

Three-Dimensional Fiber Shaped Dye Sensitized Solar Cell Using Carbon Nanotube Yarn With Photocatalytic Activity Of BiOI/TiO₂ Heterostructure

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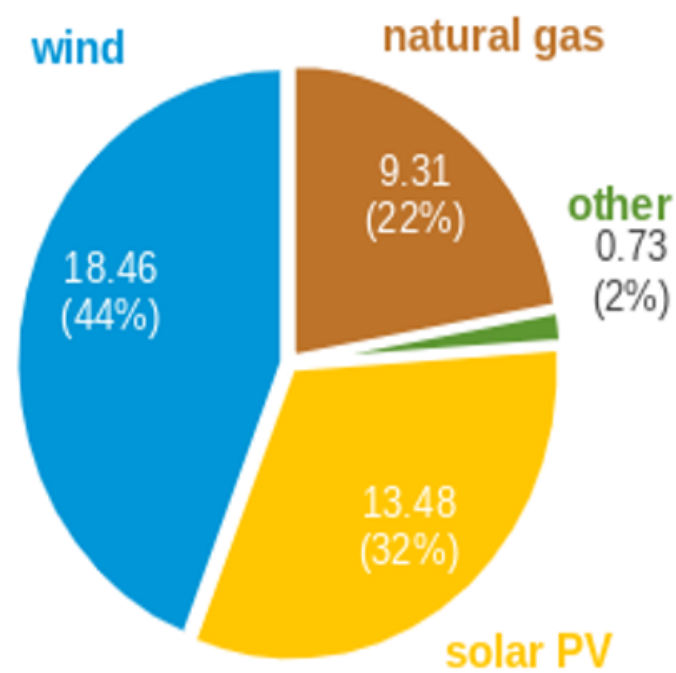
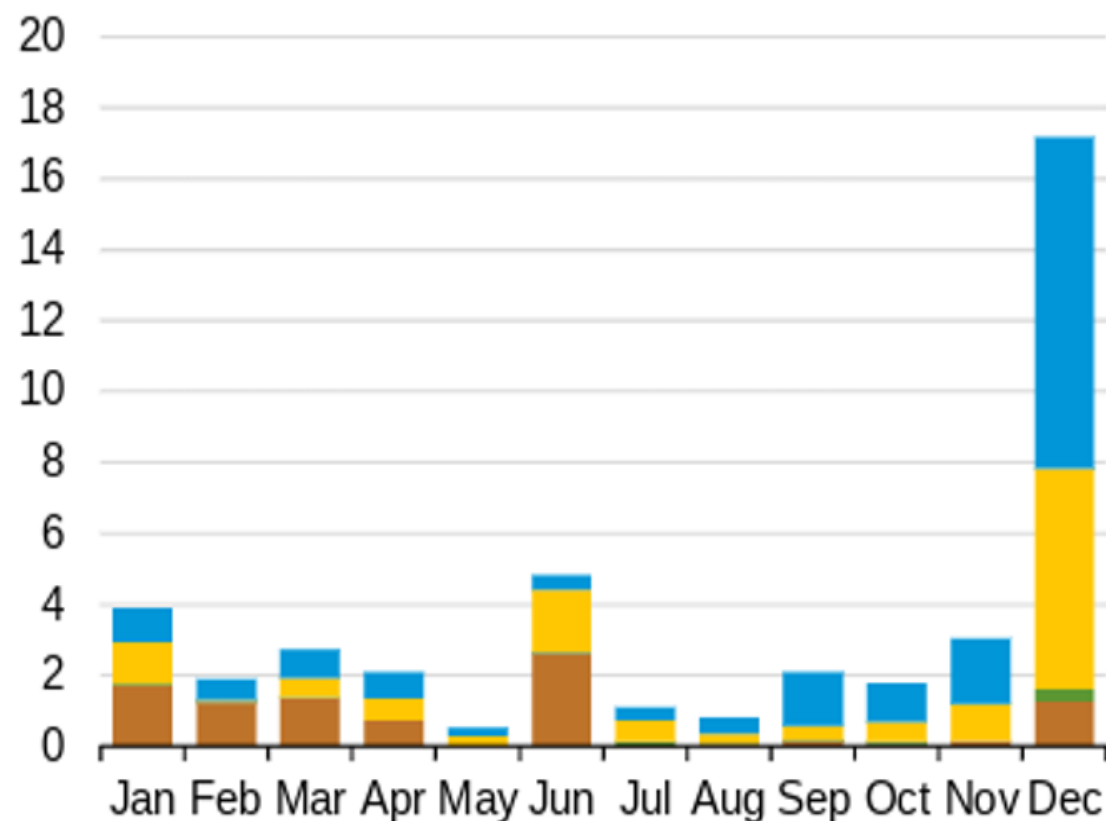
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Outline

- Electric generating capacity in USA
- Importance of Solar Cell
- Introduction to Dye Sensitized Solar Cell (DSSC)
- Recent works on DSSC
- Works in our lab in UTRGV
- Introduction of my research
- Introduction to the photocatalyst
- Figures
- Result and Conclusion
- Reference

Planned U.S. electric generating capacity additions (2020) gigawatts (GW)



Source: U.S. Energy Information Administration, [Preliminary Monthly Electric Generator Inventory](#)





Why is Solar Energy Important

- Less global warming
- Improved public health
- Inexhaustible energy
- Jobs and economic benefit
- Stable energy prices
- Reliability and resilience

Solar cell technologies

Crystalline Si based technology

monocrystalline Si solar cells

polycrystalline Si solar cells

Thin film based technology

a- Si based thin film solar cells

CdTe thin film solar cells

Dye sensitized solar cells (DSSC)

Perovskite based solar cells



Why Dye Sensitized Solar Cell is more attractive

- Low production cost and lower investment costs compared with conventional PV technologies.
- Flexibility.
- Lightweight.

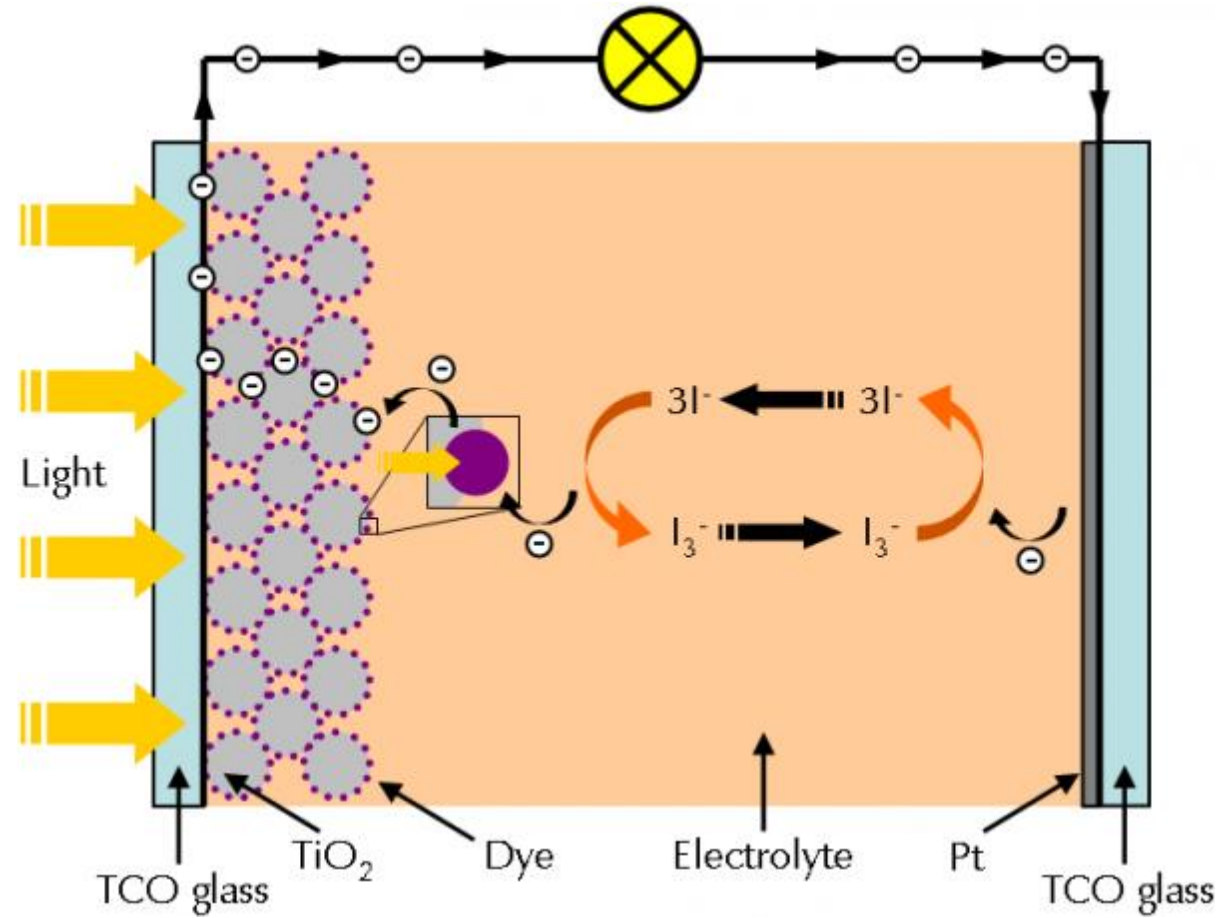
Introduction to Dye Sensitized Solar Cell(DSSC)

DSSC is based on semiconductor including

- a photo-sensitized anode
- an electrolyte
- A photoelectrochemical system



Working Principle



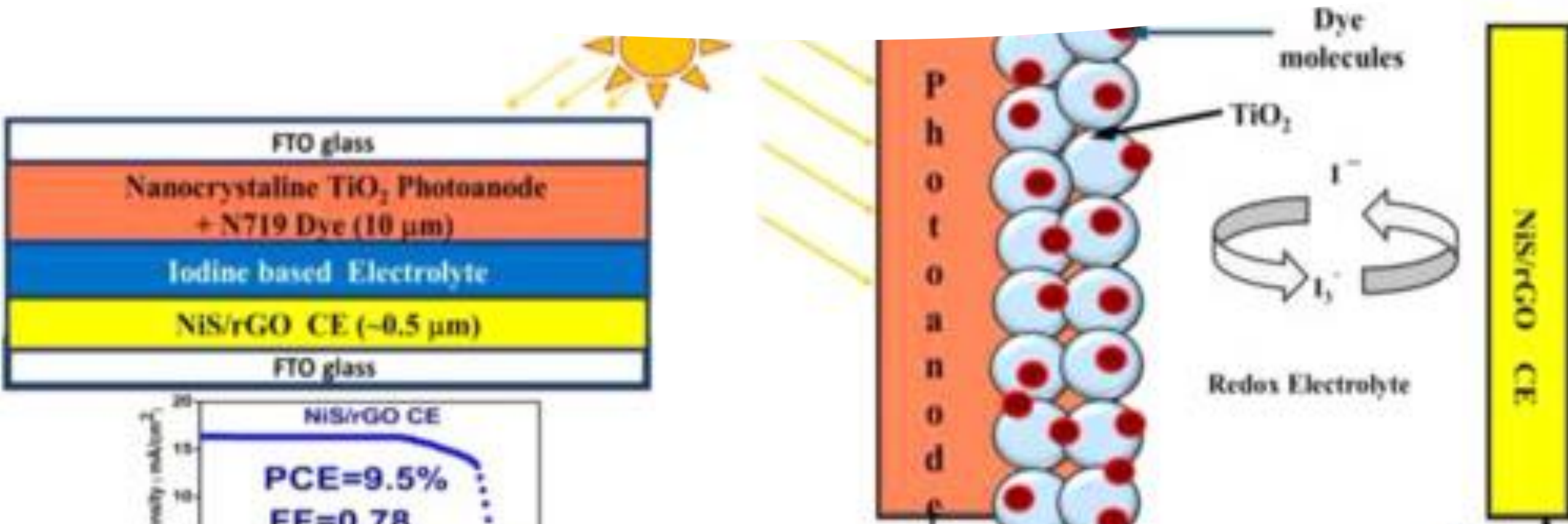
Background of DSSC

- In the late 1960s it was discovered that illuminated organic dyes can generate electricity at oxide electrodes in electrochemical cells
- Power generation with chlorophyll extracted from spinach was used to demonstrate and discussed the dye sensitization solar cell (DSSC) principle 1972
- After a lot of failure. the efficiency was improved by optimizing the porosity of the electrode made up of fine oxide powder like nanoporous titanium dioxide (TiO_2)

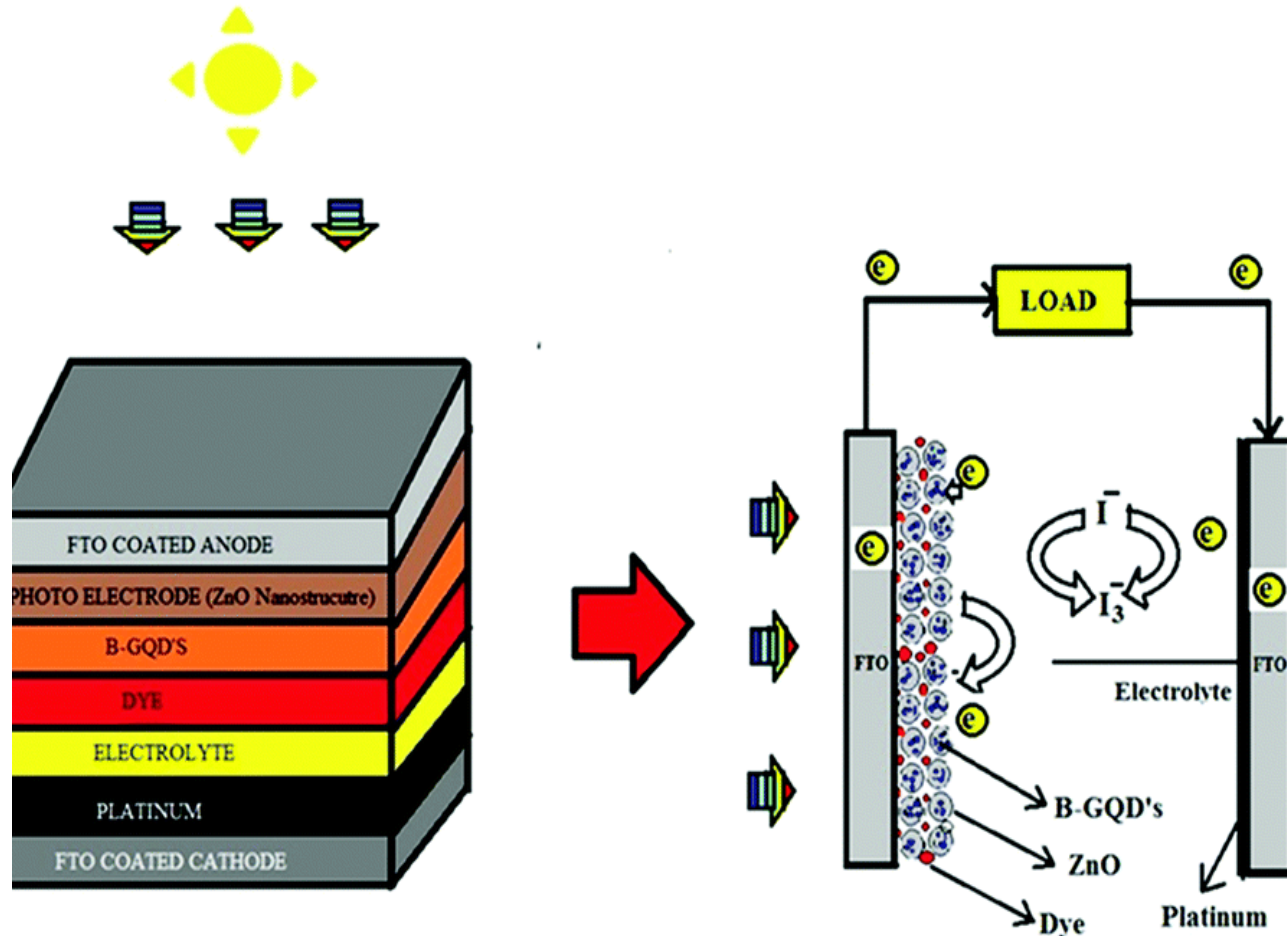
Recent Research on DSSC

A DSSC was fabricated(2018) with

- FTO glass as electrode
- NiS/rGO nanohybrid counter electrode showed efficiency as high as 9.5% suggesting its potential replace Pt
- NiS/rGO nanohybrids were synthesized using a facile and cost-effective hydrothermal approach



Quantum Dot photoanode for DSSC(2019)

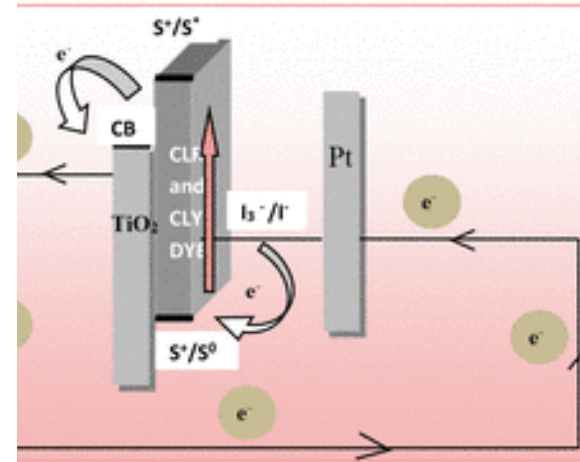


In this research

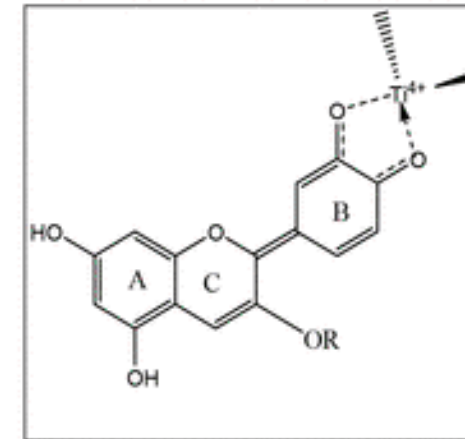
- Boron-doped graphene quantum dots (B-GQDs) have been synthesized
- Used FTO glass as electrode
- Nano ZnO is incorporated into these B-GQDs to prepare a B-GQDs-ZnO
- highest power conversion efficiency of ~3.7%

Using natural photosensitizer in DSSC(2020)

- canna lily red and canna lily yellow extracts are used as photosensitizers
- TiO_2 is implemented as a photoanode for device fabrication
- high charge collection efficiency of 95.82% studied by electrochemical impedance spectroscopy



(a)



(b)

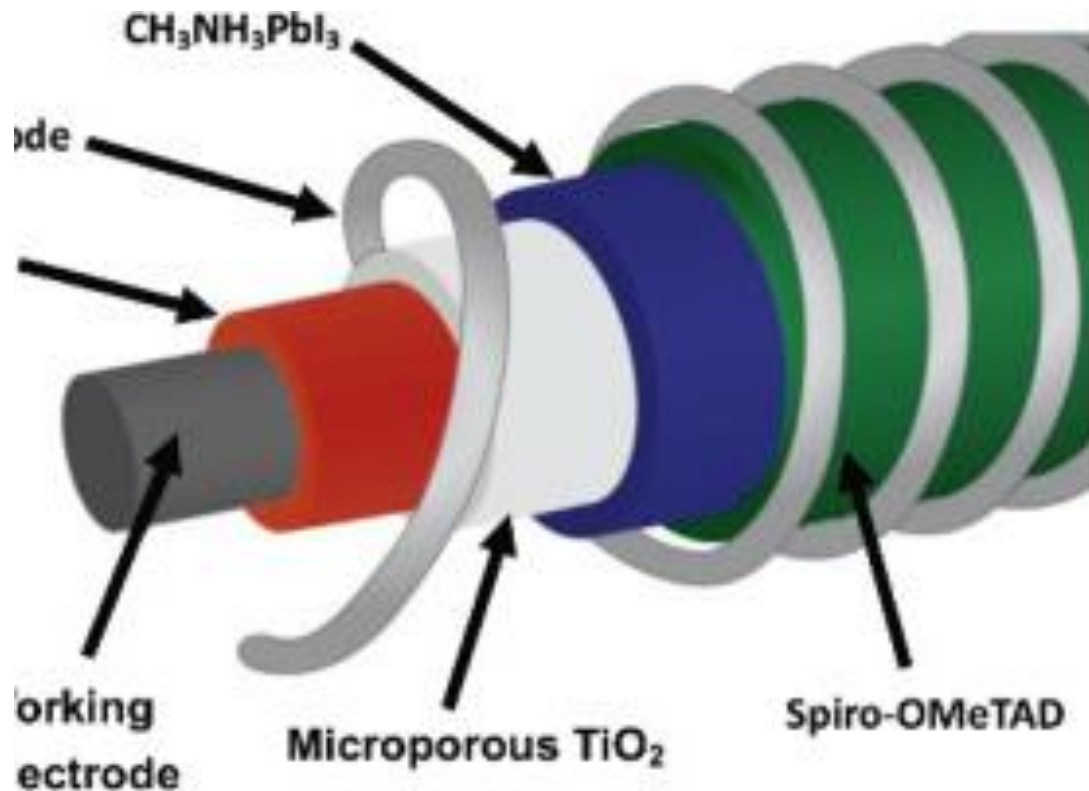


(c)



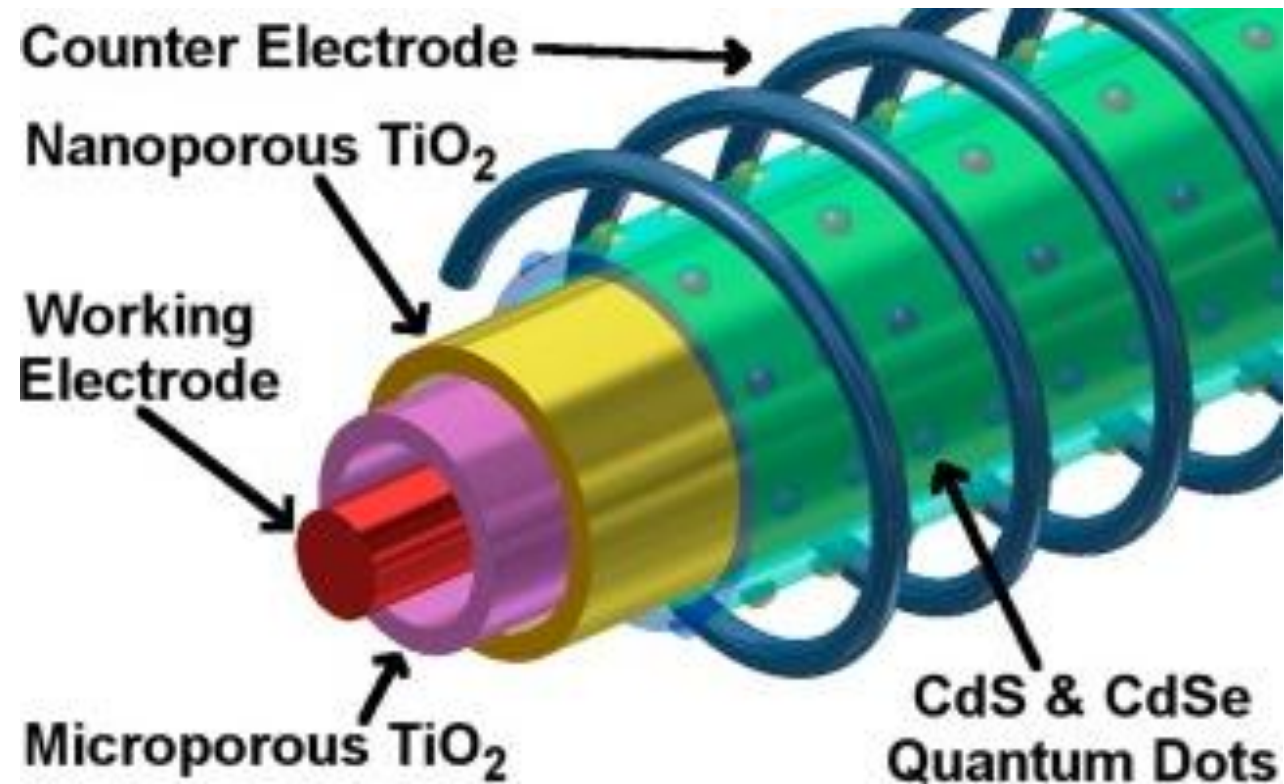
(d)

Research in PERL(UTRGV)



- An all solid state carbon nanotube yarn based perovskite solar cell has been developed
- Three-dimensional perovskite solar cells based on CNT yarn exhibit high open current voltage
- Carbon nanotube yarn based cells are flexible and capable of harvesting incident photons from any direction
- maximum power conversion efficiency of 0.631% with a high open current voltage of 0.825 V.

Three Dimensional DSSC with multiple sensitizer



- 3-D Dye Sensitized Solar Cell based on CNT yarn exhibit 7.6% efficiency
- Carbon nanotube yarn based cells are flexible
- Cadmium sulfide and Cadmium Selenide sensitizers increase efficiency

My Research Work

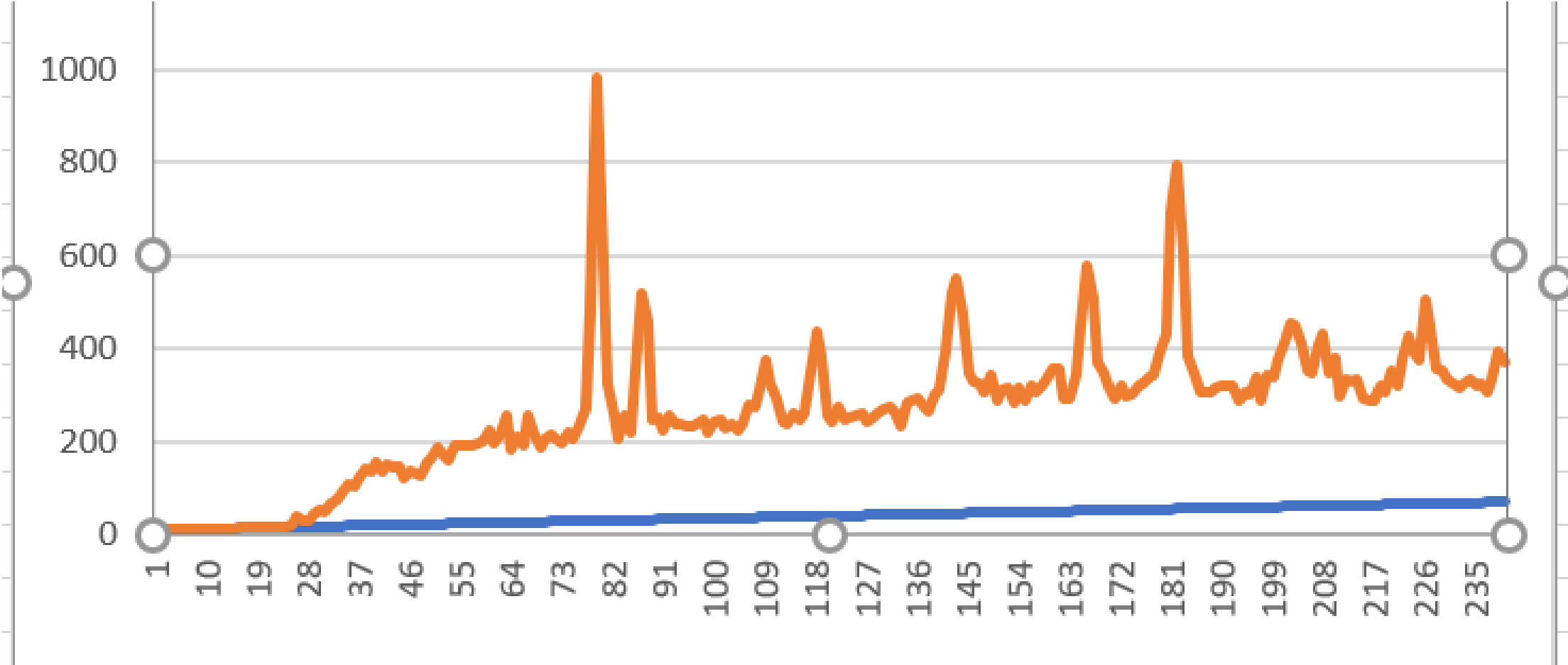
- Using Carbon nanotube yarn electrode
- BiOI/ TiO₂ heterostructure as noble photocatalyst
- No biohazardous material
- Iodine based electrolyte



Bio compatible photo catalyst

- BiOI/TiO₂ heterostructures were synthesized by chemical method at low temperatures.
- At different molar ratio it is synthesized
- 50% BiOI/TiO₂ shoed optimum result
- To compare the activity of photocatalyst, BiOI powders were also prepared by using the same procedure without adding TiO₂

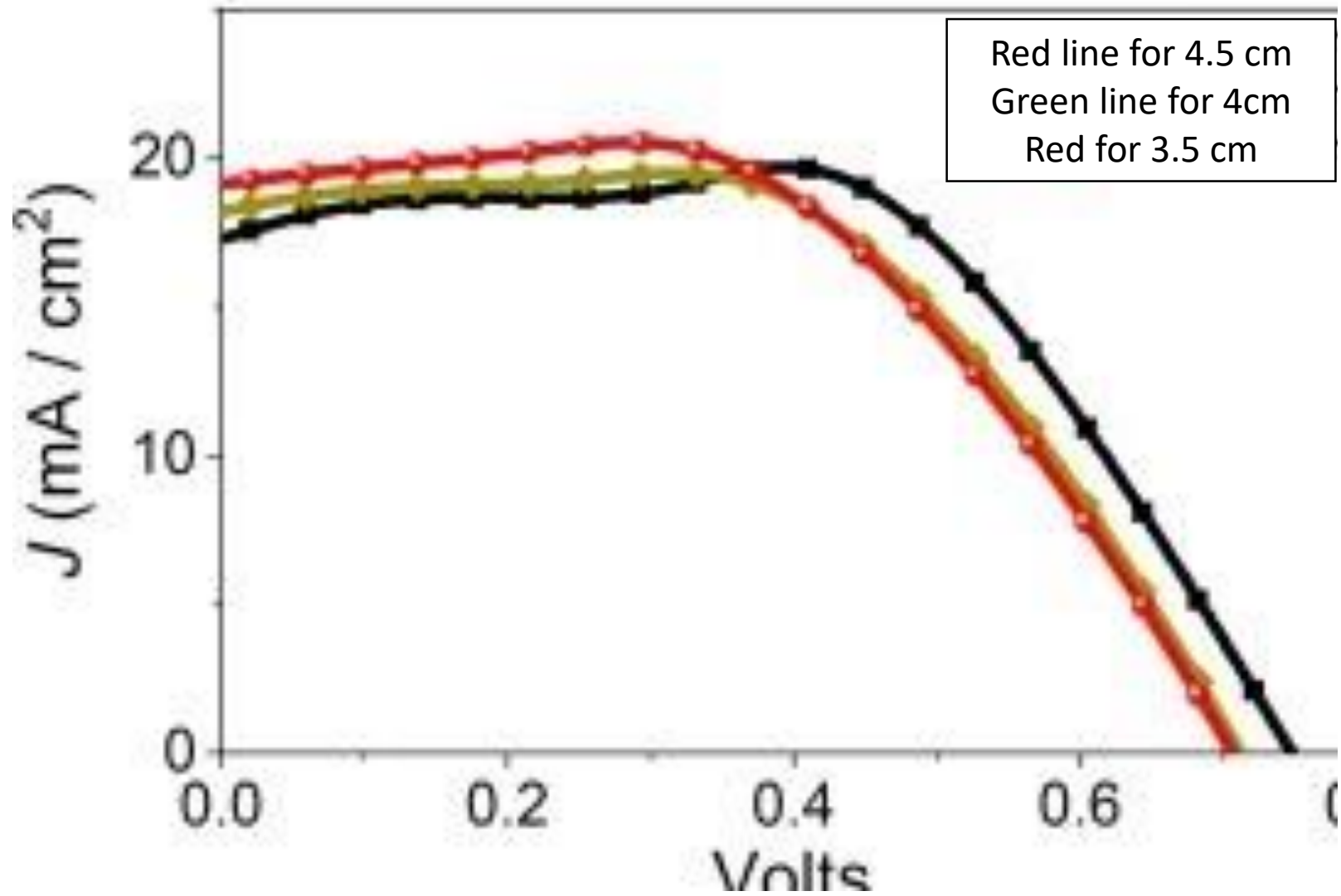
XRD of photocatalyst





Cell Fabrication

- Working electrode was prepared and immersed in Dye N719 for 24 hour
- Photocatalyst was applied though drop casting process
- Counter electrode was sputtered using a platinum target for 40s at 10mA
- Iodide based electrolyte was applied between two electrode
- Cell was fabricated with different length to evaluate the optimum length
- Solar simulator was used for light



Result of
Current vs
Voltage



Conclusion

- Highest current output is 18.73 mA/cm^2 .
- Energy efficiency is highest for 3.5 cm
- Photo catalyst works best for molar ratio 50%

Reference

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Thank You
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