Institute for Advanced Studies
in Basic Sciences
Gava Zang, Zanjan, Iran

The Abdus Salam
International Centre
for Theoretical Physics

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Optimization of Multilayer Perovskite Solar Cells through Experimental and Simulation Studies

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Outline

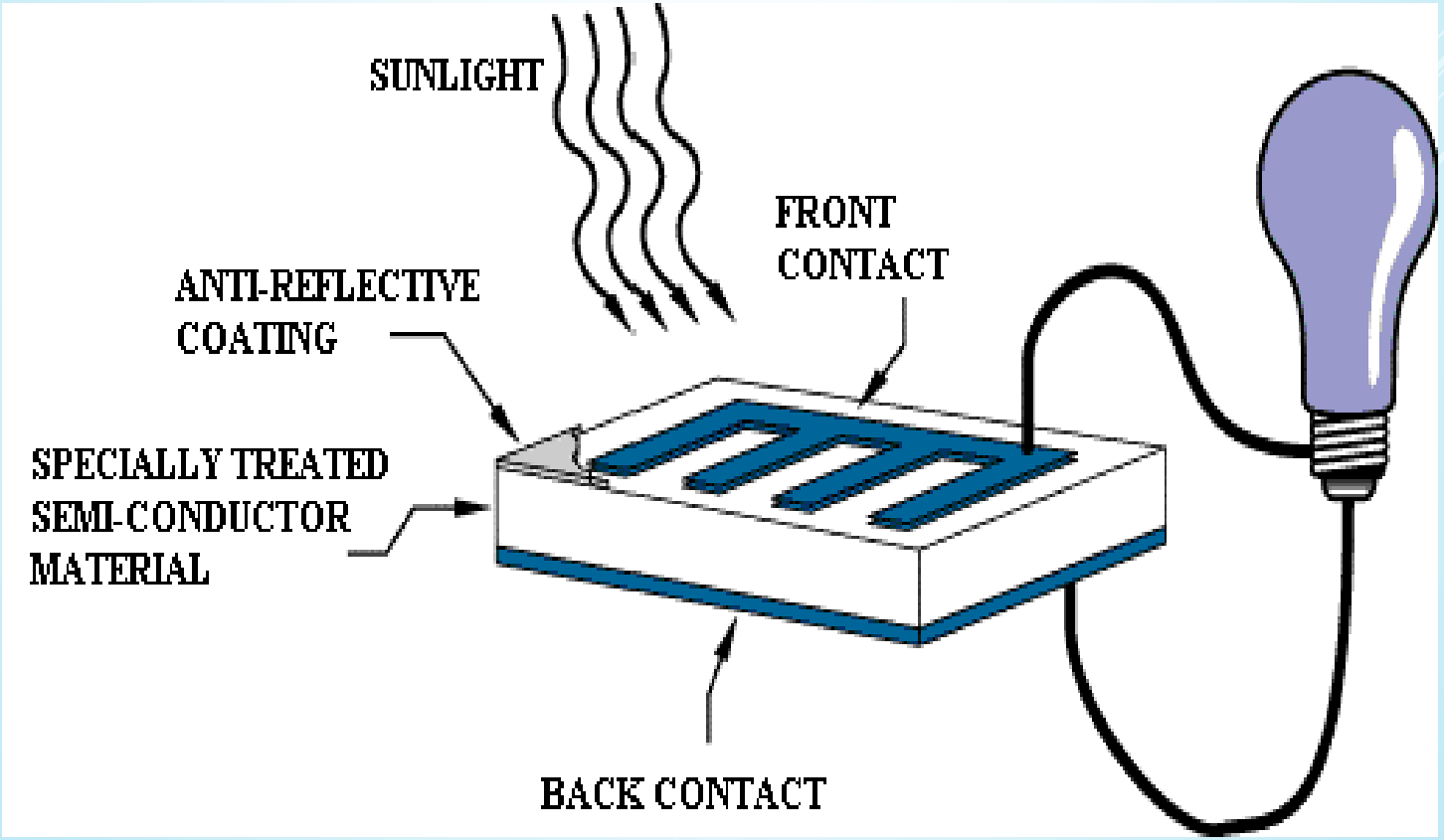
- **Introduction**
- **Solar cell & its Structure**
- **Perovskite Solar Cell**
- **Main project**
  - Optimization of perovskite solar cell by platinum quantum dots
  - Simulation of multi-layer perovskite solar cell
- **Summary & Conclusions**

Introduction

- Green energy generating
- The technology which convert the light energy to electrical energy is called photovoltaic (PV) technology [1].

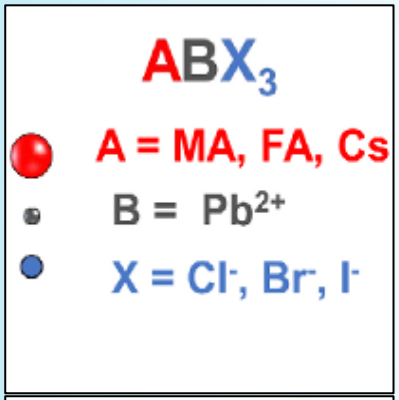
Solar cell and its structure

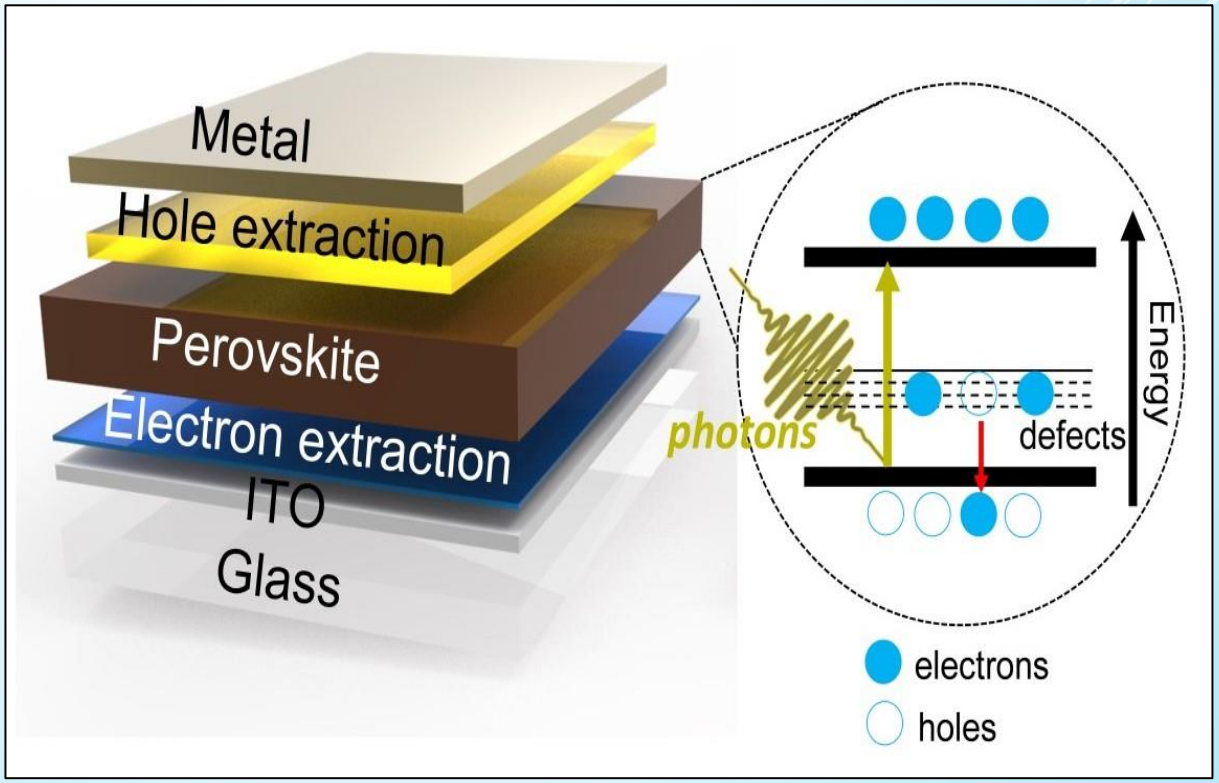
- Sandwich of active layer (semiconductor material) between two electrodes



Perovskite solar cell

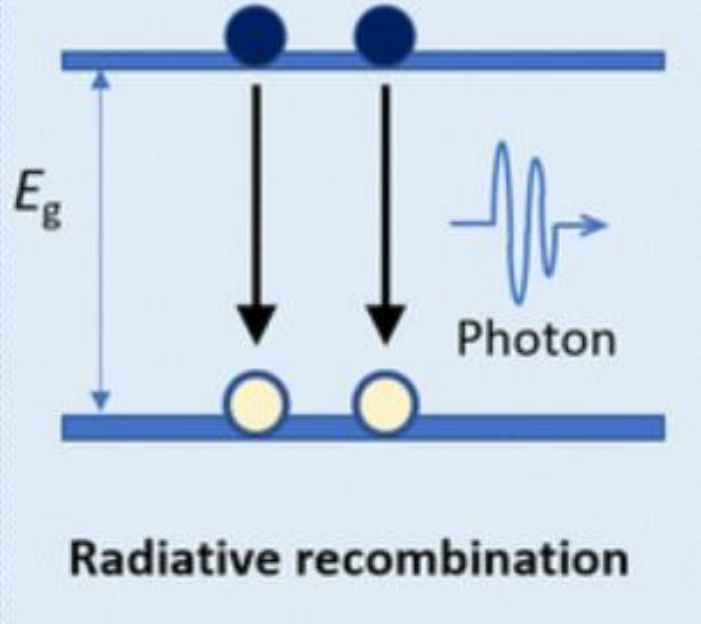
- Third generation of solar cells
- Remarkable progress in recent years with rapid increases in efficiency, from 3% in 2009 to over 25% today [2-3].

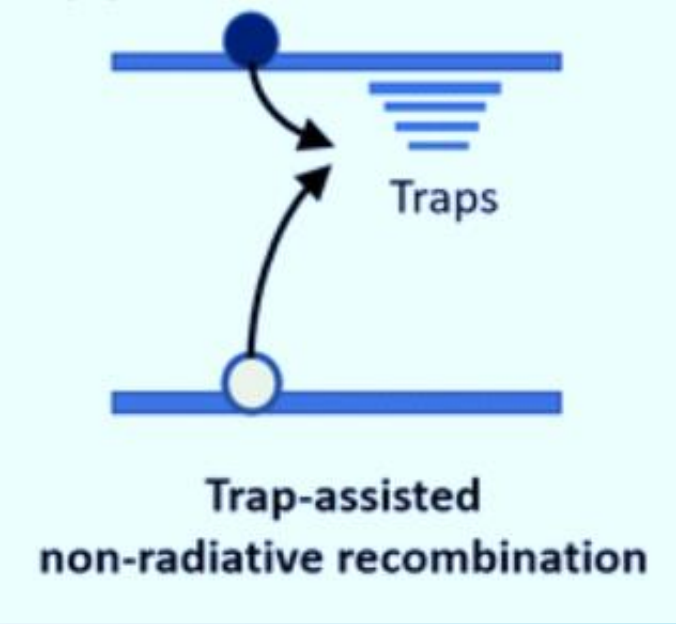




Recombination

- Radiative and non-radiative recombination
- Radiative recombination is typically less significant compared to non-radiative recombination.





Using of PtQD as dopant in ETL

- Platinum Quantum Dots (PtQD) in Electron Transport Layer (ETL).
- Can help us to reduce non-radiative recombination.
- Increase the extraction of electrons

Method

Fabrication steps:

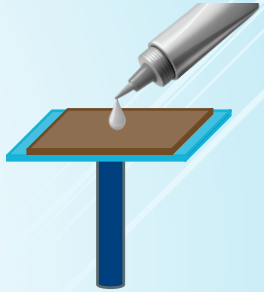
Substrate washing

deionized water (15min)
Ethanol (15min)
Acetone (15min)
UV ozone cleaner (30min)

TiO2

$50\mu l$
3000rpm (20sec)
100°C (15min)

PtQD Paste

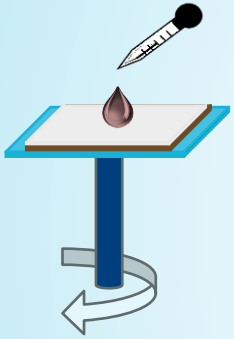


Annealed
500°C (15min)

Method

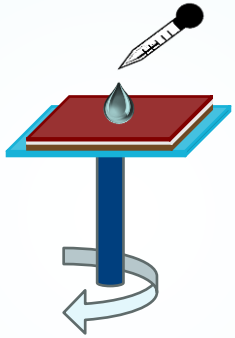
Fabrication steps:

Perovskite (MAPbI3)



$50\mu l$
3000rpm (20sec)
100℃ (15min)

Spiro-OMeTAD

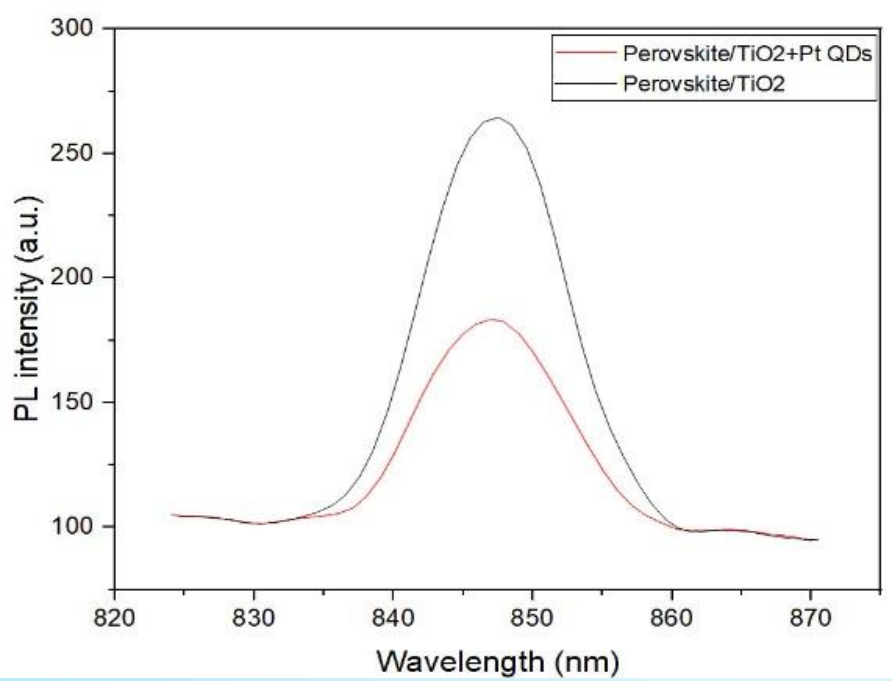


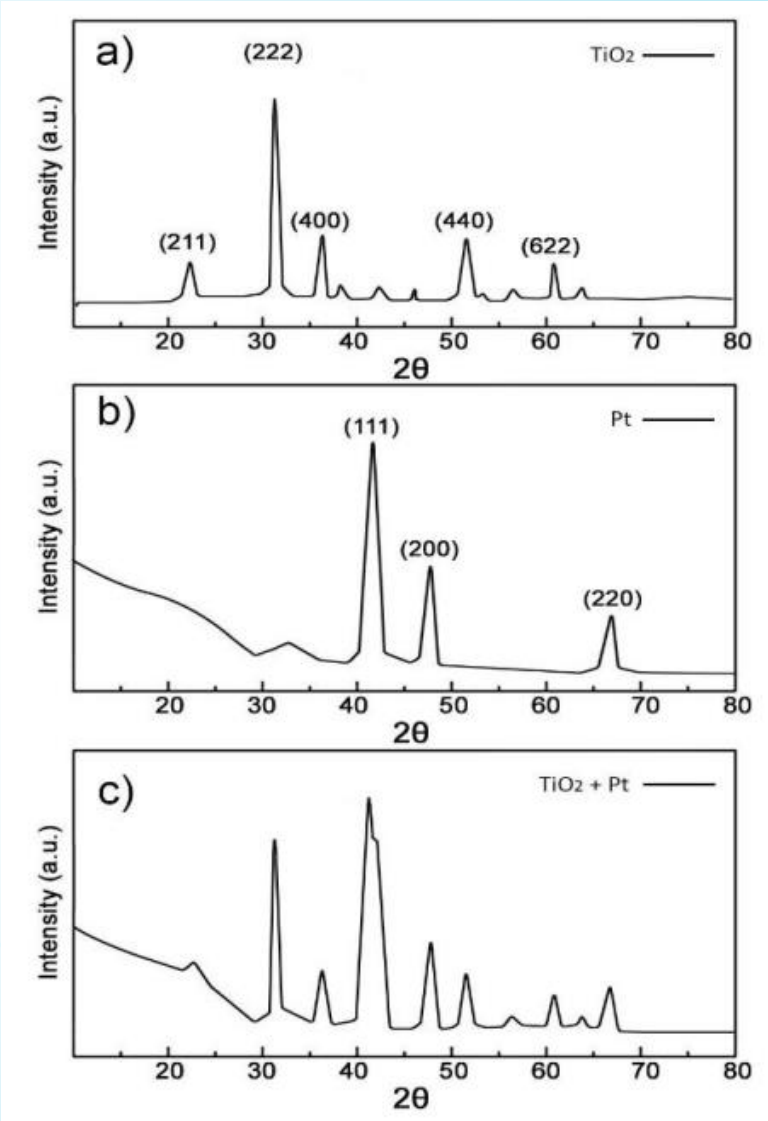
$50\mu l$
4000rpm (20sec)
100℃ (15min)

Ag electrode evaporating

Result

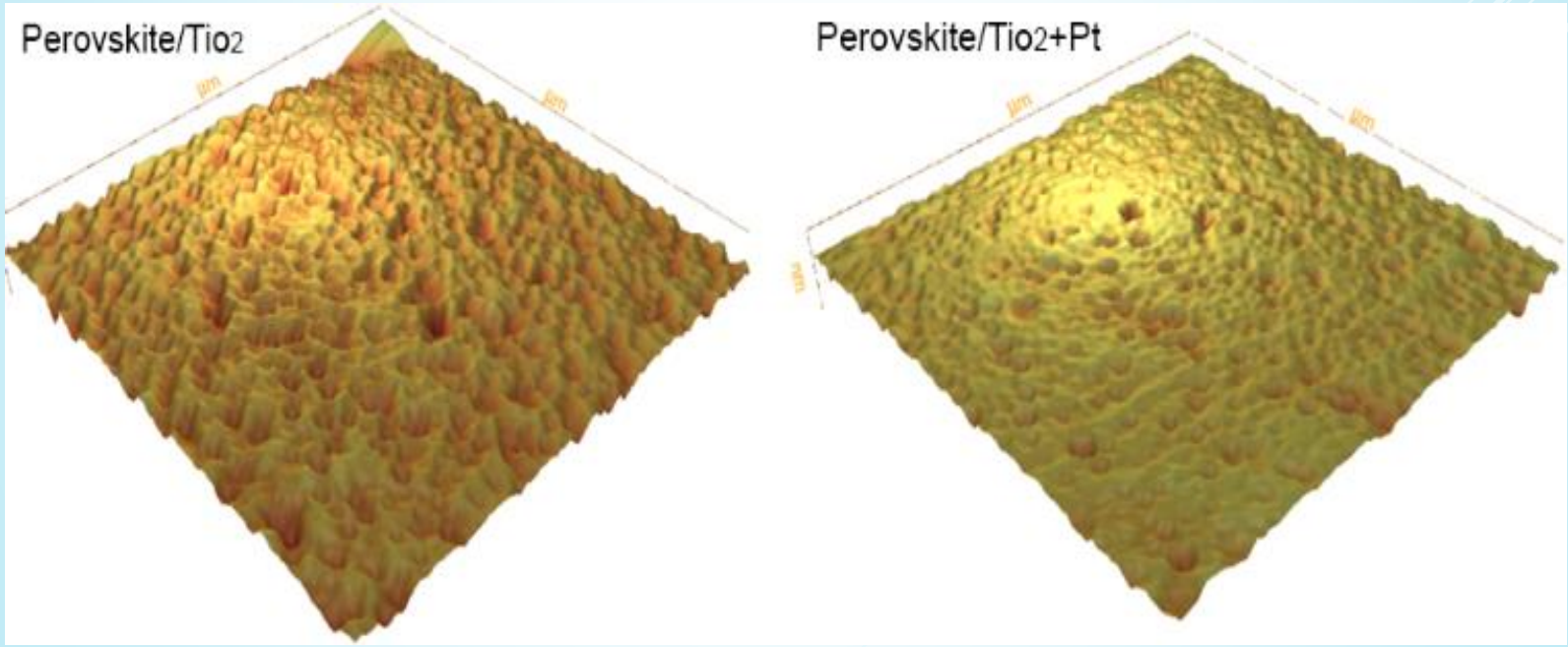
- X-ray diffraction (XRD)
- Photoluminescence
- Good penetration of PtQD particles
- Reduction of recombination





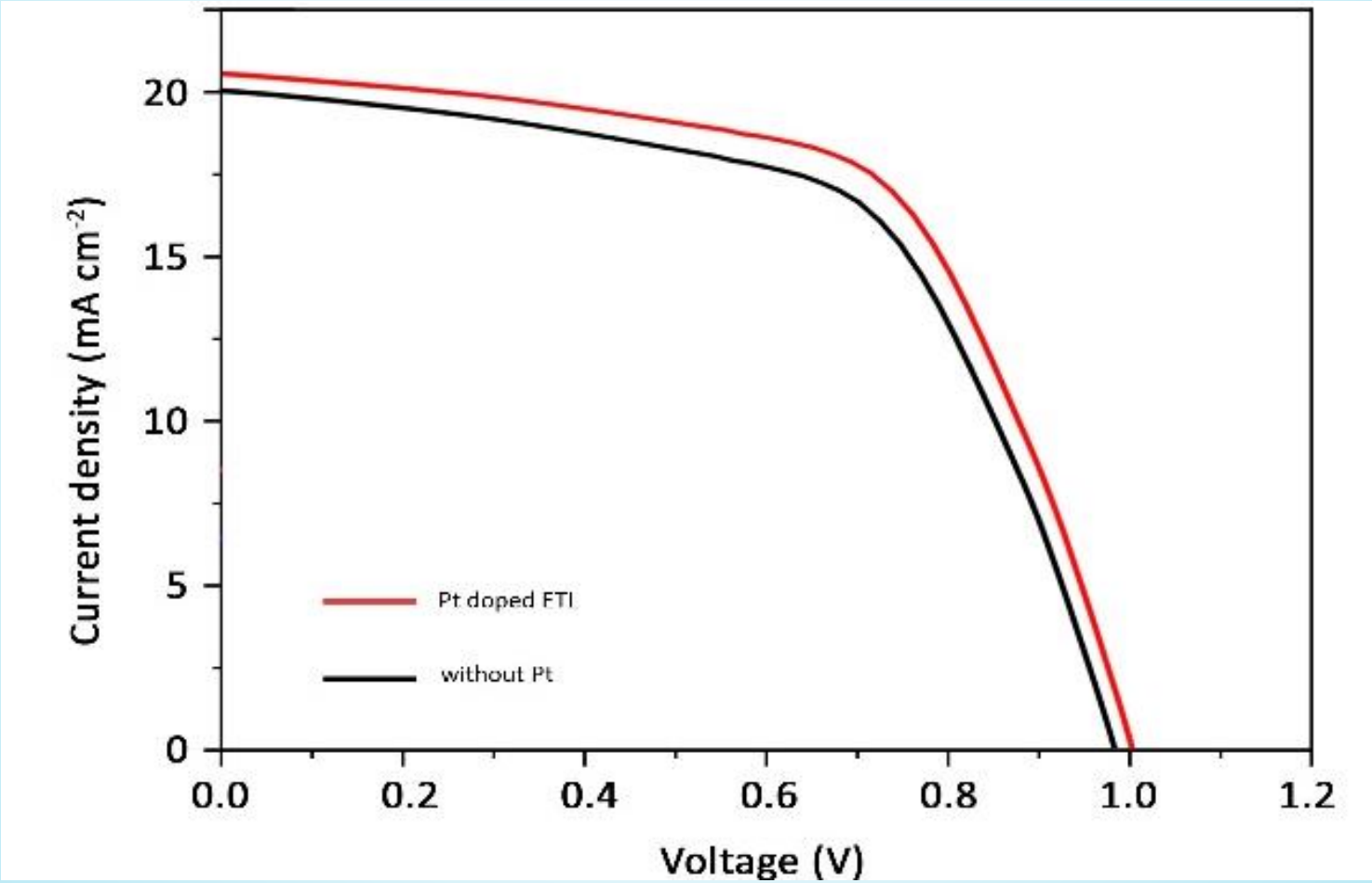
Result

- Atomic Force Microscopy AFM ⟶ improvement in the surface morphology



Result

- Efficiency from 13.32% to 14.11%



Importance of Simulation in SC

- Result in short time
- High accuracy
- Ease in optimization

Summary & Conclusions

- Using of metal ions to the electron transport layers can be used as an effective method to reduce recombination loss and increase the efficiency of perovskite solar cells.

- Simulation of semiconductors devices will help us in optimization of it.

- Expecting to reach 25% or higher efficiency.

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THANK YOU

Any Questions?

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