INVESTIGATION ON THE PERFORMANCE AND STABILITY OF $Cs_3Sb_2I_9$ BASED PEROVSKITE SOLAR CELLS EMPLOYING P3HT AND CuSCN HOLE TRANSPORT MATERIALS

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Introduction

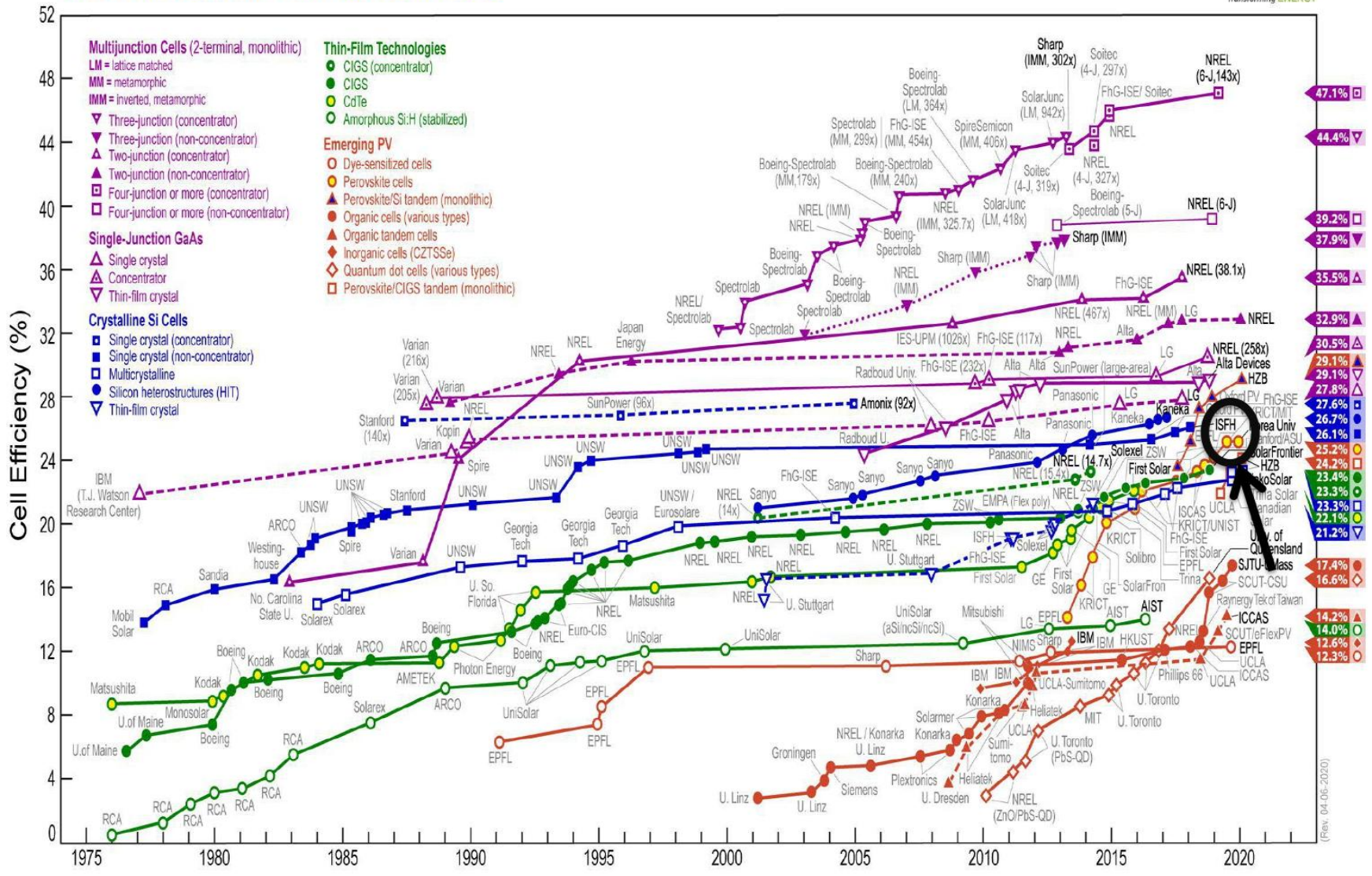
Why solar cells?

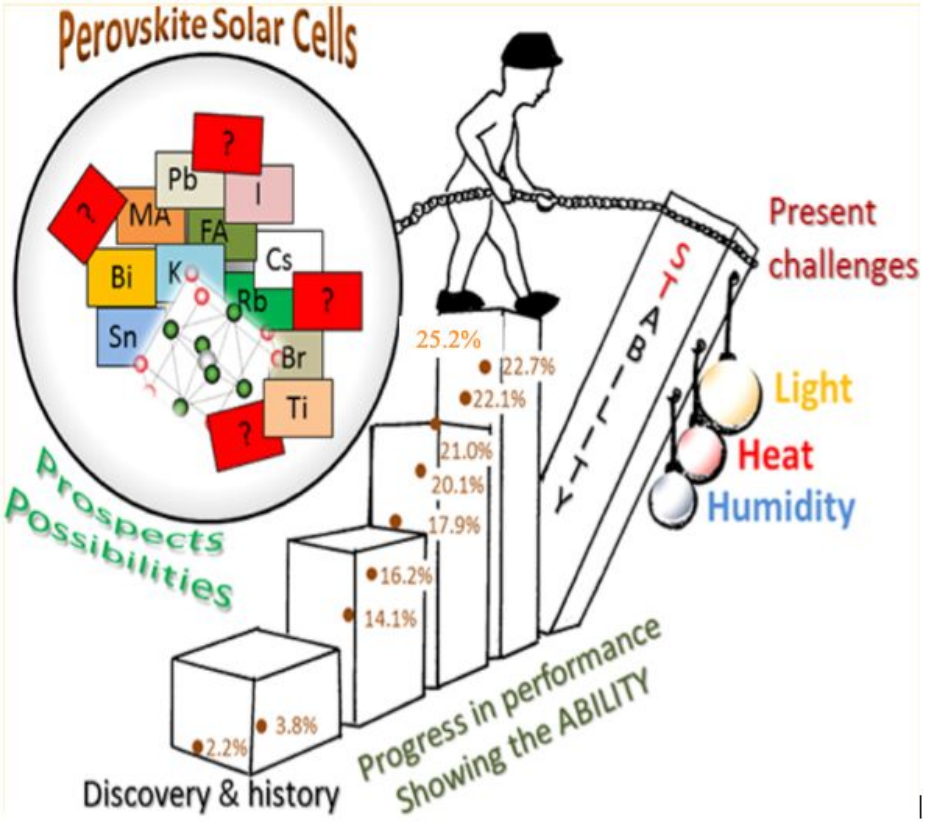
- Global warming as a result of combustion of fossil fuels
- Depletion of fossil fuels
- Increase in global energy demand

Perovskite solar cells

- Low cost materials
- High efficiencies
- Simple fabrication process

Best Research-Cell Efficiencies




Perovskite Solar Cells
Pb
I
MA
FA
Cs
Bi
K
Rb
Sn
Br
Ti
?
Prospects
Possibilities
25.2%
22.7%
22.1%
21.0%
20.1%
17.9%
16.2%
14.1%
3.8%
2.2%
Discovery & history
Progress in performance
Showing the ABILITY
Present
challenges
Light
Heat
Humidity

Lead toxicity and instability in humid condition

- Antimony Sb – suitable to address lead toxicity

  - more stable towards moisture

- Cesium Cs - Effective for improved stability compared to methyl ammonium (MA)

High performing PSC

- Hole-transport material- thermally stable, possess high hole mobility
- Spiro-OMeTAD - possesses low hole mobility ($\approx 10^{-4}$ cm^2 V^{-1} s^{-1})
  - Poor conductivity

- Copper thiocyanate (CuSCN) - higher hole mobility of about 0.1 cm^2 V^{-1} s^{-1}, suitable energy levels, affordable and simplified synthesis routes

- Poly (3-hexylthiophene) (P3HT) – exhibit excellent thermal stability and high hole mobility

Objectives

Main Objective

Evaluate the effect of introducing P3HT and CuSCN hole transporting materials on the photovoltaic performance of $Cs_3Sb_2I_9$ perovskite solar cell.

Specific Objectives

- Design and fabricate the absorber layer using $Cs_3Sb_2I_9$ as the absorber material
- Perform optical, electrical, morphological and structural characterization of $Cs_3Sb_2I_9$ perovskite layer for the perovskite solar cell applications
- To investigate the role of P3HT and CuSCN hole transport layers on the photovoltaic performance and stability of $Cs_3Sb_2I_9$ perovskite solar cells.
- Assess the charge transport and recombination mechanism of the fabricated perovskite solar cells using impedance spectroscopy and surface photovoltage.

Methodology

Deposition of Electron Transport Layer

- TiO_2 compact layer deposited by spin coating
- Annealing

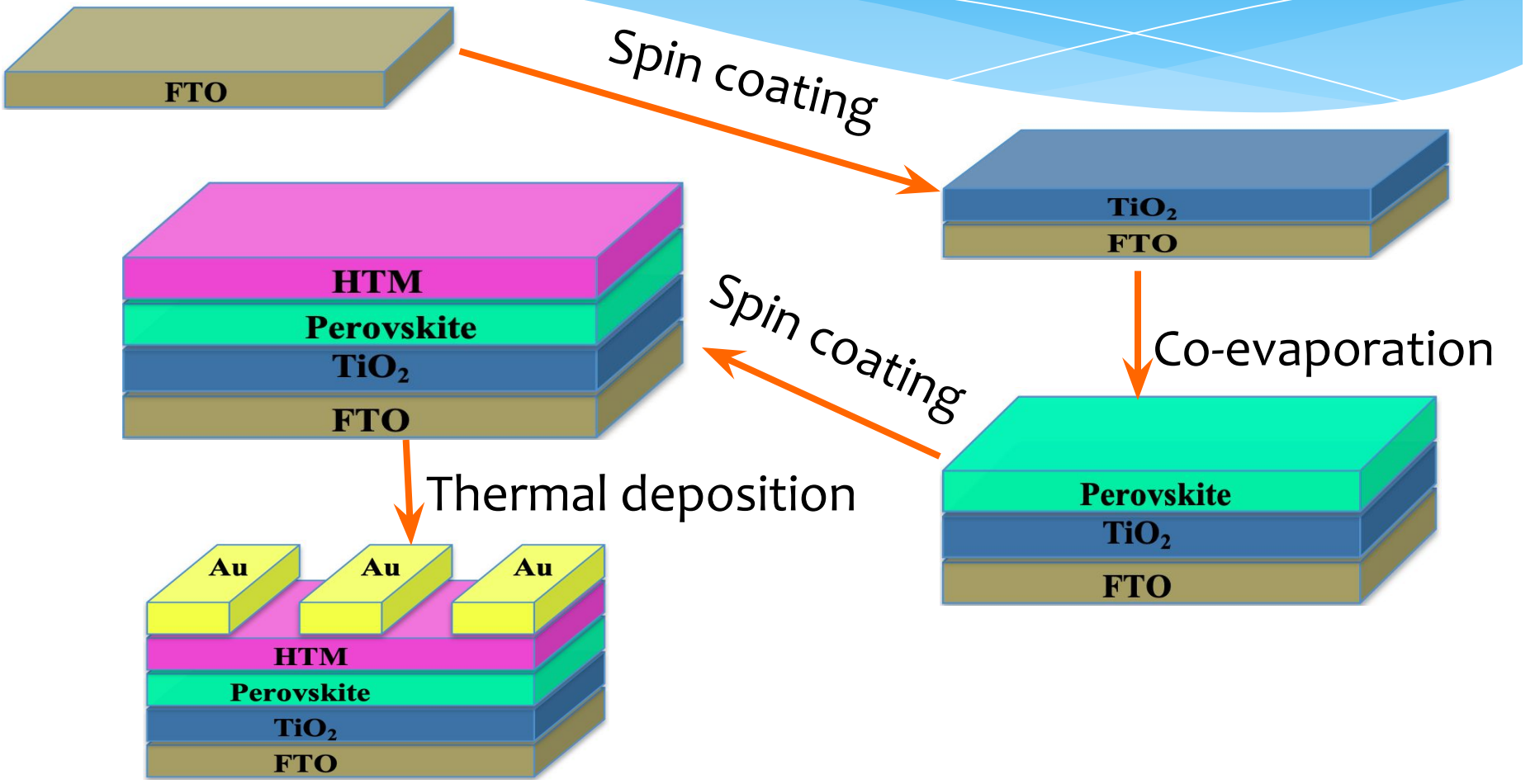
Deposition of active layer (perovskite layer)

- $Cs_3Sb_2I_9$ – Prepared by co-evaporation of CsI and SbI_3 in an evaporator

Deposition of hole transport layer (HTL)

- P3HT and CuSCN –Spin coated on to perovskite layer

- Thin film of gold (back electrode) will be deposited by thermal evaporation


FTO
Spin coating
TiO2
FTO
Co-evaporation
Perovskite
TiO2
FTO
Spin coating
HTM
Perovskite
TiO2
FTO
Thermal deposition
Au
Au
Au
HTM
Perovskite
TiO2
FTO

Film/solar cell Characterization

- Optical characterization –UV-Vis spectroscopy
- Structural properties –XRD analysis
- Band gap shifts of perovskite thin films - photoluminescence (PL).
- Deep & shallow defects in the films - Photothermal deflection spectroscopy (PDS)
- Surface electronic structure of the perovskite layer - x-ray photoelectron spectroscopy (XPS)
- Current density–voltage (*J-V*) characterization – Solar simulator
- charge and mass (ion) transport processes in the cells - electrochemical impedance analysis and surface photovoltage spectroscopy (SPS)

THANK YOU!!!