

**FORM - 2**  
**THE PATENTS ACT, 1970**  
**(39 OF 1970)**  
**THE PATENTS RULES, 2003**  
**COMPLETE SPECIFICATION**  
**(Section 10; rule 13)**

**Solar Tracking System for Energy Enhancement of PV Solar Panel using  
Advanced Coating Technology**

<b>Name</b>	<b>College Address</b>
<b>Ms. Anitha Mary M</b>	Asst. Professor (SS), Dept. of ECE, Rajalakshmi Engineering college, Thandalam, Chennai – 602105, Tamilnadu, India.
<b>Shreevidya M</b>	UG Scholar, Dept. of ECE, Rajalakshmi Engineering college, Thandalam, Chennai – 602105, Tamilnadu, India.
<b>Tharun K</b>	UG Scholar, Dept. of ECE, Rajalakshmi Engineering college, Thandalam, Chennai – 602105, Tamilnadu, India.
<b>Srivatssen D</b>	UG Scholar, Dept. of ECE, Rajalakshmi Engineering college, Thandalam, Chennai – 602105, Tamilnadu, India.

**The following specification particularly describes the invention and the manner in which it is to be performed:**

## **Solar Tracking System for Energy Enhancement of PV Solar Panel using Advanced Coating Technology**

### **Field and Background of the Invention**

To enhance the efficiency of solar panels, various strategies have been developed to address the challenges posed by dust and atmospheric moisture accumulation. These strategies include a combination of passive and active approaches, all aimed at maintaining the cleanliness of solar panels and optimizing their energy output. Passive methods typically involve optimizing the tilt angles of panels to take advantage of natural cleaning forces such as rain and wind. By adjusting the orientation of the panels, dust and debris can be more easily dislodged and washed or blown away, offering a low-maintenance solution. However, in environments where contamination is more severe or persistent, passive techniques alone may not suffice.

Active cleaning methods provide a more direct approach by using mechanical systems or manual labor to remove accumulated debris. Robotic cleaning systems, for instance, use automated arms or drones equipped with brushes or sprayers to clean the panel surfaces. These systems can be programmed to operate autonomously or controlled remotely, offering convenience and consistency. In contrast, manual cleaning, while effective, involves the use of tools such as soft brushes or squeegees and can be labor-intensive and impractical for larger installations.

In addition to these methods, anti-soiling coatings and surface treatments have emerged as effective solutions for minimizing the adherence of contaminants. These coatings are applied to the surface of solar panels to repel dust, dirt, and moisture, thereby maintaining the panels' efficiency over time. Many of these coatings also possess hydrophobic properties, which help prevent moisture accumulation and reduce the risk of corrosion or surface degradation.

Despite the benefits of existing methods, they often require regular maintenance and may not fully address the complex environmental variables that contribute to panel soiling. As a result, there is a growing need for innovative and holistic solutions that offer long-term sustainability and adaptability across diverse conditions. Ongoing research and development efforts are vital to meeting this need, focusing on advanced technologies that improve performance while reducing operational demands.

Emerging innovations such as self-cleaning surfaces and automated cleaning systems are particularly promising. "Self-cleaning surfaces are typically treated with hydrophobic or oil-repellent materials that repel dust and debris", allowing natural elements like wind and rain to keep the panels clean with minimal intervention. Automated cleaning systems, on the other hand, use mechanical or robotic devices programmed to maintain cleanliness on a regular basis, thereby enhancing efficiency and extending the lifespan of the panels. Advancements in materials science play a crucial role in these developments. The creation of durable, transparent coatings that resist dust and moisture can significantly reduce the need for frequent cleaning and help maintain optimal performance. Furthermore, the integration of smart monitoring and predictive maintenance systems allows for real-time detection of cleanliness issues. Through the use of data analytics and machine learning, these systems can recognize patterns and predict when maintenance is required, enabling proactive interventions and the optimization of cleaning schedules. Driving these advancements requires collaboration between researchers, industry leaders, and policymakers. By fostering a supportive environment for research, innovation, and implementation, stakeholders can accelerate the adoption of new technologies and contribute to a more sustainable energy future. The pursuit of improved solar panel efficiency in the face of dust and moisture challenges remains an ongoing effort, but through interdisciplinary collaboration and cutting-edge innovation, the development of robust and adaptable solutions is within reach. This collective endeavor is key to building a cleaner, brighter, and more resilient energy landscape.

## **Summary of the Invention**

The integration of advanced coatings represents a significant step forward in improving the efficiency and longevity of solar panels. These coatings provide a proactive solution to persistent challenges such as dust and moisture accumulation, which can severely impact the performance of solar panels over time. By creating a protective layer on the surface, advanced coatings effectively repel dust particles and moisture, reducing their negative effects on energy generation and helping panels maintain optimal functionality. A major advantage of these coatings is their role in enhancing energy production by ensuring maximum light absorption. When dust settles on the surface of solar panels, it obstructs sunlight and diminishes energy conversion efficiency. The application of specialized coatings keeps the surface cleaner and clearer, enabling continuous sunlight exposure and consistent energy output. In addition to boosting efficiency, these coatings also play a vital role in prolonging the operational life of solar panels. They shield the panels from environmental damage and prevent corrosion caused by prolonged moisture exposure.

As the push for sustainable energy solutions intensifies, innovations like advanced coatings become increasingly important. These technologies not only improve the performance and resilience of solar panels but also support broader environmental goals by reducing dependence on fossil fuels and lowering the overall ecological impact. Embracing advanced coating solutions helps unlock the full potential of solar energy and accelerates the transition toward a cleaner and more sustainable global energy landscape.

The future of solar energy depends heavily on our ability to apply technological advancements to overcome environmental challenges. Continued research and innovation in coating technology hold great promise for further increasing solar panel efficiency and minimizing environmental effects. As these technologies evolve and improve, they bring us closer to a future powered entirely by clean, renewable energy sources.

## **Brief Description of the System**

Transformative approach to enhancing solar panel efficiency by integrating advanced cleaning mechanisms and protective coatings into an existing solar tracking system. Traditional fixed-panel configurations in solar tracking systems often suffer from suboptimal alignment with the sun, leading to reduced energy output. Compounding this issue are mechanical limitations and the inability to adapt to constantly changing solar angles, both of which hinder overall system performance. To overcome these challenges, the proposed system utilizes insights from modern sun tracking technologies to precisely orient solar panels in alignment with the sun's position throughout the day, ensuring maximum sunlight exposure.

A key component of this system is the inclusion of automated cleaning mechanisms designed to address the efficiency loss caused by dust accumulation on panel surfaces. Dust particles can significantly obstruct sunlight and reduce the panels' ability to convert solar energy into electricity. To counteract this, the system employs automated cleaning tools such as brushes or air jets, strategically installed to cover the entire surface area of the panels. These devices operate at regular intervals to remove dust and debris, ensuring the panels remain clean and function at peak efficiency with minimal manual intervention.

In tandem with these mechanical solutions, the system incorporates protective coatings to safeguard the panels against the detrimental effects of atmospheric moisture. Moisture buildup not only causes material degradation but also contributes to corrosion, both of which compromise the panels' performance over time. Hydrophobic coatings are applied to the surface of the solar panels to repel water and prevent moisture accumulation. These coatings help maintain the optical clarity of the panels and extend their operational lifespan by minimizing exposure to damaging environmental elements.

The implementation process begins with the careful installation of solar panels, strategically placed to optimize sunlight capture. These panels form the foundational element of the system, responsible for energy absorption and conversion. Following panel placement, the sun tracking mechanism is integrated. Utilizing either single or dual-axis tracking, this component dynamically adjusts the orientation of the panels in response to the sun's movement, significantly improving energy harvesting capabilities.

To ensure robust and efficient system performance, detailed soldering and wiring procedures are carried out. These connections establish effective communication between all components and ensure long-term durability. Soldering is employed to securely link electrical components, reducing signal loss and ensuring consistent performance. At the core of the system lies an Arduino microcontroller, which governs panel movement using data received from light-dependent resistors (LDRs). Once the wiring and components are connected, the Arduino code is uploaded, initiating system operation. The system is then tested and validated to confirm proper functionality before being deployed in the field.

The Arduino-based tracking system utilizes sophisticated algorithms to continually realign the panels, ensuring they remain optimally positioned in relation to the sun throughout the day. This real-time adaptability greatly increases the efficiency of solar energy harvesting and enhances the overall performance of the solar installation. By incorporating automated cleaning tools and hydrophobic protective coatings, the system offers a cost-effective, low-maintenance, and sustainable solution that addresses key environmental challenges affecting solar panel output.

This integrated approach to solar panel optimization provides a comprehensive method for improving energy capture while extending the longevity of solar installations. By tackling the issues of dust and moisture accumulation and employing state-of-the-art tracking and control technologies, the solution presents a viable pathway toward more efficient and sustainable solar energy systems. Its innovative design and implementation promise to support broader adoption of solar power, contributing meaningfully to a cleaner and more energy-resilient future.

**Objectives:**

1. Hydrophobic coatings are applied to the panel surfaces to repel water and prevent moisture buildup, protecting the panels from corrosion and preserving their optical properties for efficient sunlight absorption.
2. Automated cleaning brushes or air jets are strategically placed to cover the entire panel surface, operating periodically to remove dust and debris, ensuring consistent cleanliness and optimal performance.
3. Solar panels are installed in positions carefully chosen to maximize exposure to sunlight, forming the essential base for effective energy capture and conversion.
4. Sun tracking mechanisms, powered by either single or dual-axis systems, are integrated to adjust the orientation of the panels dynamically throughout the day, maintaining optimal alignment with the sun's movement.
5. Soldering and wiring are meticulously carried out to establish strong and reliable connections between system components, enhancing overall durability and minimizing the risk of signal interference.

## **Newness**

Hydrophobic coatings significantly enhance the durability of solar panels by resisting moisture accumulation, which helps prevent corrosion and material degradation. This protective layer not only safeguards the structural integrity of the panels but also extends their lifespan, ensuring long-term efficiency and reliability in energy production. Additionally, the application of advanced coating technology contributes to improved energy conversion efficiency by maintaining panel cleanliness. By repelling dust and moisture, these coatings enable maximum sunlight absorption, leading to increased energy yields and consistent performance over time.

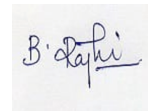
The integration of such coating technologies presents a cost-effective and sustainable solution for optimizing solar panel performance. By minimizing the need for frequent maintenance and cleaning interventions, operational costs are reduced, while the overall energy output is enhanced. This combination of efficiency and reduced upkeep supports broader sustainability objectives, making it an ideal approach for long-term solar energy applications.



## **We Claim**

1. There is a strong emphasis on refining coating technologies in solar panel development to optimize energy production and ensure long-term system viability.
2. Current efforts focus on strengthening coatings to withstand environmental elements while maximizing energy generation efficiency.
3. Researchers are exploring intelligent and self-cleaning coatings that mitigate the effects of dust, dirt, and moisture on solar panel surfaces.
4. Advanced coatings incorporate hydrophobic properties and nanotechnology-based solutions to enable self-cleaning, maintaining efficiency even in harsh conditions.
5. There is an increasing focus on eco-friendly coatings made from renewable resources and produced using sustainable manufacturing processes.
6. Sustainable coating solutions support broader environmental goals by reducing the carbon footprint of solar panel production.
7. Dust accumulation on panels obstructs light transmission, reducing energy output, while moisture can lead to corrosion and degradation.
8. Specialized coatings are being developed to repel both dust and moisture, creating a protective barrier that minimizes manual cleaning needs.

Dated this 23<sup>rd</sup> Day of April, 2025.



B. Rajakumari  
Agent for the Applicant  
IN/PA-3327

## **Abstract**

This innovative solution aims to repel foreign particles effectively, thereby ensuring the maintenance of optimal performance levels over time. Through rigorous experimentation and analysis, our research delves into extensive investigations to explore the profound impact of hydrophobic coatings on mitigating the detrimental effects of dust and moisture accumulation, ultimately leading to significant improvements in solar panel efficiency. By effectively addressing the challenges of dust and moisture accumulation through innovative coating technology, our project makes a significant contribution to advancing sustainable energy solutions. The application of hydrophobic coatings offers a cost-effective and scalable means to enhance the efficiency of solar panels, thereby facilitating broader adoption of renewable energy technologies and reducing reliance on fossil fuels. This research aligns with broader efforts to combat climate change and promote environmental sustainability through the deployment of innovative technological solutions that empower the transition towards a cleaner, greener future.