

# Exceeding 10% Power Conversion Efficiency in Solar Cells using CuSCN Hole Transport Material Deposited via AACVD

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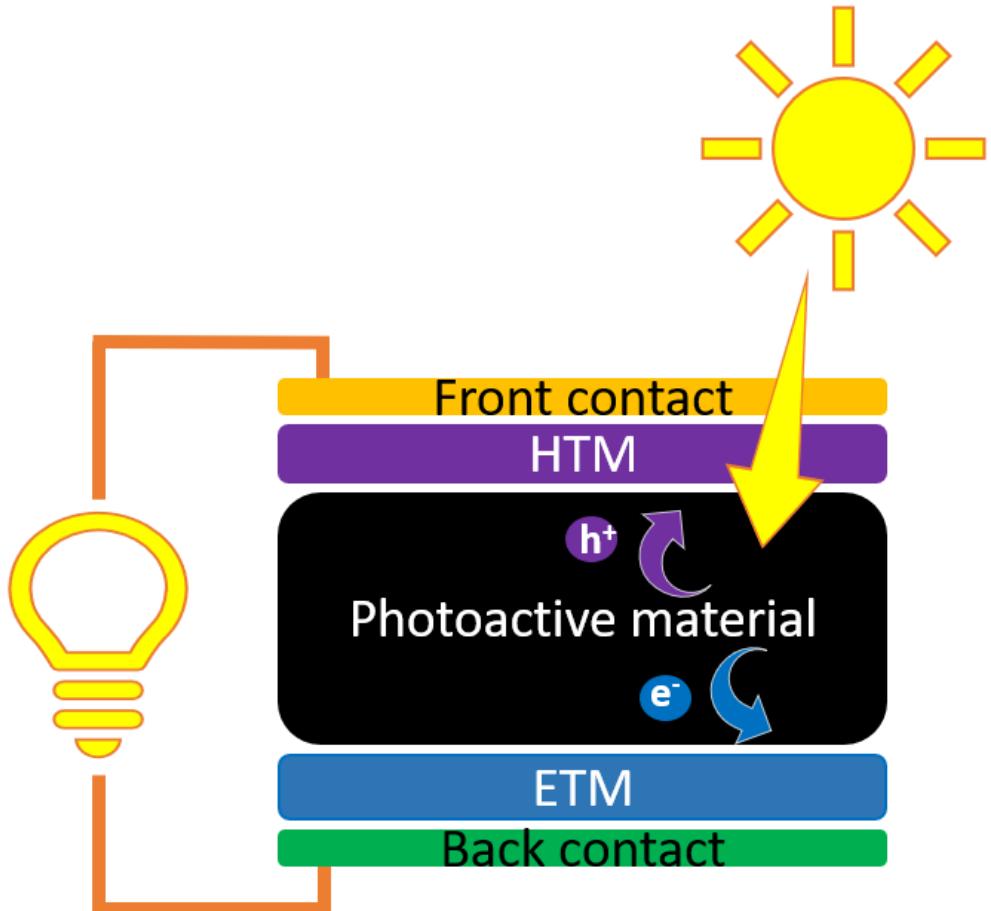
# Overview

- What is a solar cell and how does it work?
- Methylammonium lead iodide (MAPI)  
perovskite
- Incorporation of copper (I) thiocyanate (CuSCN)
- Aerosol-assisted chemical vapour deposition  
(AACVD)
- Deposition parameters
- Solar cell performance

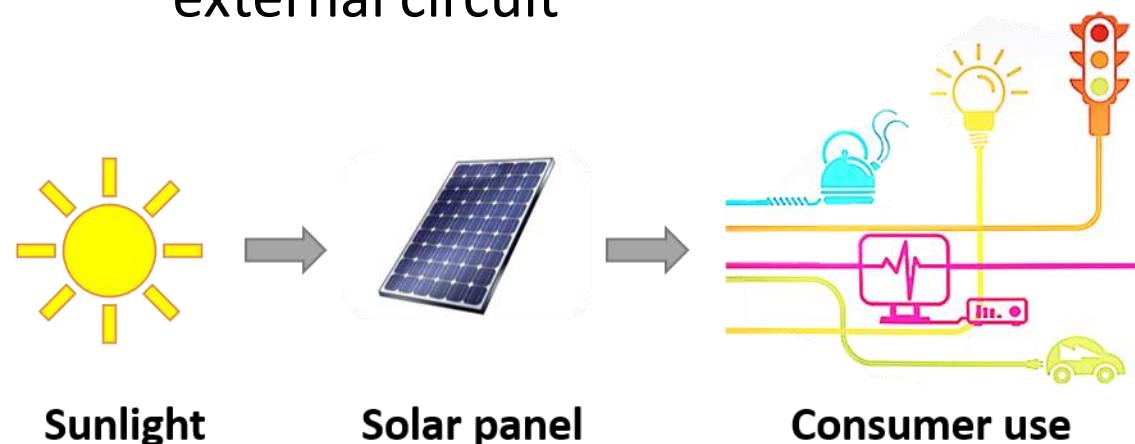


*Major New Report: What's Holding Back Solar Energy? – MIT Spectrum.  
Available at: <https://spectrum.mit.edu/continuum/major-new-report-whats-holding-back-solar-energy/>*

# Solar energy

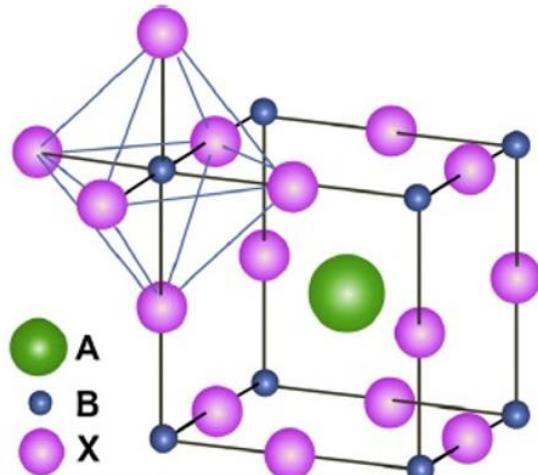


- Sunlight → electricity
- Dependent on separation of charge carriers generated in the photoactive material
- Movement of charge carriers through external circuit

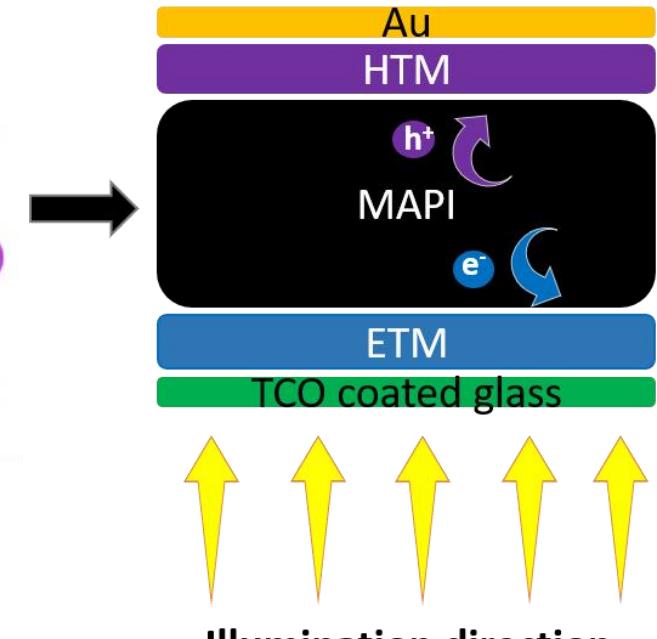


# Perovskites

- ABX<sub>3</sub> structure:
  - A- organic (MA, FA)/ inorganic (Cs)
  - B- Pb or Sn
  - X- halide (Cl, Br or I)
- MAPbI<sub>3</sub> (MAPI) most common
- Research into:
  - Different architectures
  - Layer compositions
- Performance (power conversion efficiency, PCE) measured by I-V sweep measured under AM 1.5

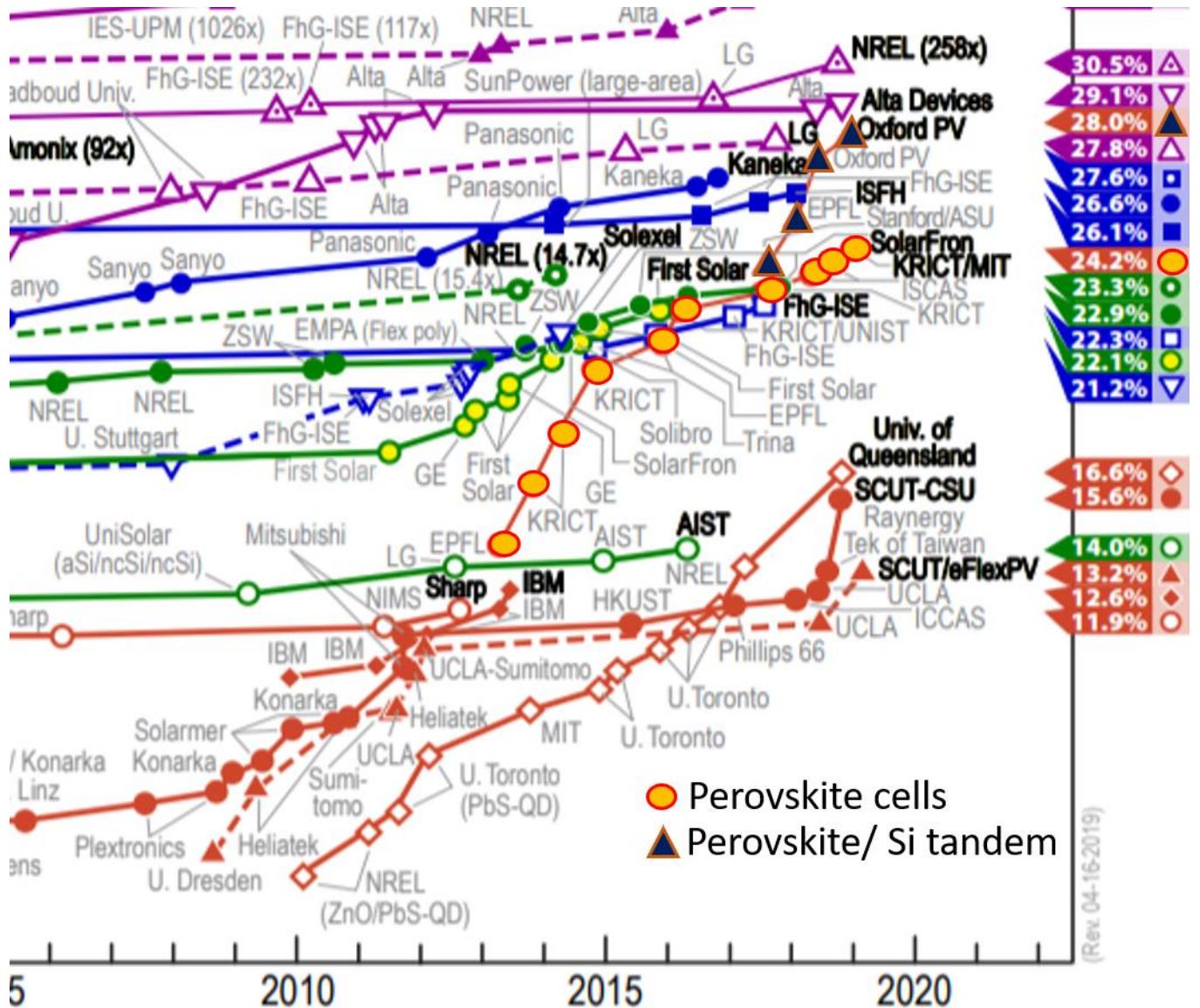


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## Evolution of perovskites

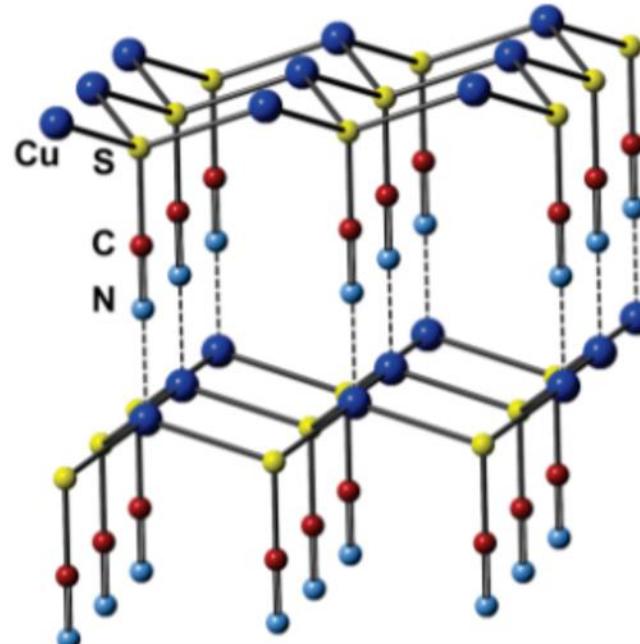
- Steep improvement in performance
  - 3.7%- 24.2% (Si- ~26%)
- Mixed cation/ tandem solar cells further boost efficiency (28%)
- Drawbacks: stability, upscaling



Best Research-Cell Efficiency Chart | Photovoltaic Research | NREL.  
Available at: <https://www.nrel.gov/pv/cell-efficiency.html>

# Copper (I) thiocyanate

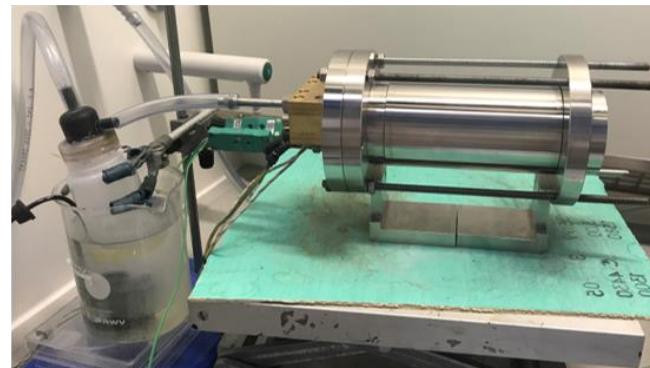
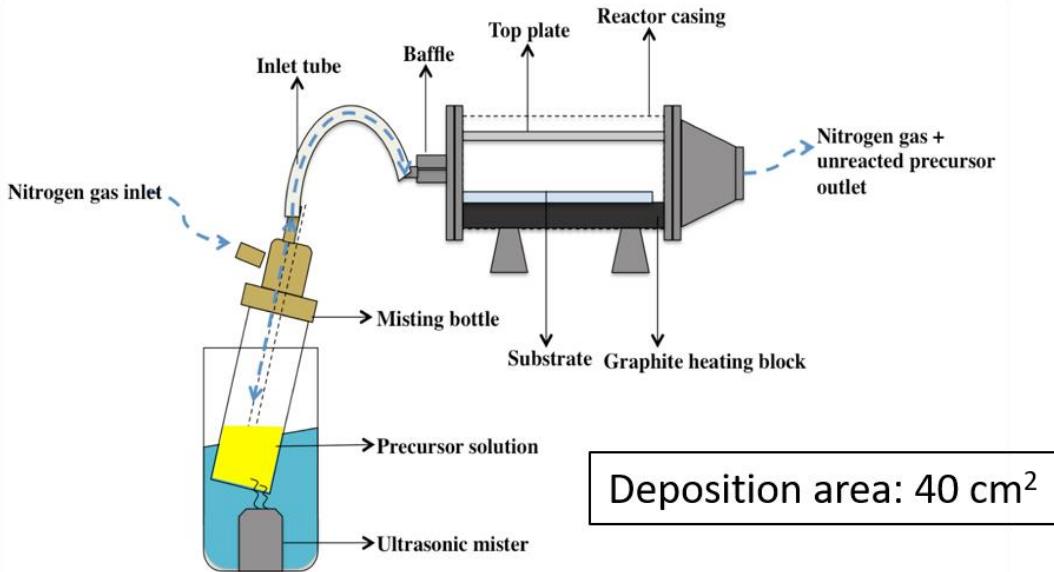
- Hole transport material
- Hole mobility ( $\sim 0.1 \text{ cm}^2\text{V}^{-1}\text{s}^{-1}$ )
- $>3.5 \text{ eV}$  bandgap- optically transparent
- Low cost
- $>20\%$  PCE demonstrated in perovskite solar cell
- Drawbacks: solubility/ limitations in processing



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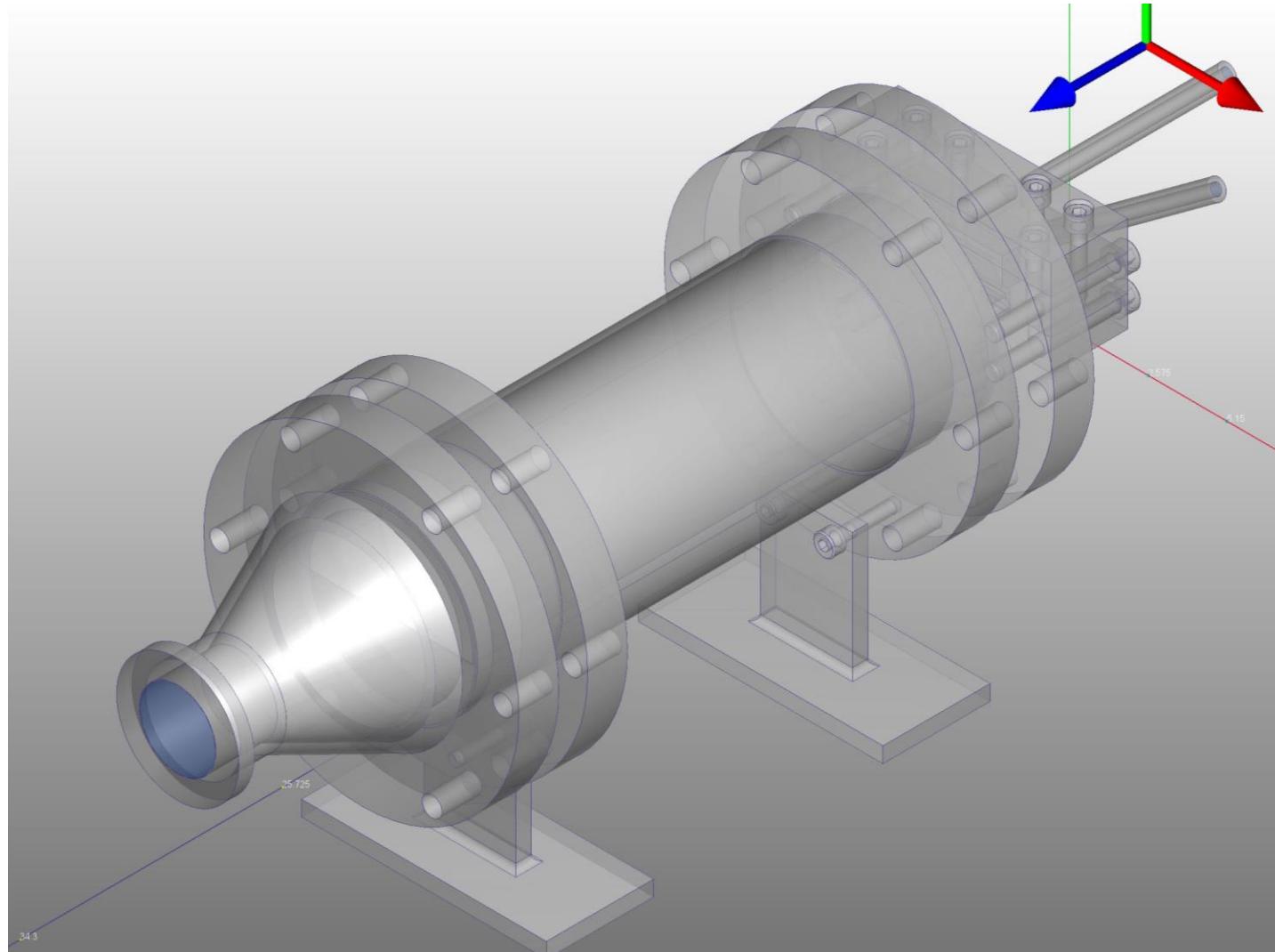
## AACVD

- Large-scale
- Low capital costs
- High growth rates
- Non-volatile precursors
- Flexibility over substrate choice
- Used for other layers:
  - TiO<sub>2</sub>
  - MAPI

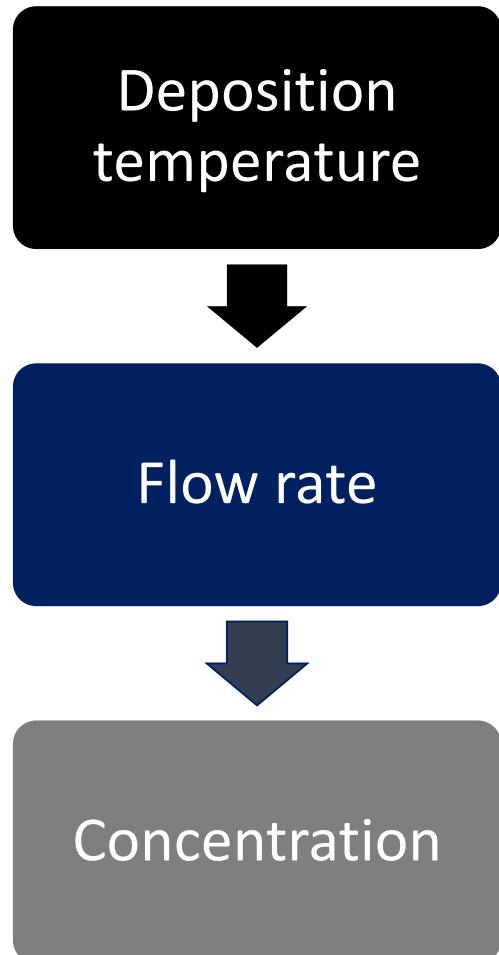




# AACVD



# Investigation of growth parameters



# Investigation of growth parameters

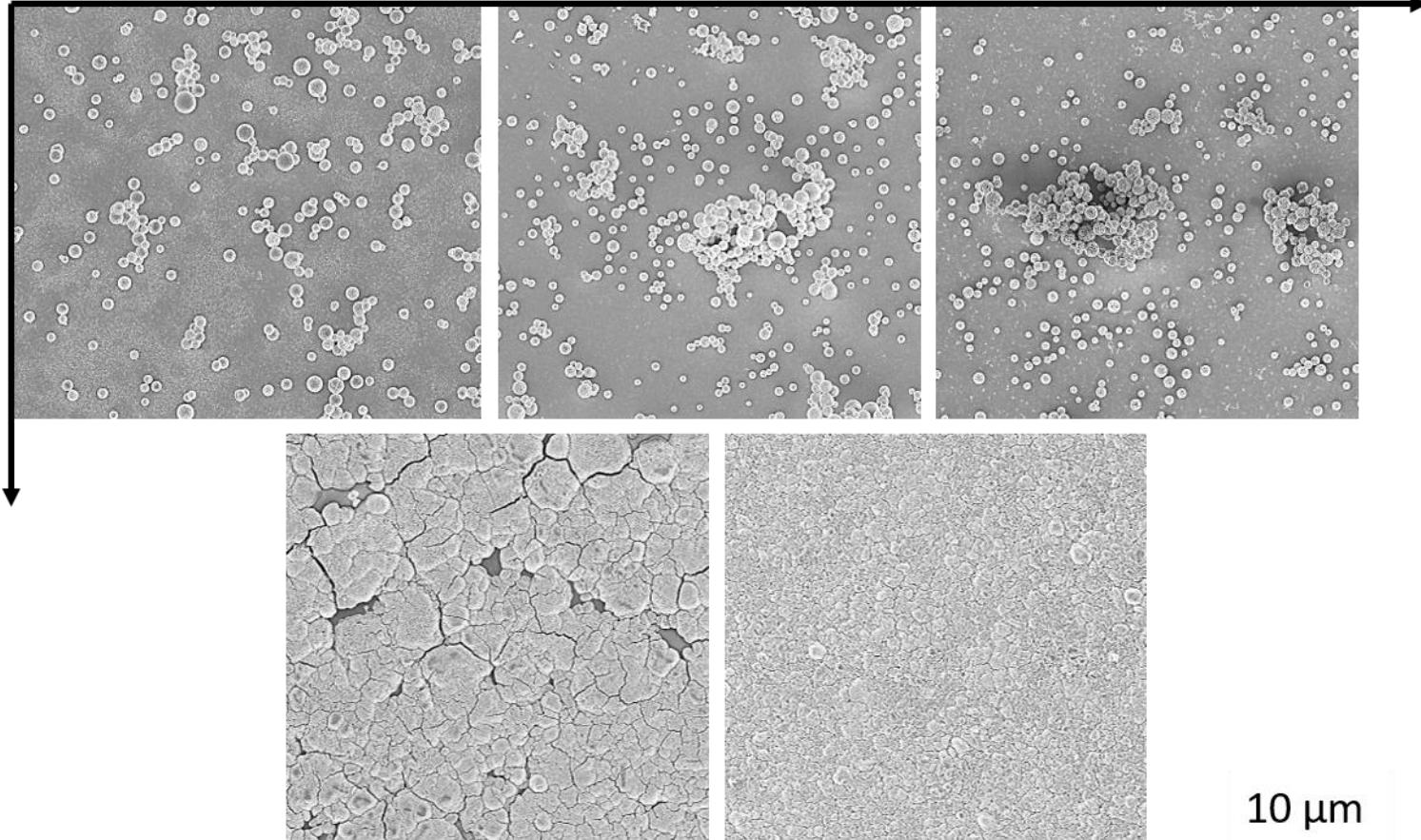
Deposition  
temperature



Flow rate



Concentration



# Investigation of growth parameters

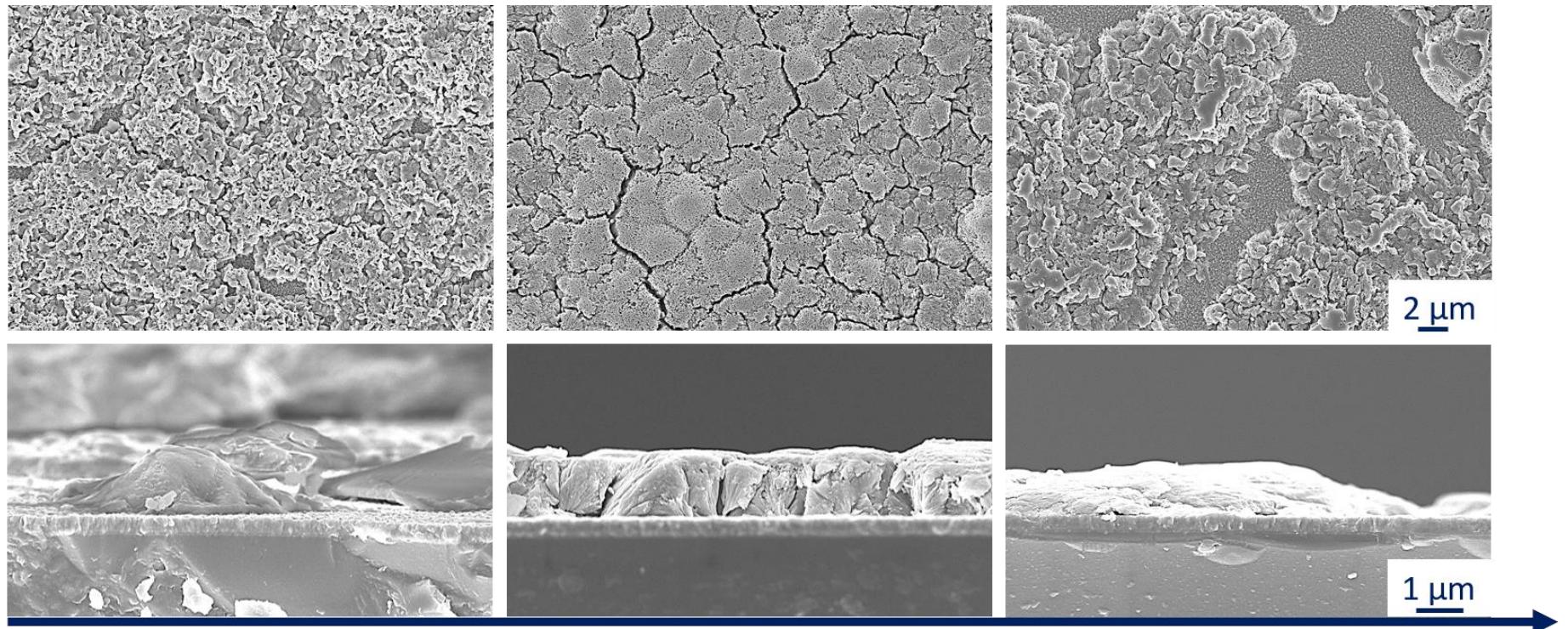
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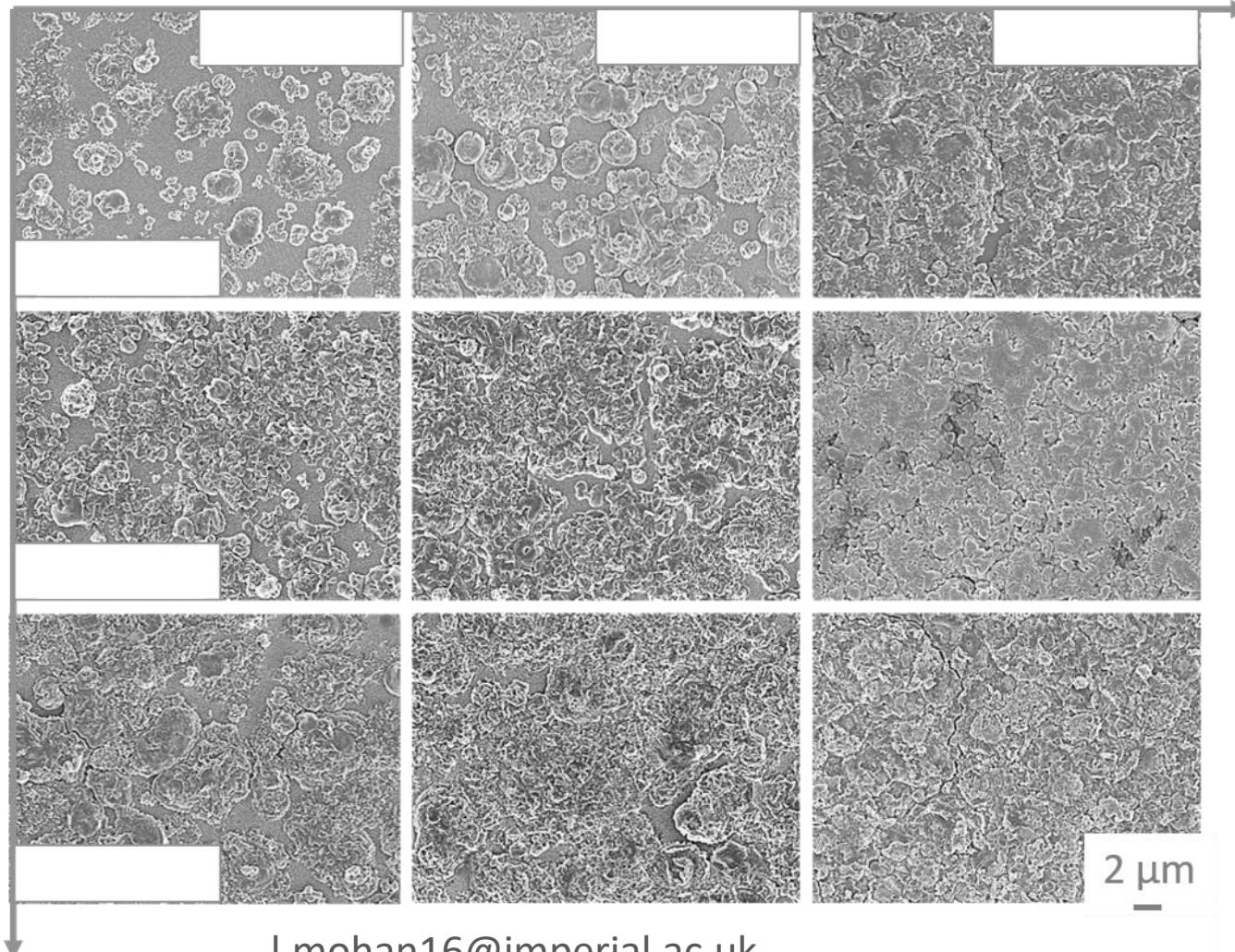
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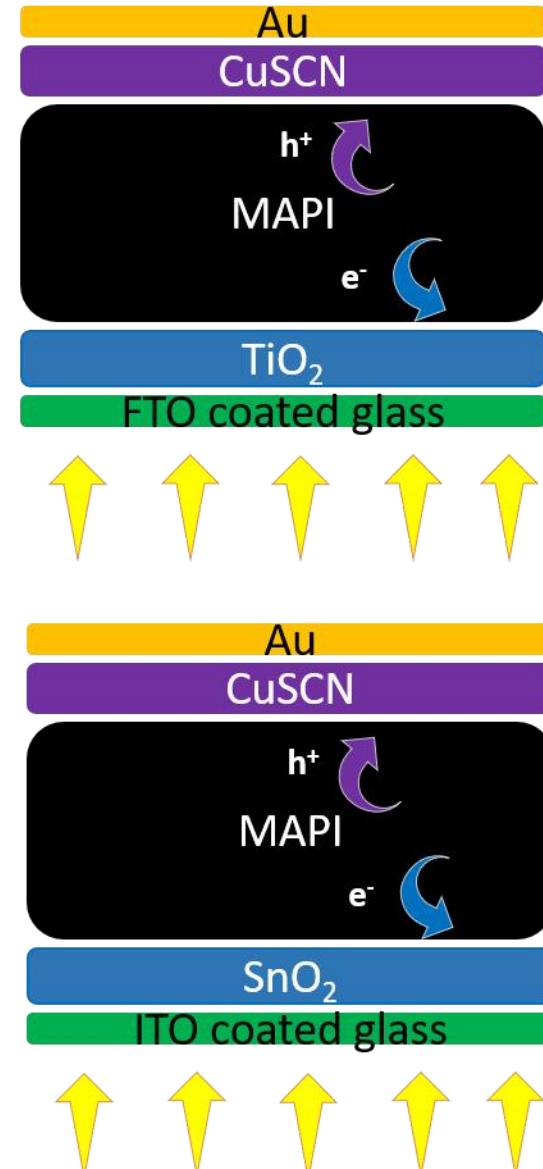
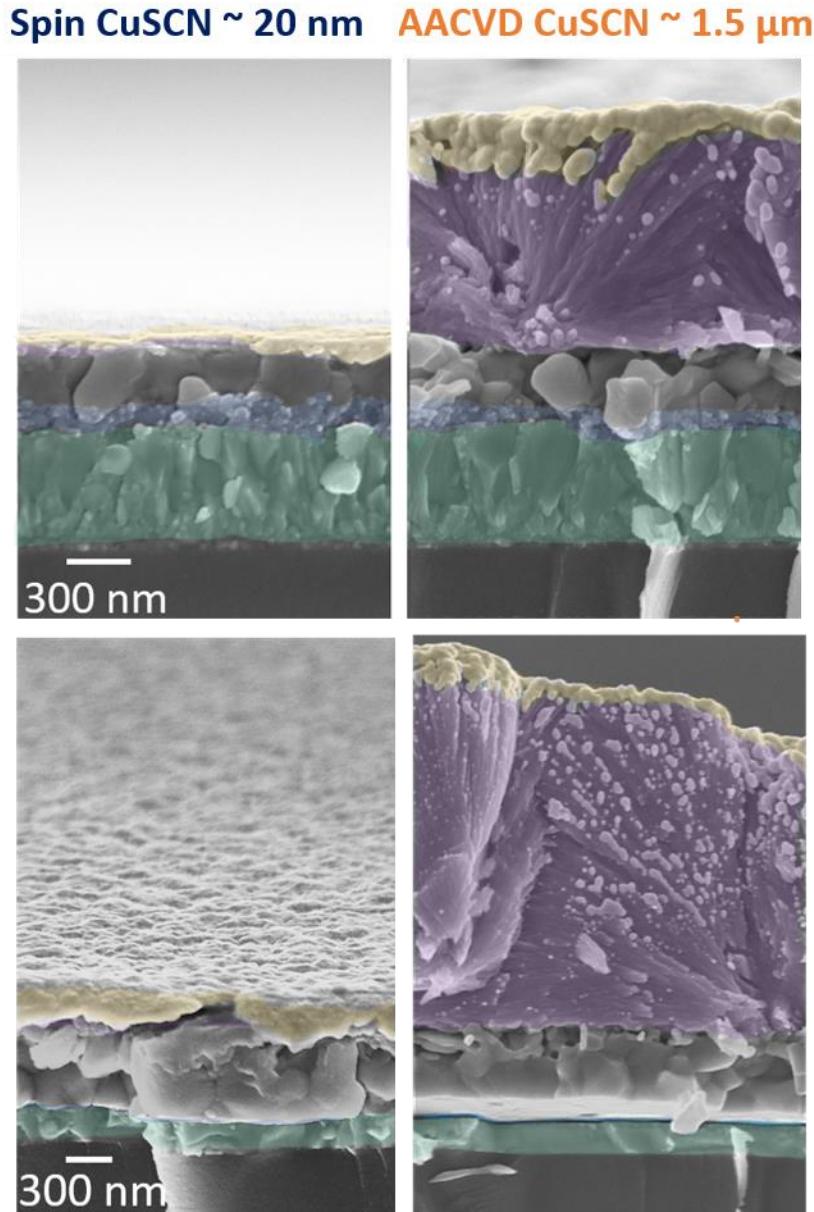
Flow rate



Concentration



## Characterisation of cells

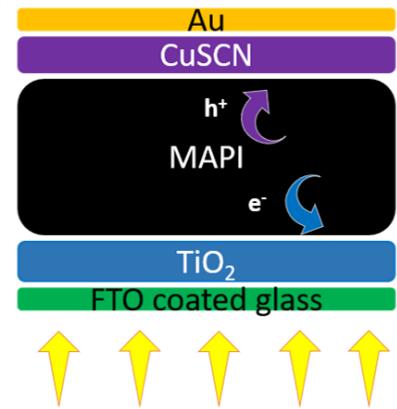


# Solar cell performance

FTO/ TiO<sub>2</sub>/ MAPI/ CuSCN/ Au

Spin-coated CuSCN

AACVD CuSCN

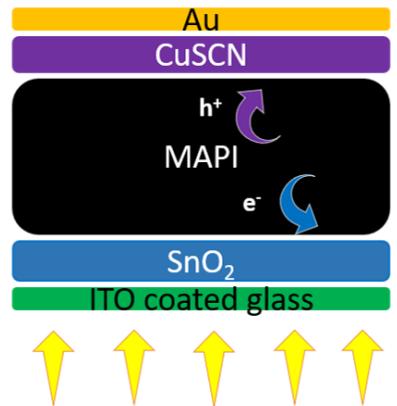


# Solar cell performance

ITO/ SnO<sub>2</sub>/ MAPI/ CuSCN/ Au

Spin-coated CuSCN

AACVD CuSCN



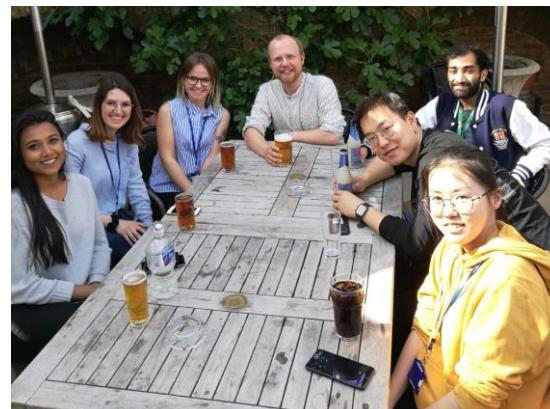
## Conclusions

- Successful deposition of CuSCN in an AACVD reactor
- Incorporation into a working cell resulted in >10 %- record efficiency reported

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Thank you for listening!