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Effect of Chlorophyll Concentration Variations from Extract of Papaya leaves on Dye-Sensitized Solar Cell

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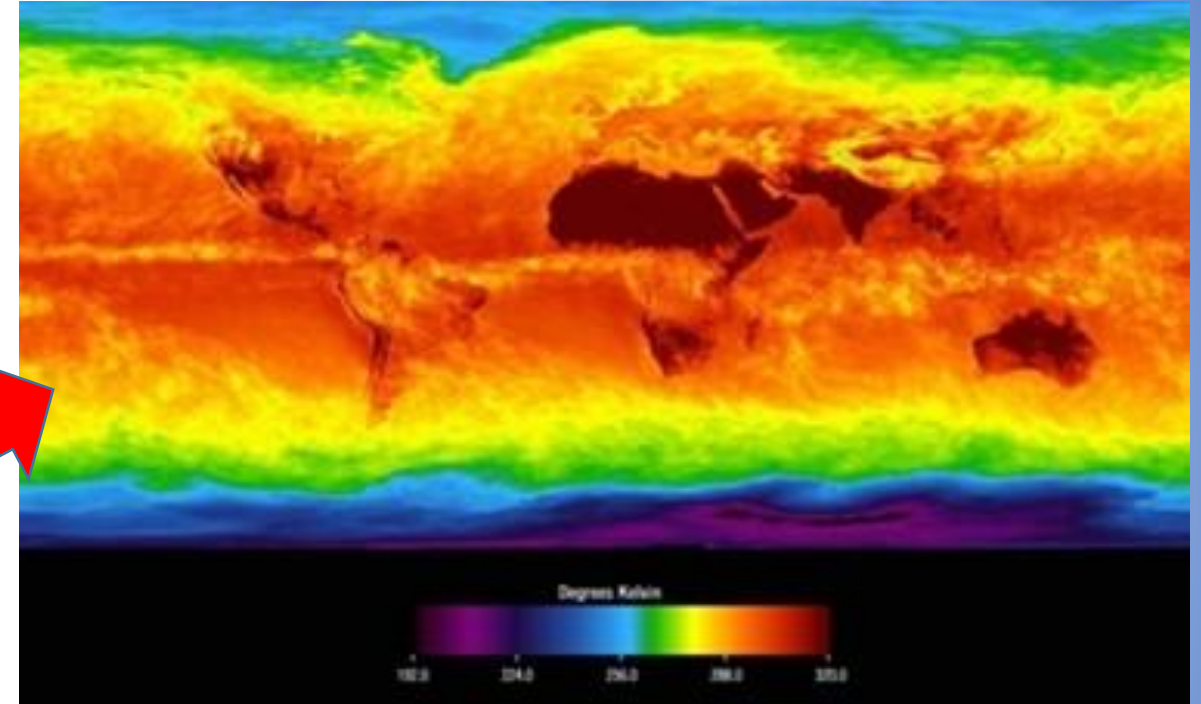
Malang, Indonesia

Background

- ✓ Increasing Energy Demand
- ✓ Limitation of Energy resource
- ✓ Solar Energy Potentials



**Indonesia Geographically located in
EQUATOR LINE
(Solar radiation of 4.8 kW/m²/day)**



Ref. [3]



Solar Cell (Conventional)

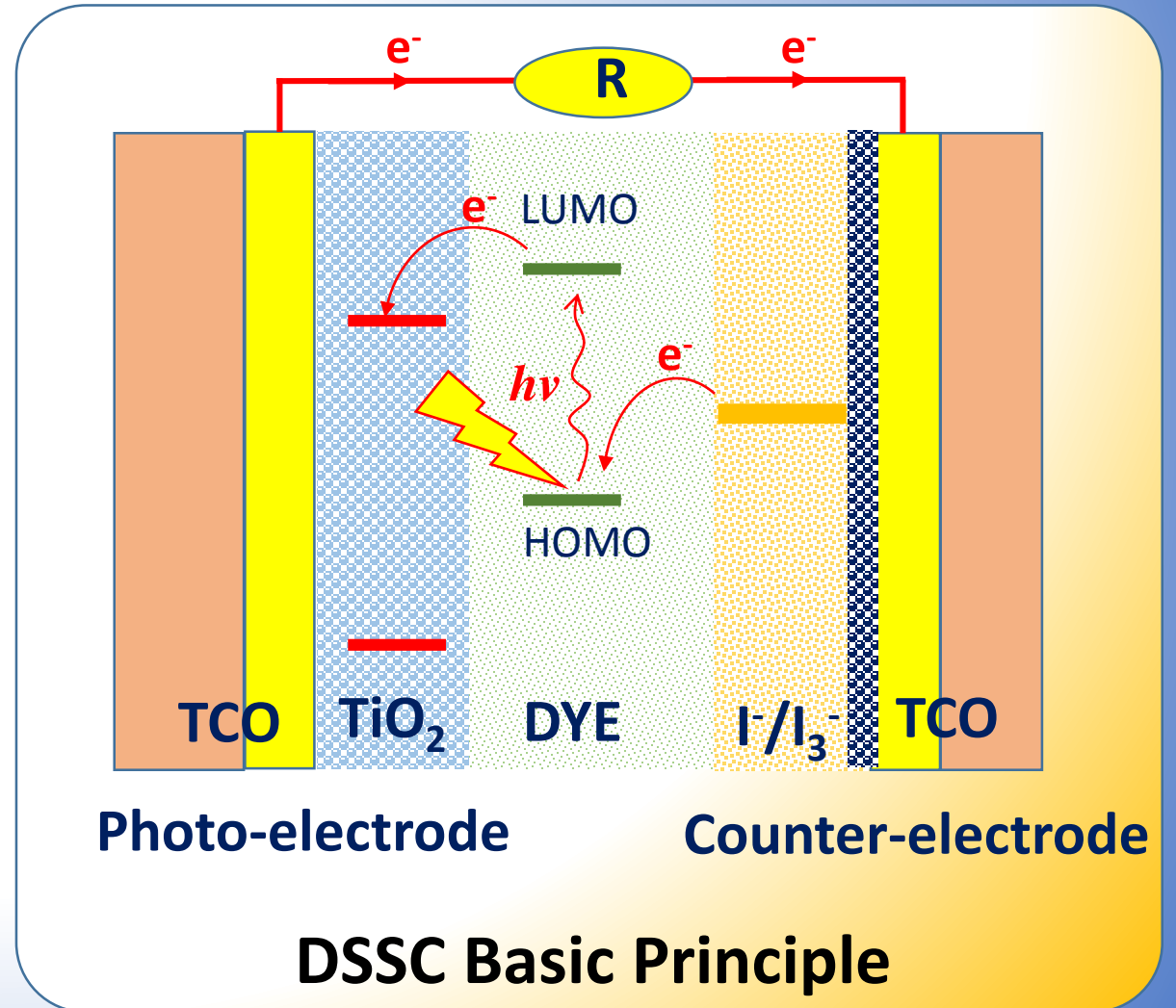
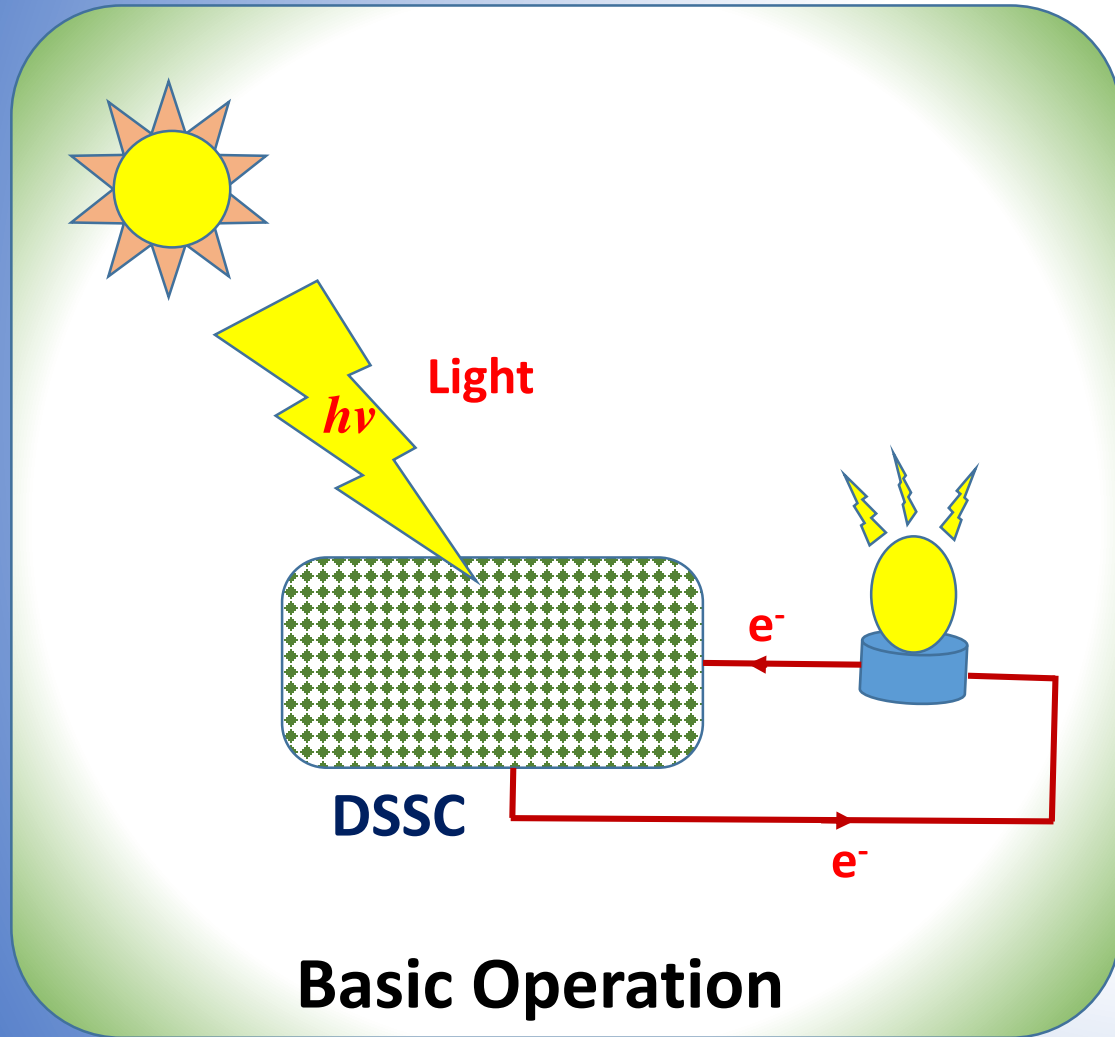
- High cost
- High temperature
- Clean room/ high tech



Dye-Sensitized Solar Cell (DSSC)

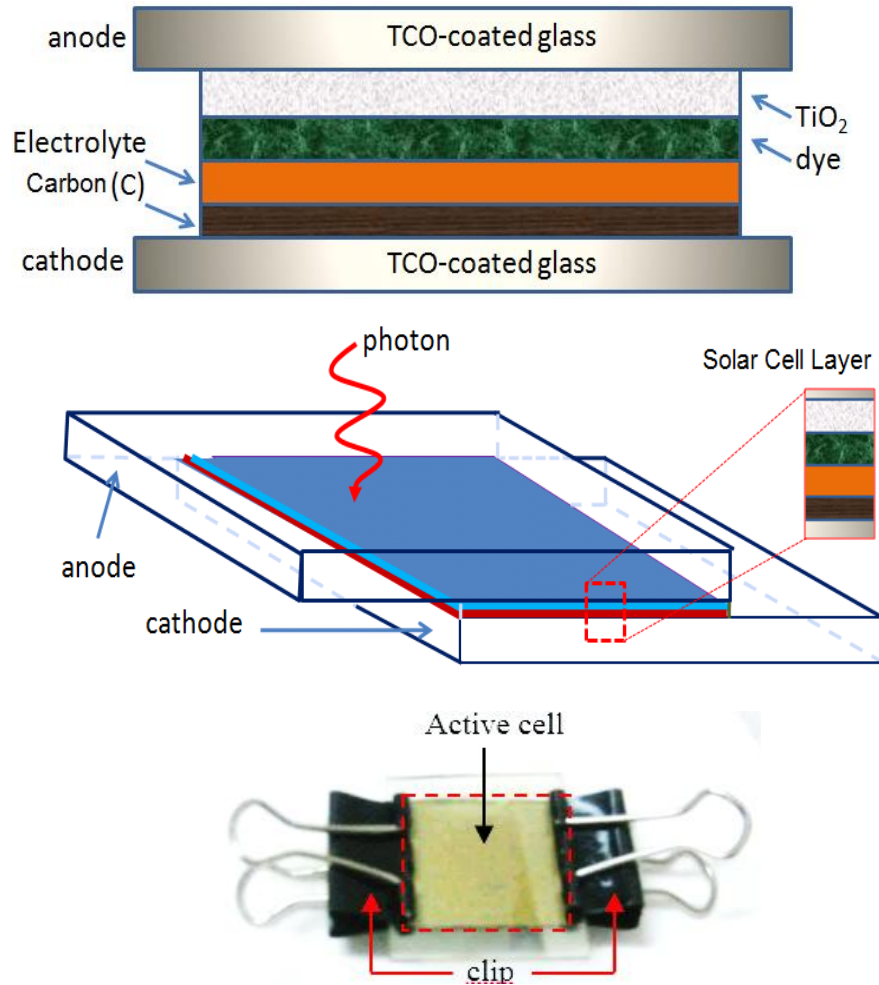
Mimic photosynthesis approach
Photo-electro-chemical phenomenon
Natural Dye extracted from Papaya Leaves

DSSC Principle



Material & Method

DSSC Structure



Chlorophyll dye



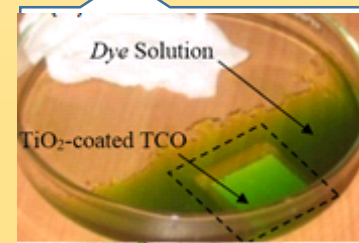
Papaya leaves extract

Variation of:

- * Ratio Leaf & solvent
- * Solvent concentration
- * Stirring time

Dye Preparation
& stirring process

Measured by
UV-Vis 1601
(400-800 nm)



Electrical Characteristic (I-V)

Substrate
Preparation

TCO glass

Photo
Electrode

Deposition of
 TiO_2 & firing

Immersion of TCO
coated TiO_2 in dye

Counter
Electrode

Carbon coated
glass

Electrolyte
Preparation

DSSC assembly

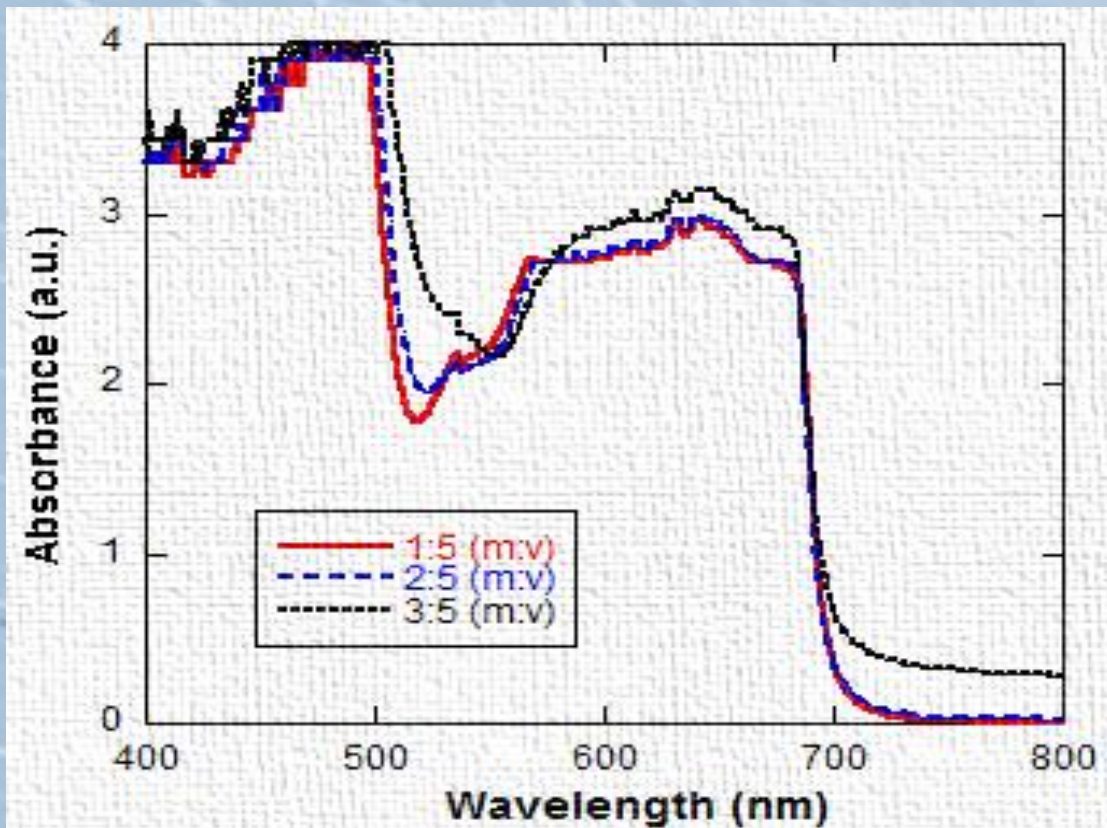
Electrode
wiring

DSSC
measurement

Result

#1 Measurement by variation of the ratio between leaves mass and solvent volume

Chlorophyll dye Absorbance Spectra



#1 DSSC Electrical Characteristic

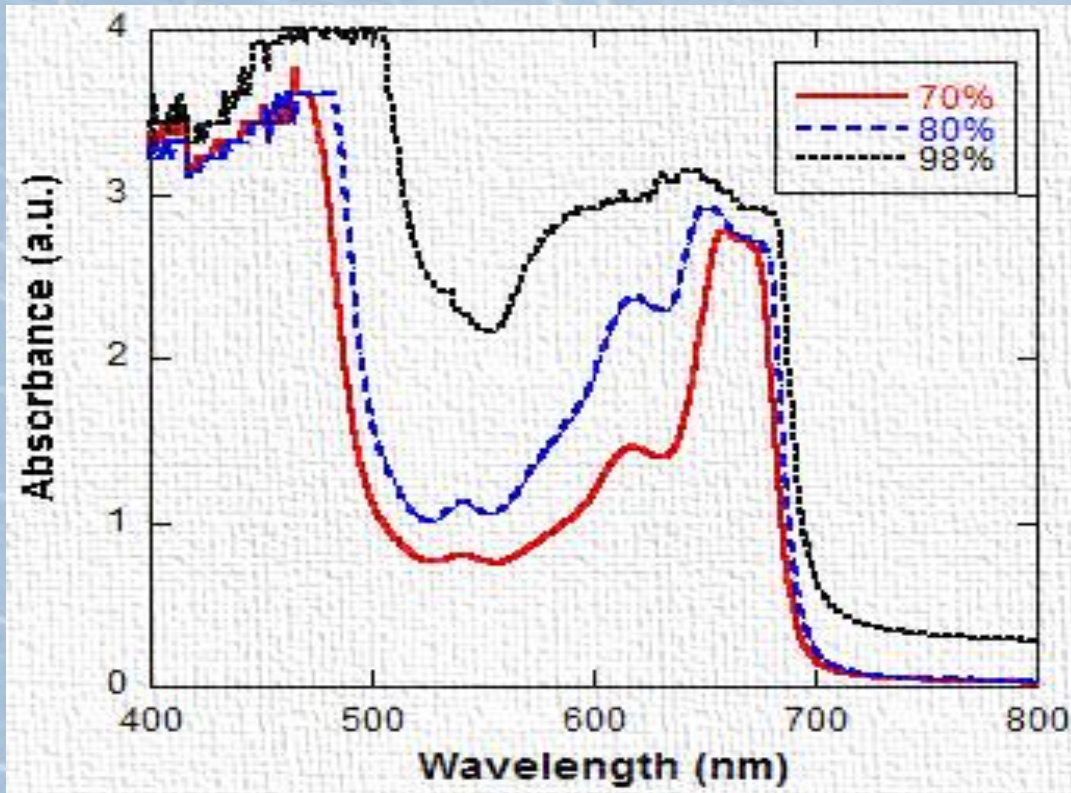
Sample (ratio)	Chlorophyll Total (mg/l)	Voc (mV)	Isc (μA)	Pmax (watt)
1:5	74.804	160.7	2.8	112.64x10 ⁻⁹
2:5	75.895	203	4	203x10 ⁻⁹
3:5	80.076	235.5	14	824.64x10 ⁻⁹

- ✓ The maximum number of *a*, *b*, and total chlorophyll was achieved of 3:5.
- ✓ The highest absorbance spectra was obtained by ratio of 3:5 (along 500-700 nm wavelength).
- ✓ The electrical measurements imply that the 3:5 ratio was maximum open voltage and sort circuit current.

Result

#2 Measurement by variation of ethanol solvent concentrations

Chlorophyll dye Absorbance Spectra



#2 DSSC Electrical Characteristic

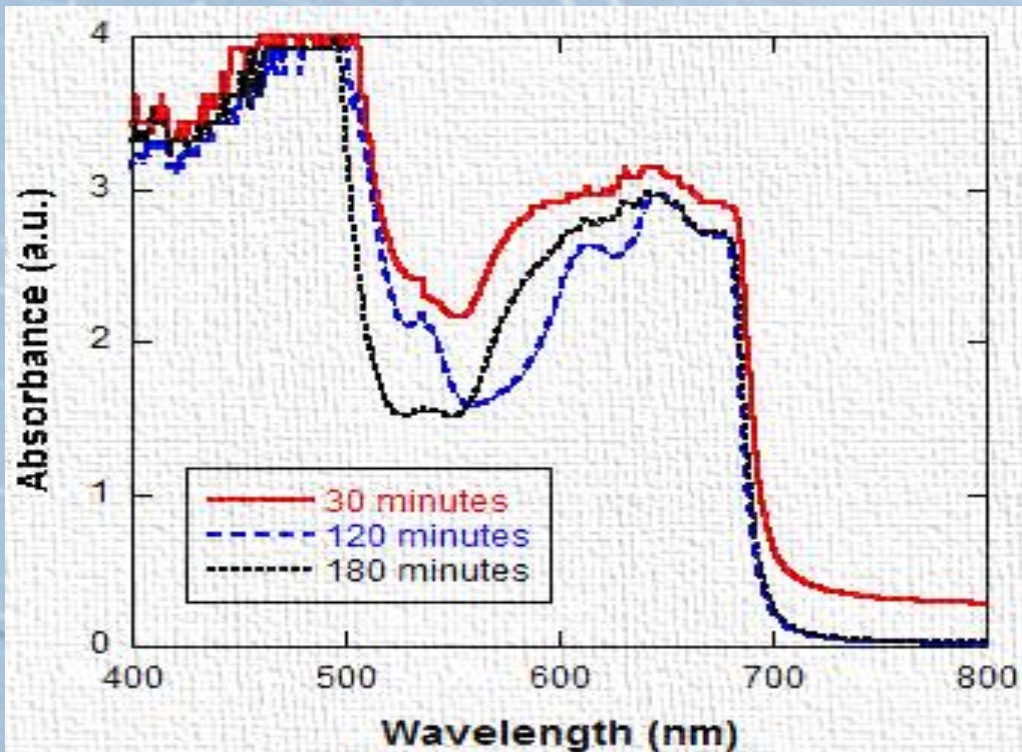
Solvent (%)	Chlorophyll Total (mg/l)	Voc (mV)	Isc (μA)	Pmax (watt)
70	61.815	218.4	5.1	279.07x10 ⁻⁹
80	75.067	224.2	8	449.24x10 ⁻⁹
98	80.076	235.5	14	824.64x10 ⁻⁹

- ✓ The highest absorbance spectra was obtained by concentration of 98%, 80% and 70%, respectively.
- ✓ The maximum chlorophyll total was achieved of 98% solvent concentration of 80.076 mg/l.
- ✓ The maximum open voltage and sort circuit current were obtained by 98% solvent concentration.

Result

#3 Measurement by variation of stirring time

Chlorophyll dye Absorbance Spectra



#3 Electrical Characteristic

Stir time (minutes)	Chlorophyll Total (mg/l)	Voc (mV)	Isc (μA)	Pmax (watt)
30	80.076	235.5	14	824.64x10 ⁻⁹
120	75.895	191	3.6	172x10 ⁻⁹
180	75.895	171	2.8	119.97x10 ⁻⁹

- ✓ The highest absorbance spectra was obtained by stirring time of 30 minutes.
- ✓ The maximum chlorophyll total was achieved by 30 minutes stirring time of 80.076 mg/l.
- ✓ The maximum open voltage and short circuit current were obtained by 30 minutes of 235,5 mV and 14 μA, respectively.

Conclusion

- **DSSC have been designed and characterized** by following method: dye processing, TiO_2 paste, TiO_2 -coated TCO glass, firing substrate, immersion TiO_2 TCO substrate into dye solution, counter electrode processing, and fabrication of DSSC by active area of 1.8×1.8 cm.
- Refer to the variation of the ratio between leaves mass to solvent volume of 1:5, 2:5 and 3:5, it can be **obtain the maximum chlorophyll number of 80.076 mg/l** and fill factor of DSSC of 25% at ratio of 3:5.
- Variation of solvent concentration were used of 70%, 80% and 98%. It can be achieved that the output power of DSSC was 824.64×10^{-9} watt at **solvent concentration of 98%**.
- The variation of **stirring time** of chlorophyll extract were observed of 30, 120, and 180 minutes. The **maximum chlorophyll number was achieved at 30 minutes by V_{oc} and I_{sc} of 235.5 mV and 14 μA , respectively.**

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