UNIVERSITI TEKNOLOGI MARA
Cawangan Terengganu
Kampus Bukit Besi

TITLE:

A study of Natural Dye Extraction of Melastoma and Metal Oxide Doping for Dye-Sensitized Solar Cells

SUPERVISOR:

DR. Noraini Binti Razali

DR. Nurul Huda Binti Kamarulzaman

SCHOOL OF CHEMICAL ENGINEERING

COLLEGE OF ENGINEERING

2025

ABSTRACT

Dye-sensitized solar cells (DSSCs) provide a sustainable energy solution, yet standards synthetics dyes are both expensive and harmful to the environment. This study investigates the potential of using Melastoma petals extracts as natural dyes and enhances the conductivity and stability using calcium oxide (CaO) doping. Conductivity of fresh and dried petals extracted for 1, 3, 5 days was studies. In case of the dried petals, the optimum extraction time for higher adsorption was found to be 3 days. CaO with a doping ratio of 5:1 increased the stability of the dye. This study highlights that Melastoma petals are a low cost, eco-friendly raw material for DSSCs to promote the sustainability of solar energy technology.

TABLE OF CONTENTS

		Page
AUTHOR'S DECLARATION		**2**
ABSTRACT		**3**
TABLE OF CONTENTS		**4**
CHAPTER ONE BACKGROUND		**6**
1.1	Introduction	5
1.2	Literature Review	6
	1.2.1 Dye Sensitized Solar Cell	6
	1.2.2 Natural Dyes in Dye-Sensitized Solar Cell (DSSC)	7
	1.2.3 Metal oxide and Doping Technique for Hybrid Solar Cells	8
1.3	Problem Statement	9
1.4	Objectives	10
1.5	Scope of Study	10
CHAPTER TWO METHODOLOGY		**11**
2.1	Introduction	11
2.2	Materials	12
2.3	Extraction of Natural Dye from Melastoma Flowers	15
CHAPTER THREE RESULT AND DISCUSIION		**17**
3.1	Introduction	17
3.2	Result of Dye Extraction of Fresh and Dried Melastoma Petals	17
	3.2.1 Result for Physical Observation and Characteristic	17
	3.2.2 Result of Conductivity Test	19
CHAPTER FOUR CONCLUSION AND RECOMMENDATION		**23**
4.1	Conclusion	23
4.2	Recommendation	24
REFERENCES		**25**

BACKGROUND

1.1 Introduction

Due to population growth and rapid industrialization in the recent decades, energy consumption has increased exponentially. Fossil energy, which is responsible in total for 84% of world energy production, has a finite supply and is one of the leading contributors to environmental pollution such as greenhouse gases emission, global warming, and air pollution. Ongoing problems associated press highlight the need in renewable and sustainable energy solution that can poisonous the increasing energy requirement without compromising the environment. Solar energy is by far one of the most encouraging renewable energy sources, due to its abundance, cleanliness, and renewable potential. (Modes, n.d.)

Light-harvesting dyes, like those employed in dye-sensitized solar cells (DSSCs) in third-generation solar cells are used to absorb sunlight and transfer this energy to two more carriers to generate electrical work. However, conventional photovoltaic solar devices have low-power and depends heavily on dye performance. Hight cost, environmental issues during and after synthesis, and low availability have motivated the increasing interest in plant-derived natural dyes as a more sustainable and less expensive alternative to conventional DSSCs synthetic dyes. (Andualem & Demiss, 2018)

Natural dyes are also accessible, biodegradable, and inexpensive, making them well suited for DSSCs. These derived from fruit, flower, and leaves that contain light-absorbing components such as anthocyanins, chlorophylls, and carotenoids that can absorb strongly. Bound with an electrical current, energy-efficient natural dyes are often hindered by low-electrical conductivity and stability of low reliability, which leads to a decline in the overall performance of DCCSs. To effectively implement natural dyes in the field of solar cells they must overcome these draw backs. (Ferreira et al., 2022)

This study investigates the potential of natural dye extracted from Melastoma flowers to be used in DSSC applications. Anthocyanins are abundant in the petals of Melastoma, a class of pigment known for its efficacy in light harvesting. The study is investigating properties and performance of dyes derived from Melastoma to enable development of more environmentally friendly solar cell technologies and understand the potential of natural dyes for renewable energy.

Before this researcher used TiO_2 for doping process which is expensive metal. Thus, it has been proposed that calcium oxide (CaO) serves as an alternative to titanium dioxide (TiO_2) when it comes to doping in DSSCs. Not only a lower cost but also enhance the stability of dye and conductivity. Doping TiO_2 with calcium increases the efficiency of DSSC from 2.93% to 4.04%, but TiO_2 is mostly a semiconductor that needs accurate control to eliminate electron recombination. ((Andualem & Demiss, 2018; Devadiga et al., 2023) Instead, CaO is non-toxic, improves the light absorption and stabilizers the dye without changing its characteristics, therefore making it a preferable option for natural dye DSSCs in this work.

1.2 Literature Review

1.2.1 Dye Sensitized Solar Cell

Dye-sensitized solar cells (DSSCs) are considered as a very suitable option to replace conventional silicon-based solar cells due to cheap manufacturing cost, simple and well-scaled fabrication method, and low-light operation. (Andualem & Demiss, 2018) DSSC devices are based on the use of light-harvesting dyes to harvest sunlight, in contrast to the prevalent use of silicon-based solar cells, which are relatively demanding to produce, DSSCs offer a possibility of sustainability, in addition to the flexible use of renewable energy sources. (Sahoo et al., 2020)