



## A Study On Photovoltaic Effects Using Dye Sensitized Solar Cell Prepared From Piperine And L-Cysteine

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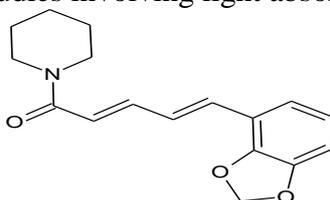
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**Abstract:** Dye-sensitized solar cells (DSSCs) have garnered significant attention due to their ease of use, low production costs, and high efficiency. In this study, we present a DSSC constructed using piperine, a natural spice dye, and the amino acid cysteine. The cell demonstrated an efficiency of 0.26% and generated an average current of 1.665 mA under single sunlight illumination, showing promise for future research. Future experimental studies could explore the use of improved electrolytes and the combination of different related spices to enhance performance.

**Index Terms** - Spices, Piperine, cysteine, DSSC, Photovoltaic studies.

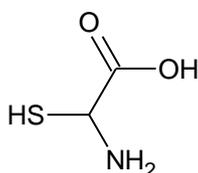
### I. INTRODUCTION

India is a land of herbs and spices. It finds its use not only in the kitchen but in ayurvedic preparations. With its pungency and characteristic flavor, pepper has reigned every preparation, be it food or ayurvedic potions, hence it is appropriately named as King of spices. The major ingredient present in pepper is piperine. It is responsible for the pungency that it offers. We can observe that piperine has an extended conjugation and suitable candidate for studies involving light absorption.



Piperine

A thiol containing important amino acid is Cysteine. With a sulphur moiety in this amino acid, it contributes to formation of disulphide bonds in proteins. It is found that cysteine is a helpful electron transporting agent for enzyme catalysed reactions. The cheapest source of L-cysteine is human hair, skin and nails. Cysteine yields a white solid cystine on oxidation. It has the general formula  $(SCH_2CH(NH_2)CO_2H)_2$ . Cysteine acts as a site for redox reactions and a mechanical linkage helping in retaining their 3D structure<sup>2</sup>.



Cysteine

In recent advances on photovoltaic cells Dye Sensitized Solar Cells (DSSCs) also called as Grizel cells developed by Michael and Brian in 1990's have received enormous attention due to its high solar-to-electric efficiency, reproducibility, cost effectiveness and versatility. A typical DSSC is made up of a dye (Photosensitizer), an electrolyte solution and a semiconductor material ( $\text{TiO}_2$ ). Dye absorbs radiations from sun, gets excited and transfers electrons to semiconductor material which is later transferred to the electrode producing current.

From the first reported DSSC power conversion of 7.1 %, the energy conversion has improved to 11.5 %. Energy conversion of 5.52% from 5 cm x 5 cm device is achieved by Fluorine Doped glass slides. G24 Innovation Ltd., based on the technology invented by Grätzel, uses a low-cost, roll-to-roll process to make its flexible DSSC modules, which produce 0.5 watts of power under direct sunlight. Researchers have developed a 2.1 mx 0.8 m DSSC module with eight pieces of 10 cm panels. Ming et al<sup>9</sup> and Sharma et al<sup>10</sup> have constructed DSSC's using L-cysteine as a redox couple and got promising results<sup>3-8</sup>.

In our present study we used piperine as the dye and cysteine as a part of anode along with graphene from pencil to study the photovoltaic effects.

## II. MATERIALS AND METHOD

All chemicals used for this study were analytical grade of sd fine chemicals or Sigma Aldrich. The graphs were plotted using a free version of MS Origin.

**Isolation of piperine:** Black pepper (10 g) was ground into a coarse powder and extracted with 95% ethanol (200 mL) in a Soxhlet extraction apparatus for 3 hours. The extract was concentrated by distillation and recovery of solvent. 10% alcoholic KOH (10 mL) was added to the residue and allowed to stand for 1 hour. The solution was decanted and allowed to stand undisturbed over-night, long yellow needles of piperine were deposited. The yellow needles were collected by filtration and washed with a minimum volume of 95% ethanol. Crystals were allowed to air dry and weighed. A Practical yield of 3.5g was obtained.

**Isolation of cysteine:** 10 g of clean, dried human hair was placed in a round bottomed flask. 5 mL of 35% KOH solution was added to it and warmed until hair dissolved completely. After complete dissolution 100 mg of activated charcoal was added to the solution and boiled. The contents of the flask were filtered and neutralized using 50% HCl. The solution was allowed to stand for a night. Crystals of cysteine were obtained. Filtered the product and dried. An yield of 2 g was obtained.

### Preparation of DSSC:

#### Preparation of Dye-Sensitizer Solutions

Piperine isolated from pepper pods were used as such. The dye solution was prepared by weighing 10 mg of the isolated piperine and dissolving in few drops of ethanol. The solution was stored by refrigeration until use.

#### Preparation of Electrodes

The conductive glass plates (FTO glass, fluorine-doped  $\text{SnO}_2$ , sheet resistance 8-12  $\Omega/\text{cm}^2$ ) and the nano titanium oxide ( $\text{TiO}_2$ ) were purchased respectively from Aldrich and sd fine chemicals respectively. Thin films of  $\text{TiO}_2$  were prepared by spreading a thin paste of the semiconductor on the conducting glass. The film was later heated at 450 °C for 60 min using a hot air blower, The  $\text{TiO}_2$  photo-anodes were then soaked in piperine solution (pH 1-10), rinsed with distilled water, ethanol and dried. Graphene was coated onto the slide using a pencil and cysteine polymer power was sprinkled on it, this acted as the counter electrode.

#### Preparation of electrolyte

A 0.1 M electrolyte solution was prepared by mixing 0.05 M of KI and 0.05 M of 3-methoxypropionitrile in 50 ml. of acetonitrile and stirring for 60 min.

#### Assembling

The electrolyte solution was poured onto the plate with  $\text{TiO}_2$  layer and the counter electrode was placed on it. The excess electrolyte solution was wiped out from the corners and the slides were clamped

### P-V Studies:

The electrode was exposed to direct sun illumination when the light intensity was maximum i.e. at 3.30 pm. Only after the cell showed current output they were subjected to breakdown potential studies using Zener diode. The prepared DSSC cells were illuminated with tungsten filament source (2370 Lux 15 W) kept at a distance of 10 cm and maximum power was determined using Zener Diode. A PV plot was plotted and

(maximum efficiency) % was calculated. Control slides of different pH were prepared without solutions and all showed zero conductivity.

### III. RESULTS AND DISCUSSION

#### Photovoltaic studies under one sun illumination

Table-1 shows the results of photovoltaic studies under one sun illumination.

TIME	Current (mA)
3.30	1.655

#### P-V STUDIES

A Current versus Voltage graph obtained after was plotted as shown in Figure-1. All slides were illuminated at a distance of 10 cm from source using tungsten filament as source.  $\eta_{\max}$  (maximum efficiency) % calculated from the graph was found to be 0.26 %

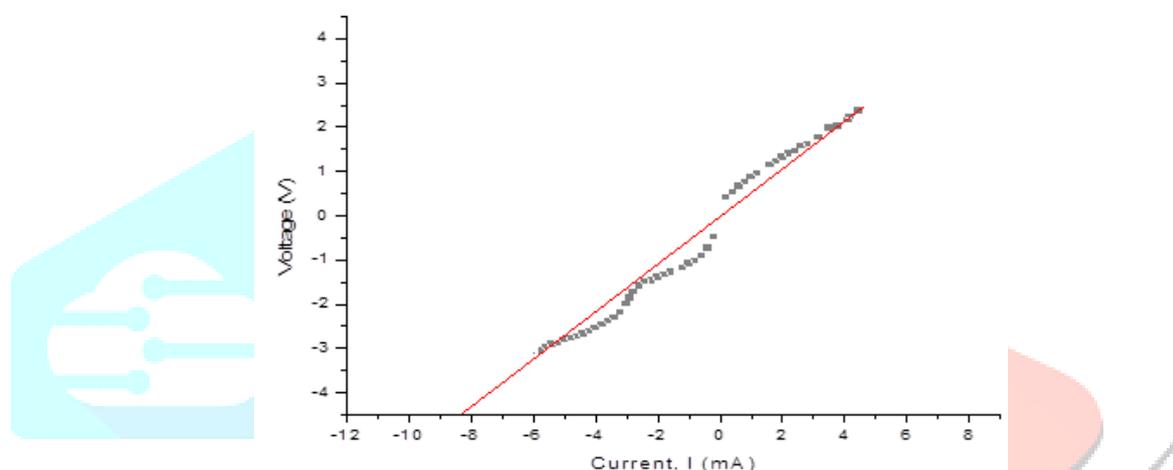


Figure – 1: PV diagram of DSSC

### IV. CONCLUSION

Due to ease of usage, low production cost and high efficiency, DSSC's have been extensively studied. In this present work, we report a DSSC made from natural spice dye, piperine and an amino acid cysteine. It showed an efficiency of 0.26%, and an average of 1.665 mA of current under one time sun illumination which is promising for further studies. Use of better electrolyte and combination of different related spices may be considered for future experimental studies.

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