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# A Survey Paper on Plastic Solar Cell Technology

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***Abstract:*** ***The demand of energy is increasing day by day so non-conventional source of energy has to be used. Sun is the non-conventional source of energy. Conventional solar panels convert solar energy into electrical energy. A plastic solar cell is the type of photovoltaic that makes use of organic electronics dealing with conductive organic polymers or small molecules for light absorption and charge transport to produce electricity from sunlight by the photovoltaic effect. Polymers Provide the Advantage of Solution Processing at Room Temperature, which is Less Expensive and Enables One to Use Plastics. Therefore, If Silicon Is Replaced with Polymer Nanowires, The Solar Cell Would Be Much Lighter and Ultimately Less Costly. These Solar Cells are Thin, Several Microns in Diameter, and Scavenge All the Rays from the Sun's Radiation. Plastic Solar Cell Technology is Based on Conjugated Polymers and Molecules. Polymer Solar Cells have Generated Considerable Interest Since it Provides Environmentally Friendly, Flexible, Lightweight, Low Cost, Possibility of High-Efficiency Solar Cells in the Last Couple of Decades. Plastic Solar Cells are More Efficient and Viable in Usage. This dissertation focuses on the development and optimization of plastic solar cell technology, in particular this potential towards flexible, lightweight, and cost-effective alternative sources to traditional silicon-based solar cells. The focus of the present research work is to find optimum organic materials for higher efficiency and stability in plastic solar cells, varying from conjugated polymers to small organic molecules. Some of the main goals are improving the charge transport mechanisms and optimizing the architecture of devices through state-of-the-art techniques of fabrication, like roll-to-roll printing and layer-by-layer deposition. The other key aspect is that the project assesses the environmental aspects and lifecycle of plastic solar cells to ensure an environmentally friendly production process. Huge preliminary results were achieved at high power conversion efficiencies and durability has been greatly improved, targeting very wide spread application from portable electronics up to building-integrated photovoltaics. Therefore, the discovery of plastic solar cells might be a major step for applicable solutions in renewable energy and towards overcoming the world's increasing energy challenges.***

***Keywords: Plastic Solar Cell, Organic Photovoltaics, Polymer Solar Cell, Flexible Solar Cells, Renewable Energy, Sustainable Energy, Energy Efficiency , Low Cost Production, Electron Transport Layer.***

## I. INTRODUCTION

The sources of Energy are decreasing due to more energy demand and there is global warming problems. The global demand of energy is increasing constantly. The consumption of energy is directly proportional to the progress of mankind with ever growing population, industrialization etc. Therefore, the non-conventional source of energy is used in order to fulfill the energy needs. Sun is Non-conventional source of energy, so we Developed Conventional Solar Cells to fulfill Energy Needs. Along with this increase in renewable energy sources, great research has been achieved in novel solar technologies.

Basically, Conventional Type Solar Cells Photovoltaic Cells Are Made of Special Materials Called as Semiconductors Such as Silicon. The Conventional Solar Cells are More Expensive, they Requires Large Space and they Don't Work Under Cloudy Days. To Overcome These Problems Plastic Solar Cell Technology is Used.

Organic Solar Cells also named Organic Photovoltaics, are an Organic Solar Cell that uses Organic Materials for the absorption of sunlight to generate electricity. Plastic Solar Cell is Based on Conjugated Polymers and Molecules. Polymer Solar Cells Environmentally Safe Flexible as Well as Lightweight. The Plastic Solar Cell Technology is more Effective compared to the conventional Solar Cell. The Major advantage is that they can even work on cloudy days. Plastic solar cell technology is more Effective and easy to apply.

These advantages include flexibility in design and lighter weight, with potential for low-cost production, thus appropriate for wide-ranging applications-from portable electronics to building-integrated photovoltaics. n plastic solar cells, the raw material is essentially of organic nature, like conjugated polymers and small organic molecules, which provides them with the prospective advantage of absorbing solar light and converting it into electricity. This technology opens more scope to mass production by making use of roll-to-roll processes. The production cost comes down, and new design opportunities are opened.

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Despite its benefits, there were challenges in the performance efficiency and stability of plastic solar cells over the years. However, breakthroughs in material science and device architecture have been unfolding new avenues for performance improvement in these cells in recent times. The present project discusses the various breakthroughs that could be made in optimizing charge transport properties and increasing the durability of these plastic solar cells.

In addition to the improvement on the technical aspect, the project addresses the problem of plastic solar cells with considerations on environmental dimension. Therefore, the authors then assess the sustainability and lifecycle of the solution in terms of renewable energy during their engagement with it. Through this exploratory aspect, the project enables giving more opportunities for developing an efficient and environmentally friendly technology in solar power in support of a shift toward a more sustainable future.

## II. RELATED WORK

Based on a synergy between material innovation, improvements in device architecture, and enhanced manufacturing techniques, the past two decades have seen great developments within the field of plastic solar cell technology. The review below gives a summary of the key contributions made and the direction in which this field is moving, thereby defining the current state of organic photovoltaics (OPVs).

### *A. Material Development*

Recent research work has been done on conjugated polymers and small molecule acceptors with better light absorption capability and charge mobility. Some of the prominent work includes that by Zhang et al. (2019) where non-fullerene acceptor systems have exposed various devices that have shown efficiency and stability much higher than the conventional fullerene-based ones.

### *B. Device Architecture*

Innovations within device architecture are categorized to significantly enhance the performance of the plastic solar cell. For instance, bulk heterojunction BHJ structures have been extensively studied whereby separation and transportation of charges take place. Within such a concept, Liu et al., in the year 2020, optimized the thickness of the active layer and the layer morphology for maximum efficiency light harvesting and charge collection.

### *C. Flexible Substrates and Manufacturing Techniques*

Flexible substrates and roll-to-roll manufacturing processes have been cited as a leading development in the effort to make plastic solar cells commercially viable. It has been shown that such approaches lower the cost of production without sacrificing device performance. Most recently, Kim et al. published work in 2021 on scalable printing methods while retaining high efficiency in large-area devices.

### *D. Stability and Durability*

Major challenges still remain in stabilizing plastic solar cells under real-world conditions. For instance, through research by Cheng et al. (2022), several encapsulation techniques and additives to materials were determined extending the OPVs' lifespan, with the tests showing a successful accelerated aging test

### *E. Environmental Impact*

Analysis of the lifespan of plastic solar cells is one of the most recent trends that is based upon more and more growing needs for sustainable energy solutions, and research by Martinez et al. in 2023 analyzed the environmental footprint of different OPV materials and especially needs production processes that are less toxic and also addresses an end-of-life recycling strategy.

### *F. Commercialization Efforts*

The rising market feasibility is further underscored by the fact that several companies have begun to commercialize plastic solar cell technology. While many start-ups have in recent years commercialized OPV technology, it remains mostly for niche applications, such as building-integrated photovoltaics and portable charging solutions.

These related works underline the dynamic and fluctuating nature of plastic solar-cell technology, with some having been achieved but countless yet to be solved. This project aims to stand on this ground by further improving plastic solar cells in their efficiency, stability, and sustainability in all possible aspects.

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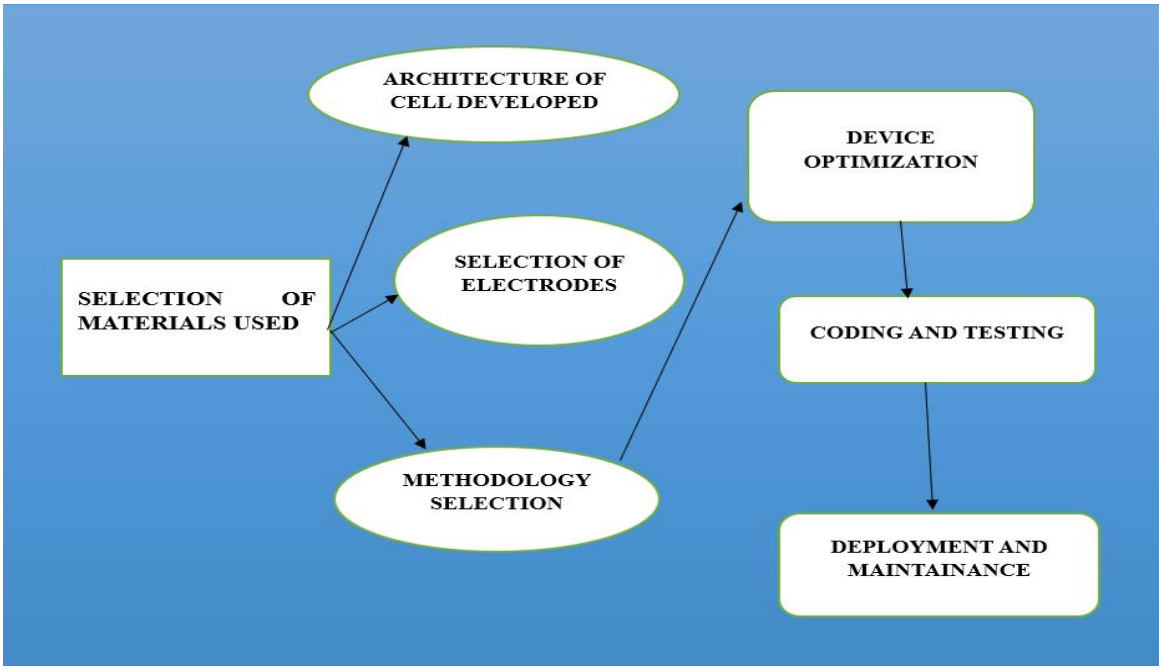
## III. METHODOLOGY

This chapter covers the systematic methodology applied in the development and optimization of plastic solar cell technology. This methodology consists of a number of key phases that are designed to tackle very specific objectives, concerning material selection, device fabrication, characterization, and sustainability assessment. Plastic Solar Cells Consist of Various Materials Including Polymers, Nanorods and Conduction Plastic. Plastic Solar Cells are Printed on Flexible Foil Made from a Combination of Solid and Liquid Materials. They are Light in Weight, Bendable and Applied to Most Surfaces. Plastic Solar Cells have a Highly Inclusive Production Process which includes Printing, Nanomaterials, and Thin Film.

Making Plastic Solar Cells is not such a Simple Process; it Involves a Series of Steps:

1) *Spin Coating:* Special Ink is Spread on a Glass Plate. Then this plate is spun at high speed so that the ink gets spread into thin film. The ink contains polymers mixed in a way to form A dense network.
2) *Special Additive:* A tiny amount of a slow-drying liquid additive is mixed into the ink. This additive helps the red polymer spread out and dry slowly, which increases the efficiency of the solar cells.
3) *Covering A Metal Layer:* A metal layer is placed over the top of the polymer to act as a negative pole
4) *Using a Flexible Base:* The Cell is Developed on a Flexible Base, Such as Glass.
5) *Adding a Transparency Cover:* A cover is added to the base that allows sunlight to pass through to the core of the cell.

### A. *System Architecture of Plastic Solar Cell*




1) *Substrate Layer:* It mainly comprises of flexible plastic to support the structure and at the same time able to flex.
2) *Transparent Conductive Layer:* It is mainly made of Indium Tin Oxide or conductive polymers. This layer allows light transmission while conducting electricity.
3) *Active Layer:* It consists of organic photovoltaic materials such as polymers or small molecules. In this layer, the effects of light absorption and charge generation occur. This layer contains a donor acceptor system.
4) *Charge Transport Layer:* It is formed of the materials which assists in transporting holes i.e. positive charge and electrons i.e. negative charge generated in active layer to the electrodes. This layer is made up of conducting polymers.
5) *Metal Electrode:* Typically, a metal of aluminium or Silver is Used in a Plastic Solar Cell. This Electrodes collect and conduct the generated electrical current.
6) *Encapsulation Layer:* This layer prevents the Solar Cell from Moisture and environmental degradation. This layer is made up of Transparent Polymers.

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In Plastic Solar Cell the Sunlight Strikes on the Active Layer, Excites Electrons. Separated into holes and electrons by interface between donor and acceptor materials are excited electrons. Holes move towards anode, and electrons move toward cathode through transport layers. Collecting charges causes the generation of an electrical current.

## IV. CONCLUSION

This paper of plastic solar cell technology has unveiled great potential for organic photovoltaics as a flexible, light, and cheap substitute for the silicon-based solar cell. Most profound efforts have been invested in the systematic study of materials, device architectures, and fabrication techniques to close the major gaps in efficiency and stability.

There are various organic materials being investigated with different non-fullerene acceptors and advanced conjugated polymers, which have portrayed some significant improvements in power conversion efficiencies. Another innovative structure showing promise for maximal absorption of light and separation of charge is the bulk heterojunction and tandem structures.

Other scalable techniques are under consideration to ready plastic solar cells for commercial readiness and widespread usage. Roll-to-roll manufacturing methodology is one of the adoption techniques. Environmental Impact Assessments Our environmental impact assessments have emphasized sustainability by promoting materials and production processes that are on par with global energy goals and use of eco-friendly materials.

This project's findings add value to the plastics solar cells toward promoting its potential role in a renewable energy landscape. More research and development are needed in order to overcome further challenges and pave the way toward more sustainable energy solutions. The future of plastic solar cell technology will be promising for enhancement in accessibility to energy and toward a greener, sustainable planet. Hence, we conclude that plastic solar cell is more practical in application.

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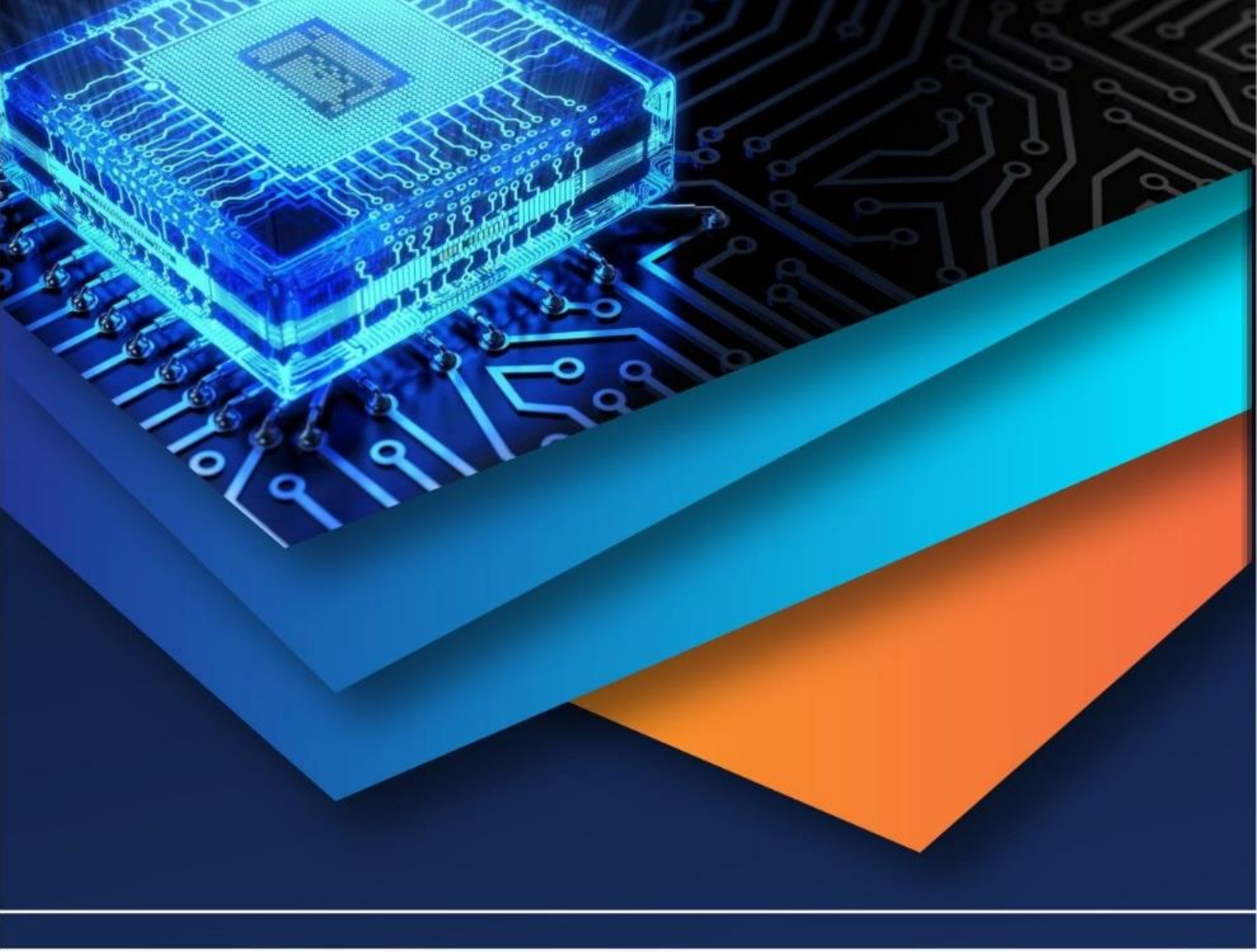
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