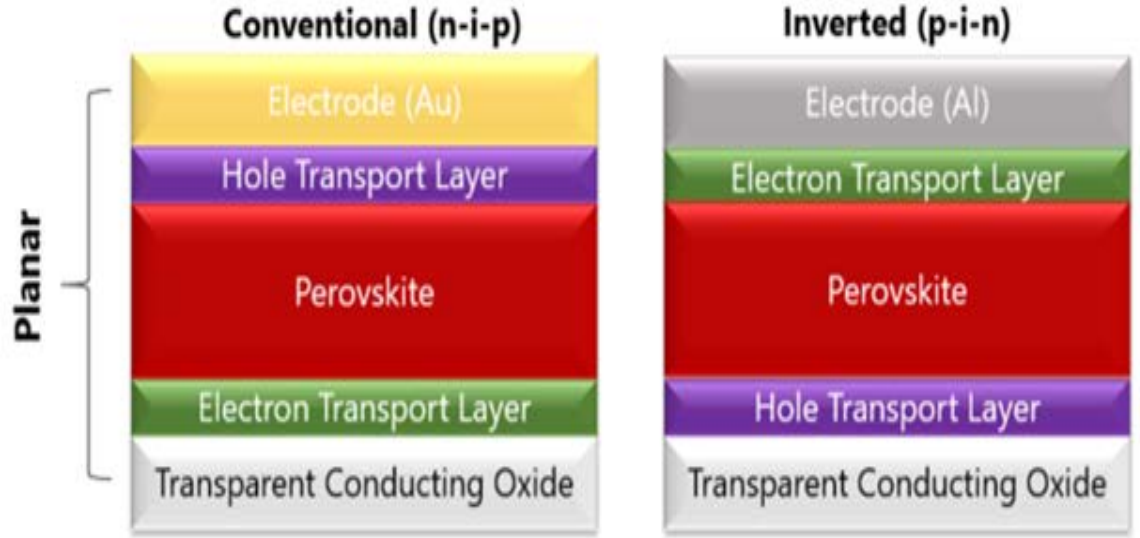
A: Na^+、K^+、Ca^{2+}、Sr^{2+}、Pb^{2+}、Ba^{2+}

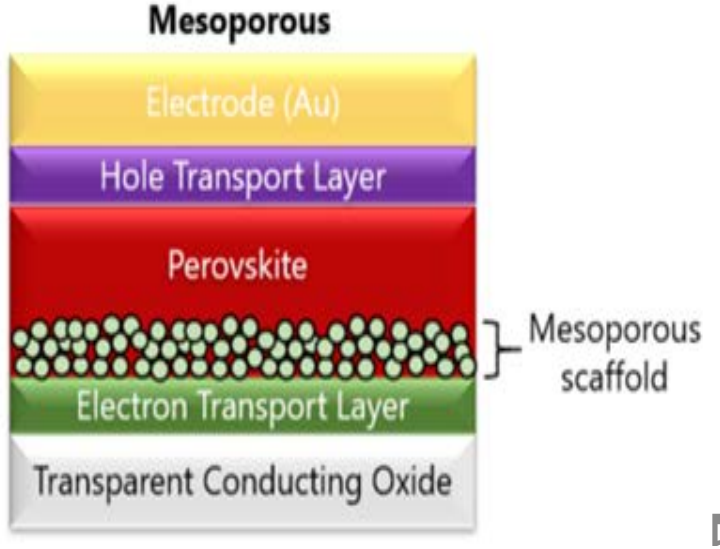
B: Ti^{4+}、Cd^{2+}、Nb^{5+}、Mn^{6+}、Fe^{3+}、Zr^{4+}

X: O^{2-}、F^-、Cl^-、Br^-、I^-

$CH_3NH_3PbI_3$ is one of the most used perovskite materials

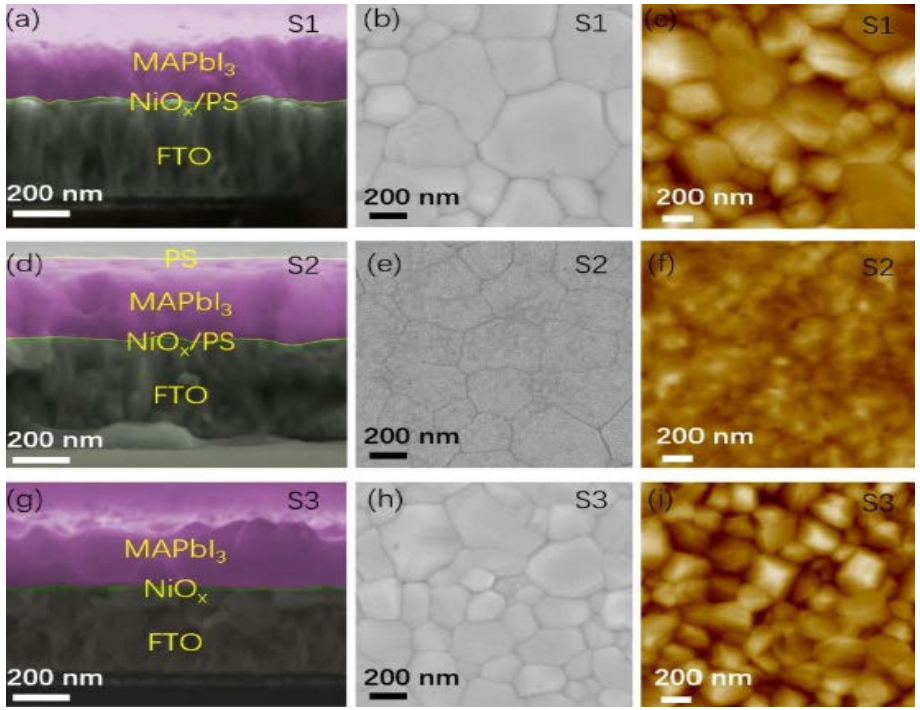
Common Structure

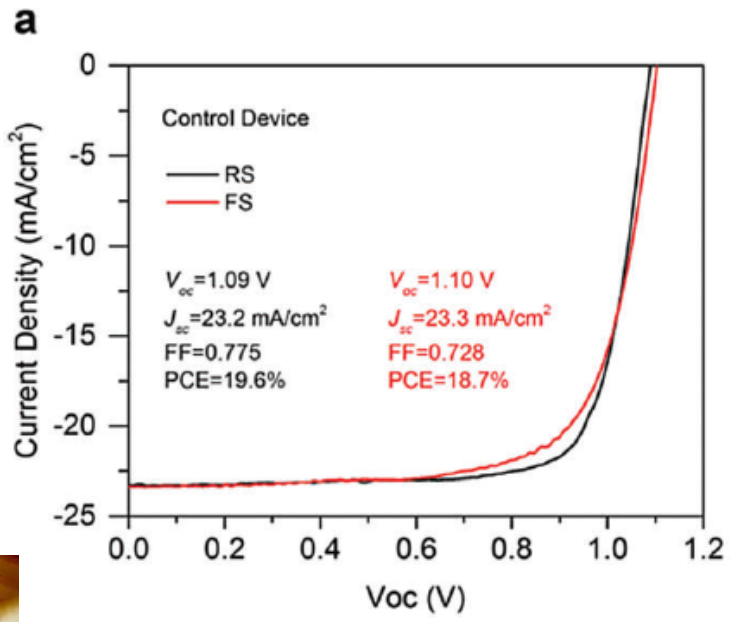


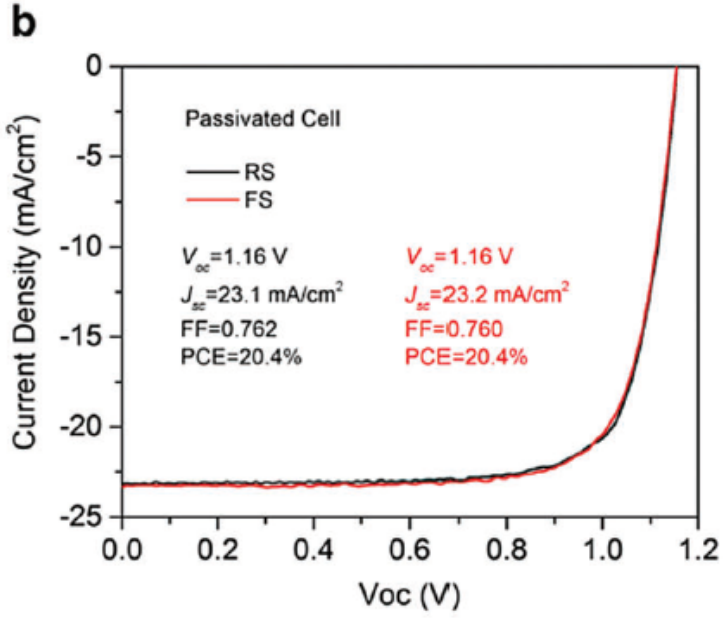


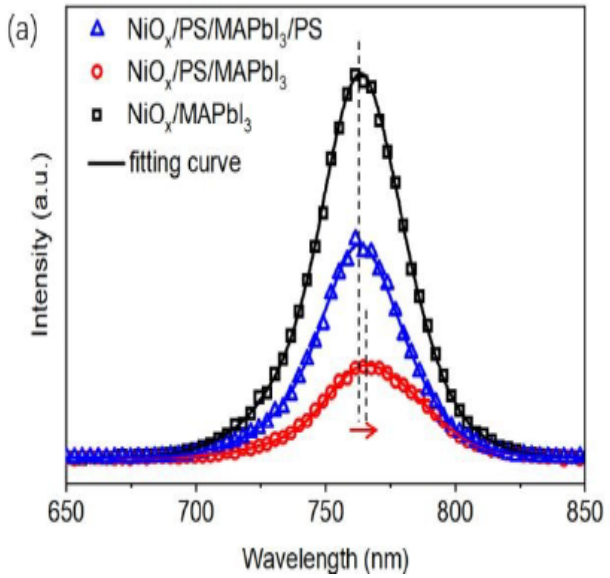
Interface passivation

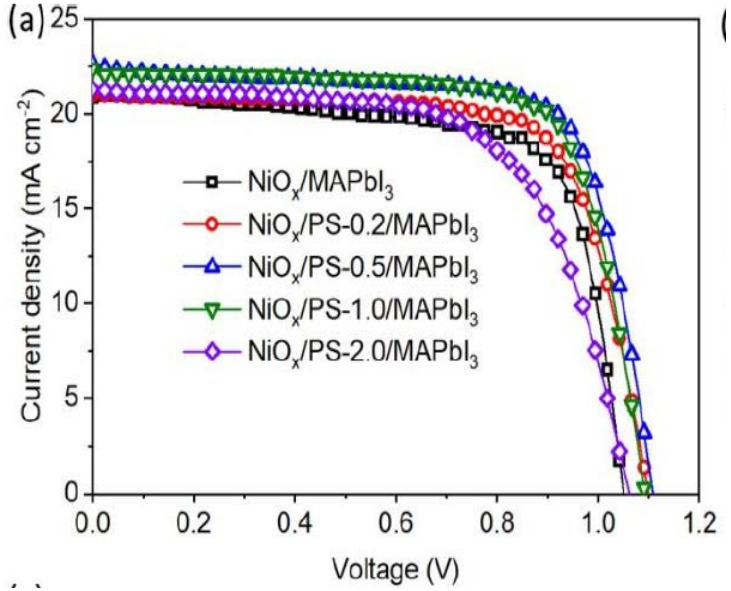
Energy Environ. Sci. 2017, 10, 1792
J. Mater. Chem. A 2019, 7, 21730



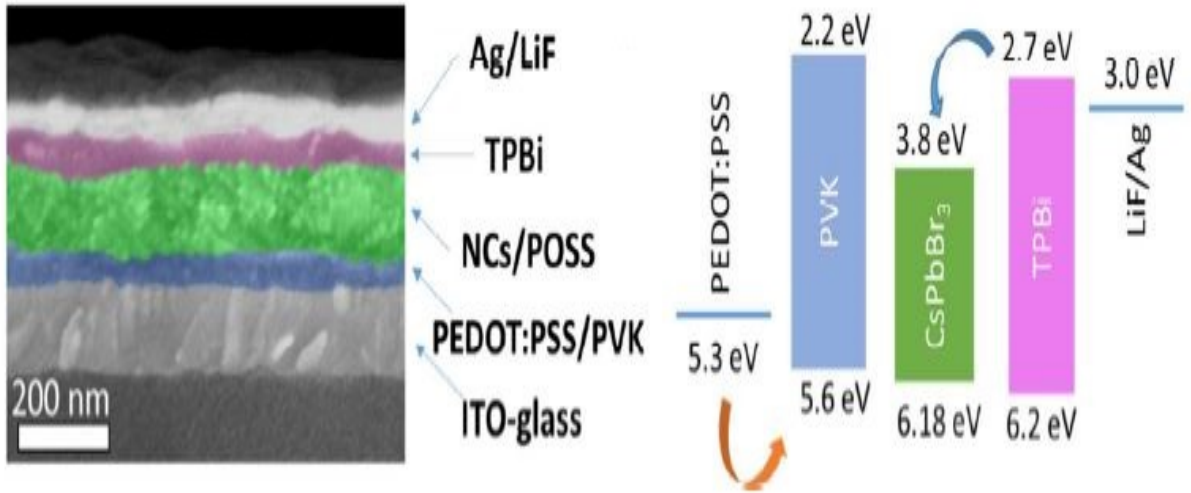






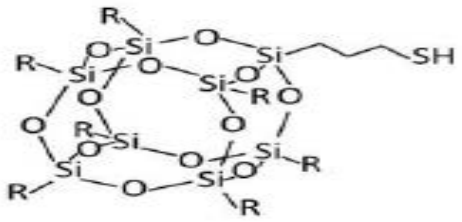


Enhancement by Polyhedral Oligomeric Silsesquioxane (POSS)

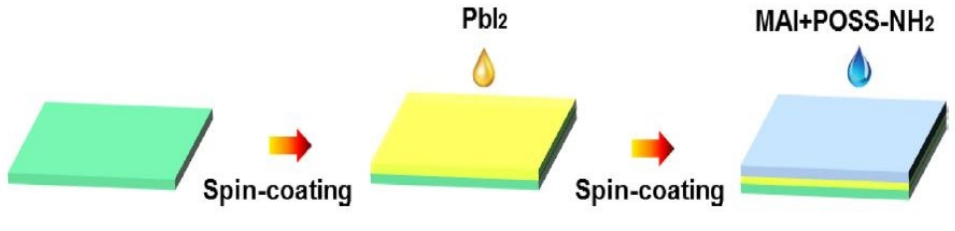


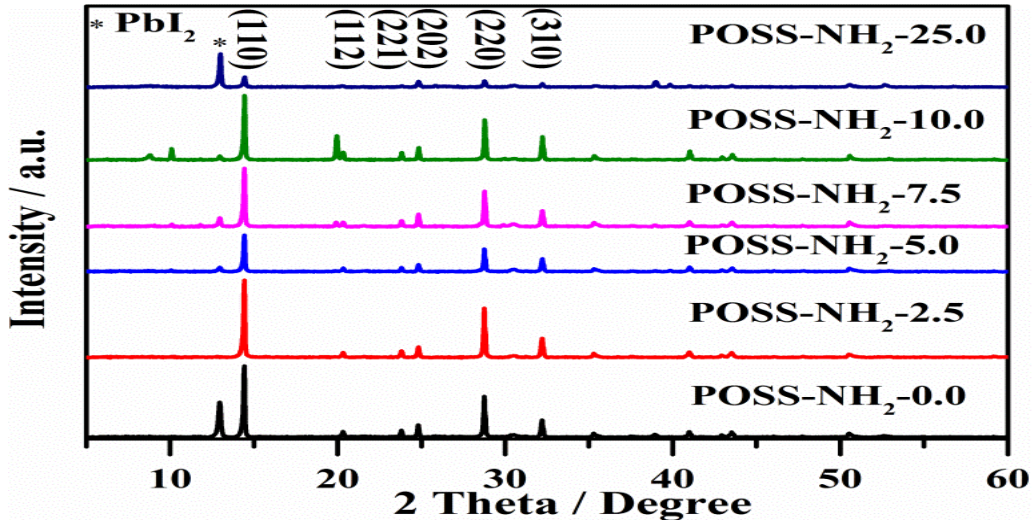
Ag/LiF
TPBi
Perovskite/POSS
PEDOT:PSS/PVK
ITO-glass

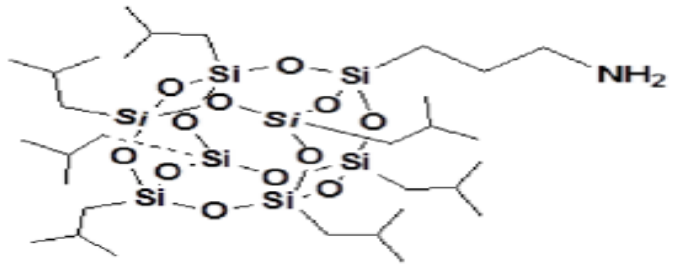
POSS



J. Phys. Chem. Lett. 2016, 7, 4398







POSS-NH2

Solar RRL 2018, 2, 1800069

NiO_x Synthesis

Ethylenediamine (EDA)

$\mathbf{EDA:Ni^{+}=1:\frac{2}{3}}$ $\boldsymbol{molar\ ratio}$

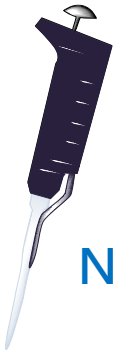
On hotplate stirring
overnight keep at 60 ℃

	Boiling point
ethylene glycol	197.3 °C
2-Methoxyethanol	124-125℃

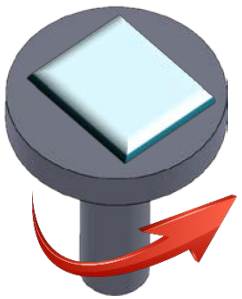
NiOx precursor

0.6M Nickel(II)
nitrate(99.9985%, Alfa Aesar)
2-Methoxyethanol Sol.

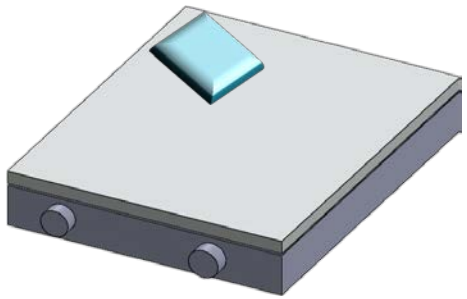
High Voltage NiO_x Synthesis



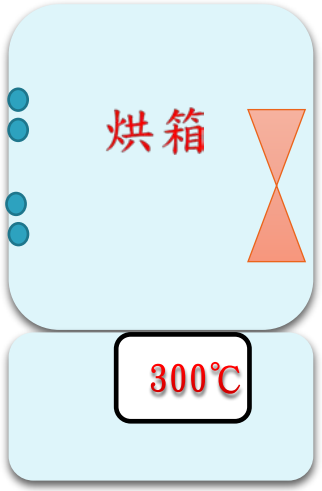
NiOx precursor



4000 rpm
40s



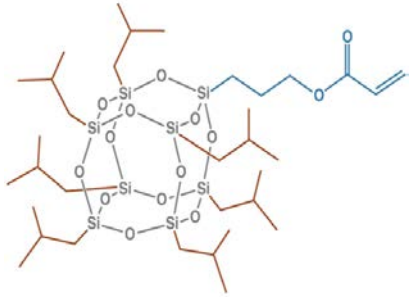
100℃ 10min
pretreatment

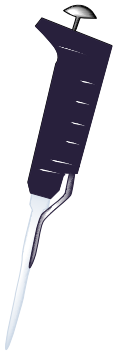


Sintering
300℃ 1 hr

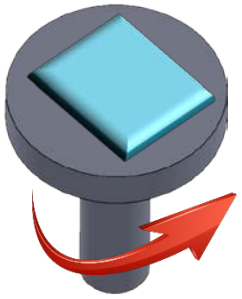
Cooling down,
Into glovebox to
fabricate solar cell

Device Fabrication





MA0701 POSS
different conc.
(W.O.、0.005、0.01、
0.015、0.05 mg/ml
IPA Sol.)

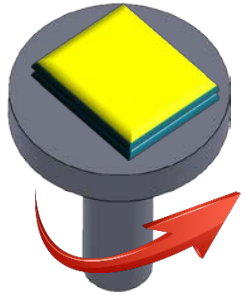


6000 rpm
20s

Annealing

100℃
10 Min

$MAPbI_3$ 1.45M
DMF : DMSO=4:1

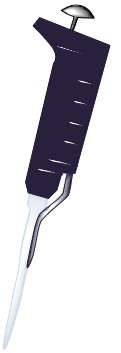


4000 rpm
25s

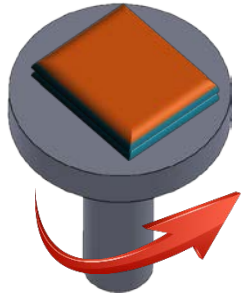
Added Anisole as
antisolvent within 10s

Annealing

100℃
10 Min

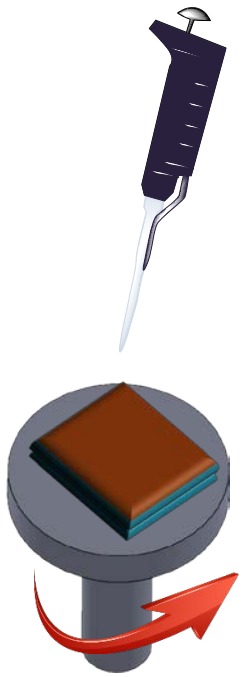


$PC_{61}BM$



3000 rpm
20s

Device Fabrication

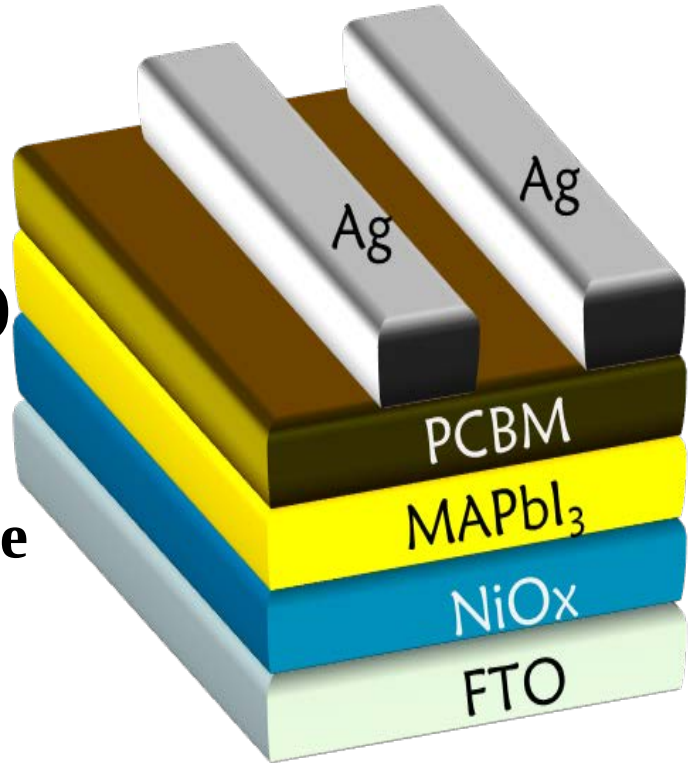


BCP

No Annealing

5000 rpm
20s

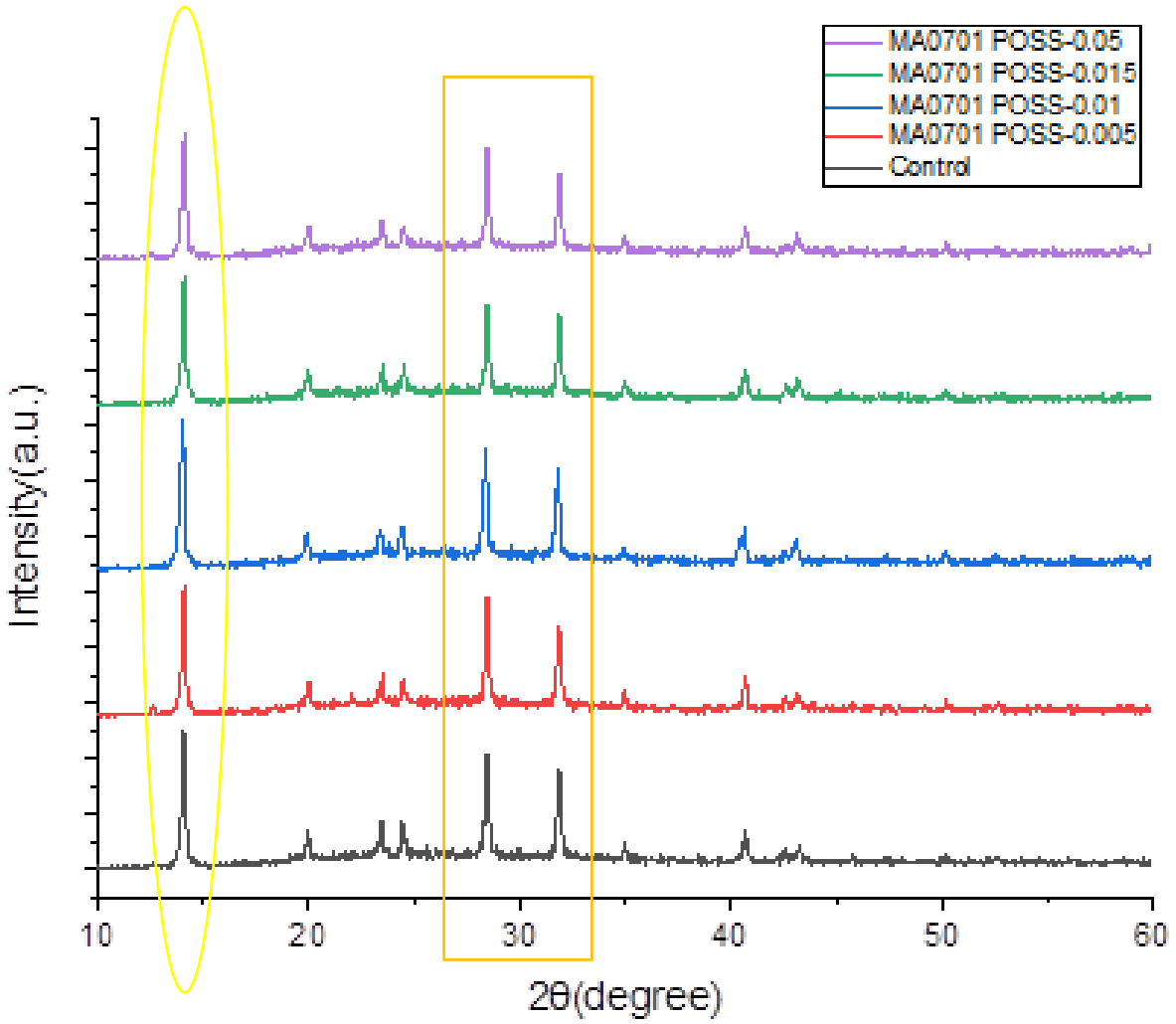
an Ag electrode (~100 nm) was thermally deposited under a base pressure of ~2×10^{-4} Pa to complete the device.

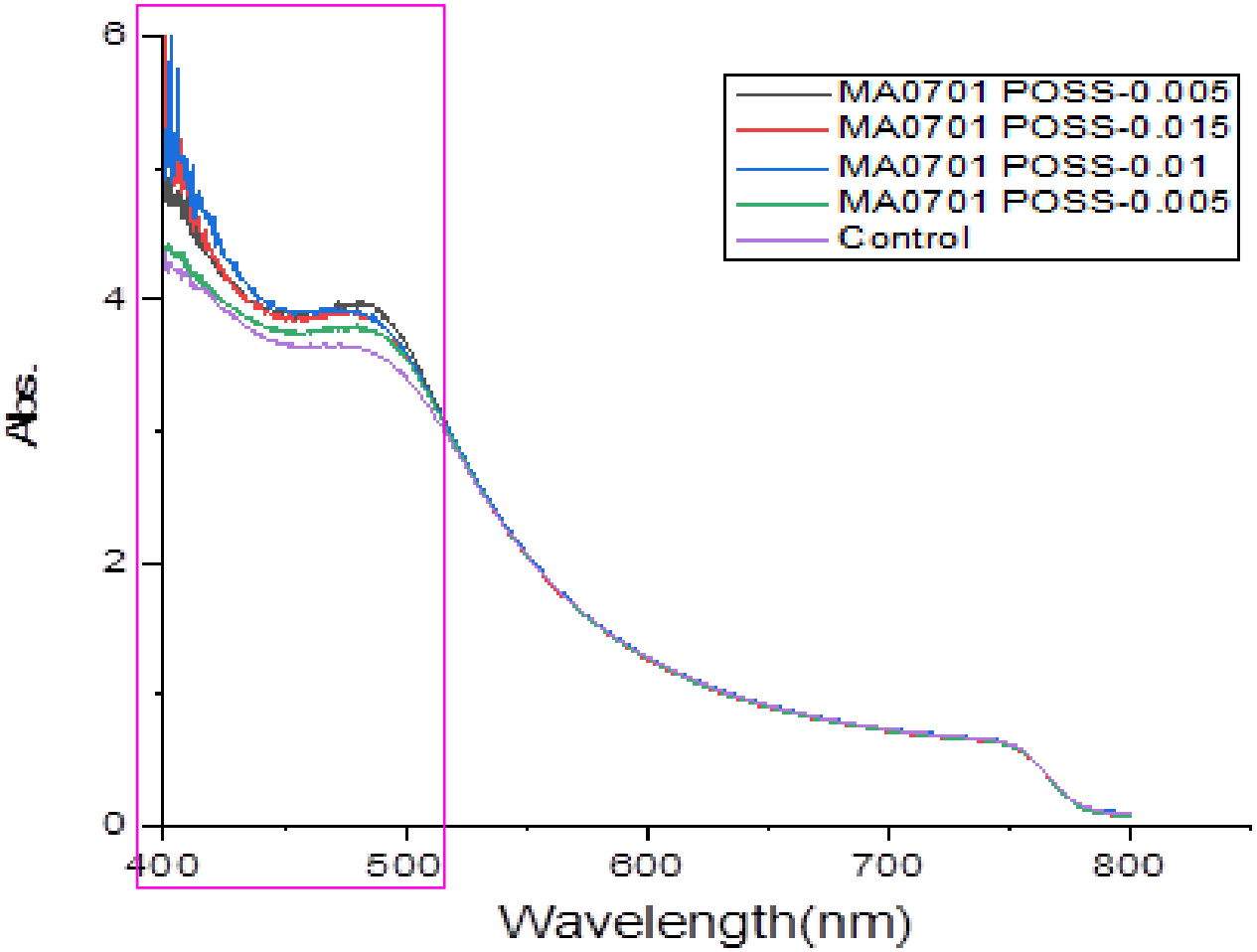


Insert Buffer layer BCP

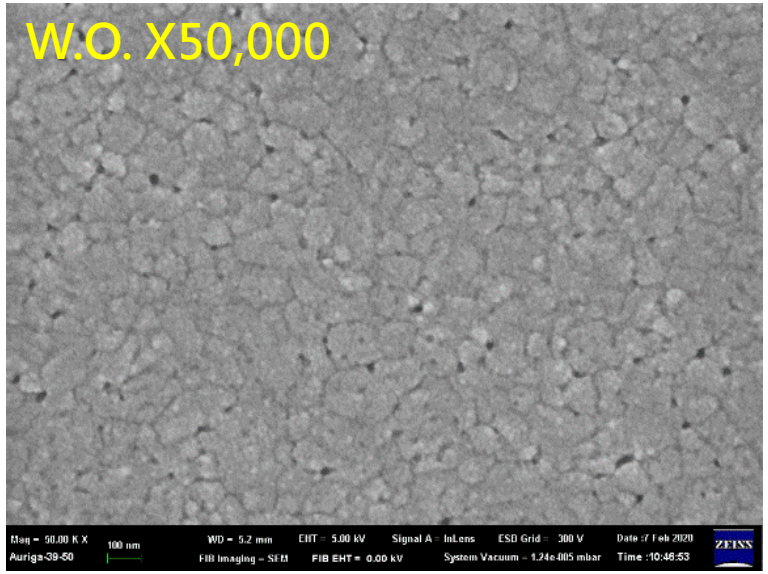
Insert charge tunnel POSS

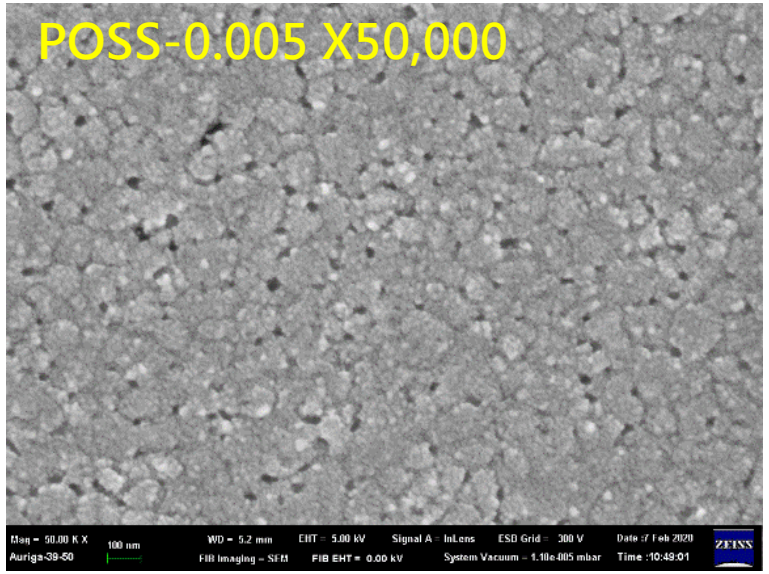
XRD & UV-Vis

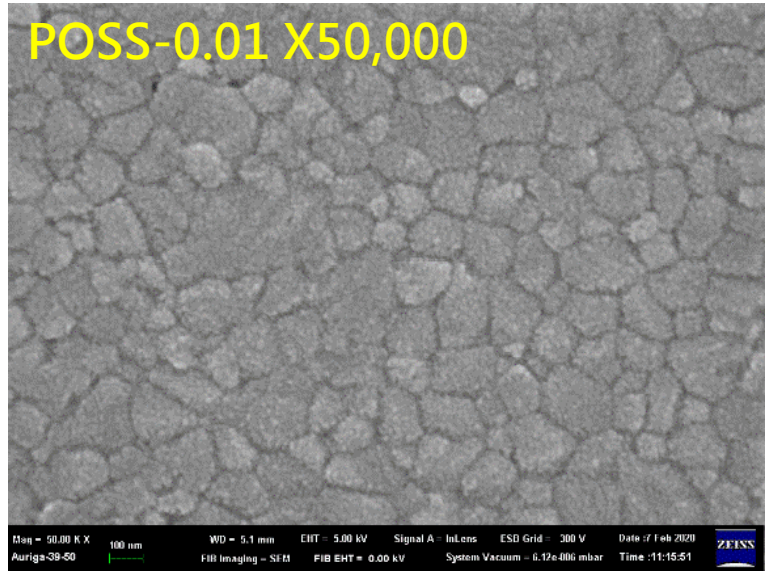

MA0701 POSS-0.05
MA0701 POSS-0.015
MA0701 POSS-0.01
MA0701 POSS-0.005
Control
Intensity(a.u.)
10
20
30
40
50
60
2θ(degree)

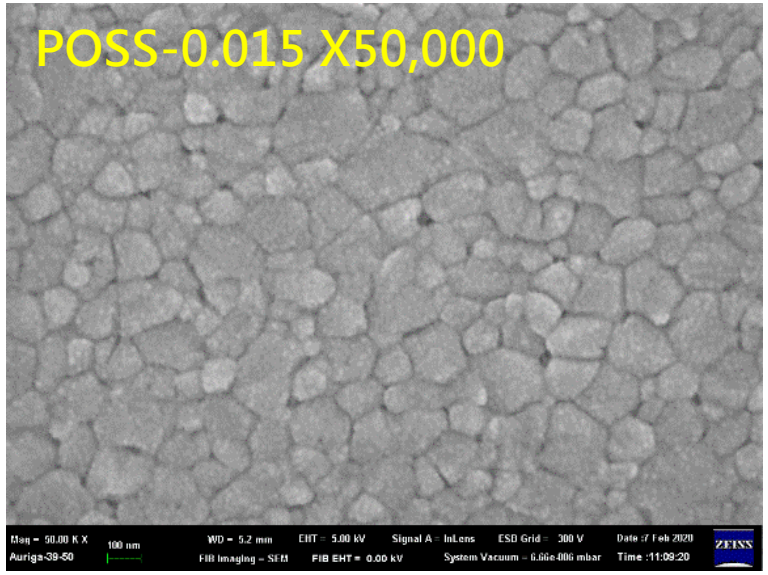

MA0701 POSS-0.005
MA0701 POSS-0.015
MA0701 POSS-0.01
MA0701 POSS-0.005
Control
Abs.
0
2
4
6
400
500
600
700
800
Wavelength(nm)

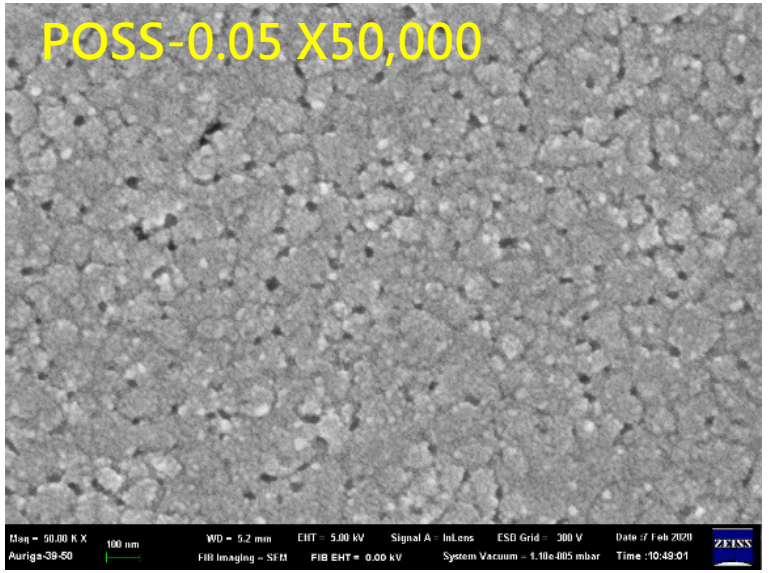
MA0701 POSS/ NiOx SEM images



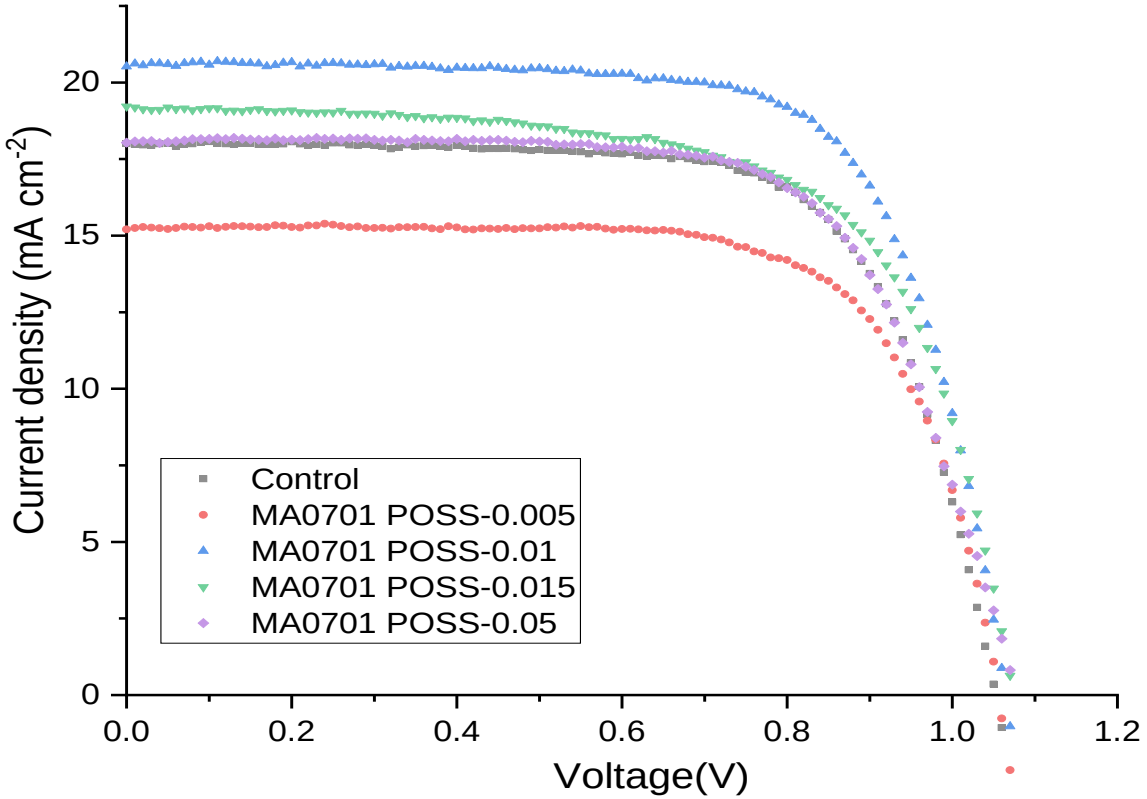






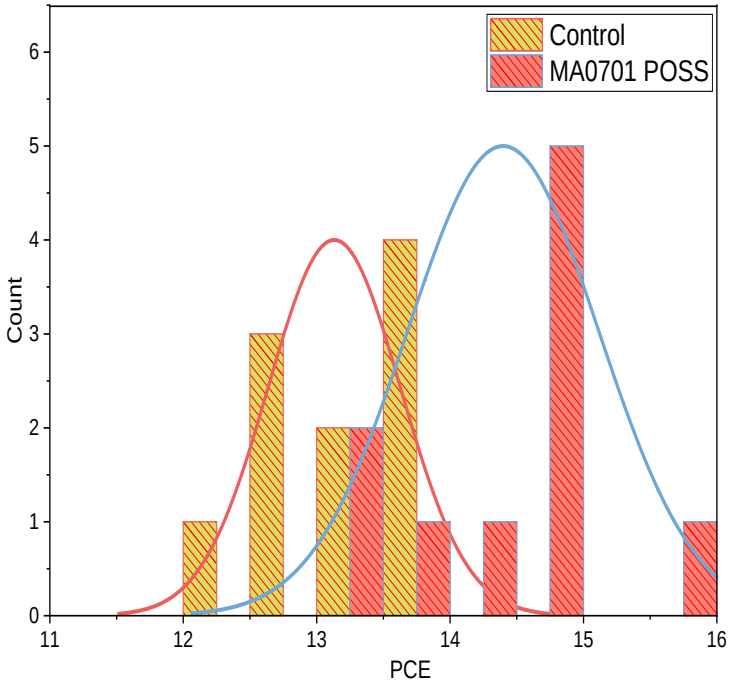


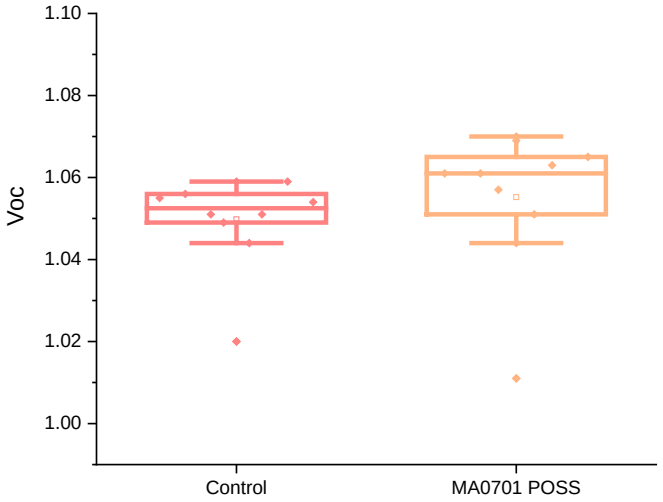
Effect of POSS on J-V curve

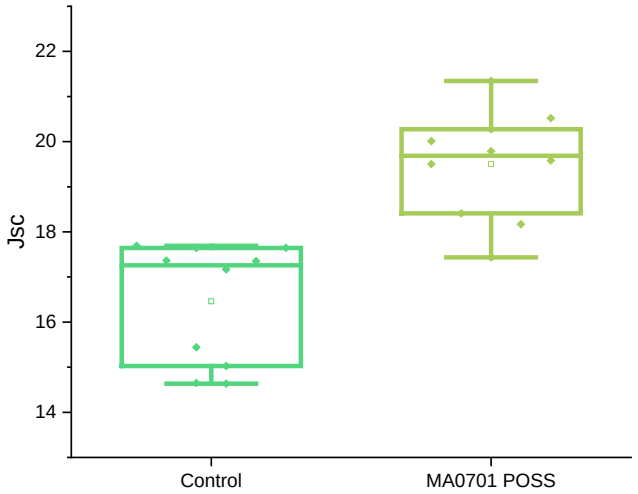


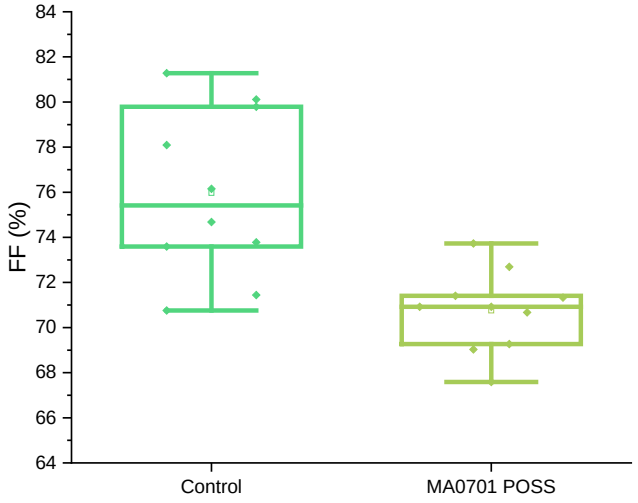
Sample	Voc [volt]	Jsc [mA cm^{-2}]	FF [%]	Average PCE [%]〔Best〕
Control	1.053	18.004	70.18	12.55±0.49〔13.30〕
POSS-0.005	1.048	18.391	73.78	12.64±1.23〔14.14〕
POSS-0.01	1.065	20.521	71.33	14.75±0.71〔15.58〕
POSS-0.015	1.074	19.222	66.16	12.85±0.35〔13.66〕
POSS-0.05	1.056	15.206	71.60	10.91±0.62〔11.50〕

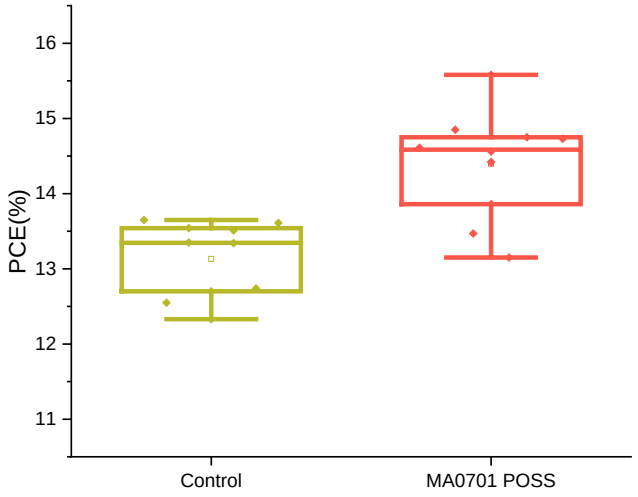
Effect of POSS on photovoltaic properties











Conclusions

- In this study, we are the first to attempt to use POSS to passivate NO_X. The PSCs with fluorine-doped tin oxide (FTO)/NO_X/POSS/$MAPbI_3$/$PC_{61}BM$/Bathocuproine (BCP)/Ag structure were fabricated.

- The result showed that the POSS passivation improved significantly crystal size of perovskite, short circuit current (J_{SC}), and PCE.

- At 0.01-wt% POSS, the PCE increase from 13.3 to 15.58%, an enhancement of 17%. This enhancement was mainly due to the increase of the J_{SC} from 18.0 to 20.5 mA/cm^2, an increase of 13%.

THANKS

FOR YOUR LISTENING!