Development of Dye-Sensitized Solar Cells using Algal-based Natural Dyes for Climate Change Mitigation

Rahul Chauhan[1*], Parasharam M. Shirage , **Kiran Bala**[1]

Department of Biosciences and Biomedical Engineering

Indian Institute of Technology Indore

*Rahul Chauhan; phd1901171006@iiti.ac.in

MOTIVATION

- Generating traditional or conventional energy from fossil fuels emit greenhouse gases and cause different types of pollution resulting in 7 million deaths/ yr as per WHO.
- Mining and Dumping due to energy production and consumption causes destruction of natural ecosystems and reduced protection from natural calamities.
- Minerals required for Renewable Energy alternatives are non-abundant in nature and majority non-native to Bharat making us dependent on imported fuels and crucial minerals for energy production totaling to above 80% energy import for Bharat.
- Traditional Solar entities have high water print, hazardous production and recycling in comparison to eco friendly Dye sensitized solar cells (DSSCs) developed with natural dye.

Working Mechanism of DSSC

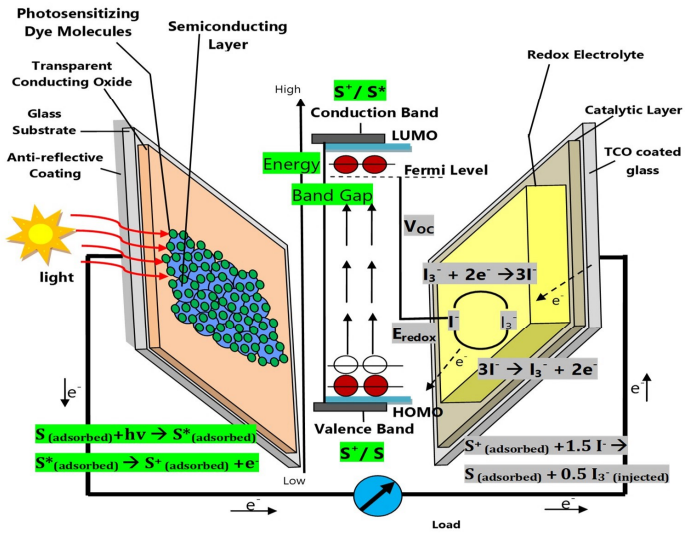


Fig. 1. A schematic Energy band diagram of DSSC operational components

Objectives

- Screening and selection of Algal species based on various process parameters.
- Fabrication/ Development of algal dye based DSSC and characterization.

Methodology

Cold Solvent Extraction Method with Methanol & Acetone → Sonicated 15 min → incubated 12 hours at 4° C

Hot Solvent Extraction Method with Methanol & Ethanol → Boiled at 100 ° C for 5 min → Absorption Spectra of supernatant taken

- The absorption spectrum taken on 0th , 5th , 10th , 15th , 20th , 25th , & 30th day.
- Extraction with 5 concentrations 100%, 95%, 90%, 85% & 80%.

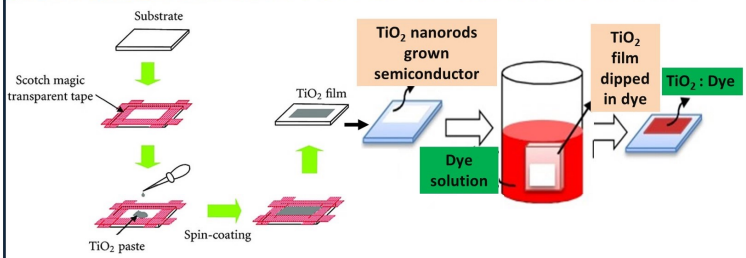


Fig. 2. Mechanism of photoanode preparation

Results

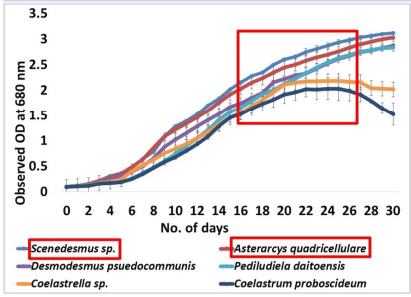


Fig. 3. OD based algal species growth pattern

Table 1. Chlorophyll conc. (mg/L) in algal species.

Species Name	15th day	20th day	25th day
Scenedesmus sp.	42.44 ±7.77	77.39 ±0.83	54.47 ±11.96
Asterarcys Quadricellulare	38.98 ±2.03	71.87 ±9.81	36.70 ±5.60
Desmodesmus Psuedocommunis	34.21 ±1.24	54.64 ±6.24	45.54 ±1.50

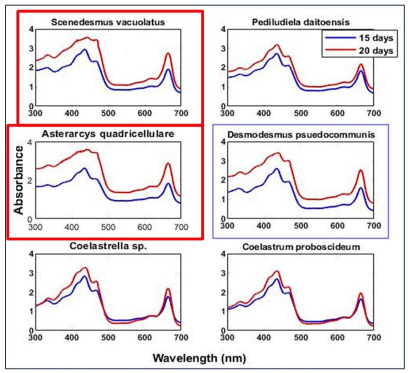


Fig. 4. Absorption spectrum of algal species

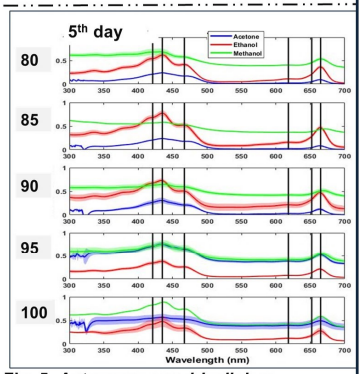
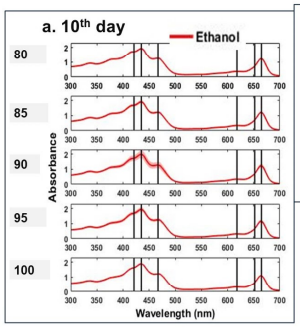
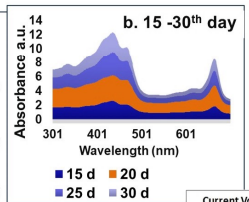


Fig. 5. *Asterarcys quadricellulare* absorption spectrum with various solvents





6. b. various days

Fig. 6. *Asterarcys quadricellulare* absorption spectrum with a. various ethanol concentrations

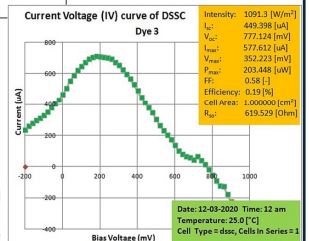


Fig. 7. Fabricated DSSC performance plot

Conclusions

- Algal species screened according to their growth, chlorophyll content & absorption spectrum rate w.r.t. efficient solvent concentrations.
- *Asterarcys quadricellulare* & *Scenedesmus vacuolatus* have a better combination of test results on 20th & 15th day.
- DSSC efficiency matched well with dye fabrication process & dye's spectral efficiency.

Acknowledgement

- We acknowledge EPCO for granting financial support, and appreciate SIC and BSBE, IIT Indore for providing research facilities.

References

Chauhan, R. (2022). Scanning prevalent technologies to promote scalable devising of DSSCs: An emphasis on dye component precisely with a shift to ambient algal dyes. Inorganic Chemistry Communications, 139, 109368.