# FORM 2

**THE PATENTS ACT, 1970 (39 OF 1970)**

# AND

**THE PATENT RULES, 2003 COMPLETE SPECIFICATION**

# (See section 10 and rule 13) Title of Invention:

**“ANALYZING THE PERFORMANCE OF ULTRATHIN, LIGHTWEIGHT AND FLEXIBLE PEROVSKITE SOLAR CELLS WITH AN EXCELLENT POWER PER WEIGHT PERFORMANCE”**

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The following specification describes the invention and the manner in which it is to be performed.

# FIELD OF INVENTION

The present invention relates to the field of designing & implementing a framework of analyzing the performance of ultrathin, lightweight and flexible perovskite solar cells. The proposed invention aims at evaluating power per weight performance.

# BACKGROUND OF INVENTION

**[0001]** Background description includes information that may be useful in understanding the present invention. It is not an admission that any of the information provided herein is prior art or relevant to the presently claimed invention, or that any publication specifically or implicitly referenced is prior art.

**[0002]** Perovskite solar cells have shown remarkable progress in recent years with rapid increases in efficiency, from reports of about 3% in 2009 to over 25% today. While perovskite solar cells have become highly efficient in a very short time, a number of challenges remain before they can become a competitive commercial technology.

**[0003]** A number of different types of perovskites based solar cell analysis systems that are known in the prior art. For example, the following patents are provided for their supportive teachings and are all incorporated by reference.

**[0004]** Ultrathin, lightweight and flexible perovskite solar cells with an excellent power-per-weight performance:- Lightweight and flexible photovoltaic devices have attracted great interest for specific potential applications, such as miniaturized drones, blimps, and aerospace electronics.

This study aims to demonstrate ultralight and flexible perovskite solar cells (PSCs) with orthogonal silver nanowire (AgNW) transparent electrodes fabricated on 1.3 μm-thick polyethylene naphtholate foils. The smooth surface morphologies of the orthogonal AgNW transparent electrodes help prevent nonconducting silver halide formation generated by chemical reaction between the AgNWs and iodine in the active layer. The resultant PSCs with orthogonal AgNW transparent electrodes exhibit substantially improved device performance, achieving a power conversion efficiency (PCE) of 15.18%, over PSCs with random AgNW network electrodes (10.43% PCE). Moreover, ultralight and flexible PSCs with the orthogonal AgNW electrodes exhibit an excellent power-per-weight of 29.4 W g−1, which is the highest value reported for a lightweight solar cell device. These lightweight energy harvesting platforms can be further expanded for various wearable optoelectronic devices.

**[0005]** High-Performance Flexible Perovskite Solar Cells via Precise Control of Electron Transport Layer:- Flexible perovskite solar cells (f-PSCs) have attracted great attention due to their promising commercial prospects. However, the performance of f-PSCs is generally worse than that of rigid counterparts. Herein, it was found that the unsatisfactory performance of planar heterojunction (PHJ) f-PSCs could be attributed to the undesirable morphology of electron transport layer (ETL), which results from the rough surface of flexible substrate. The precise control of the thickness and morphology of ETL tin dioxide (SnO2) not only reduces the reflectance of the indium tin oxide

(ITO) on polyethylene 2,6-naphthalate (PEN) substrate and enhances photon collection, but also decreases the trap-state densities of perovskite films and the charge transfer resistance, leading to the great enhancement of device performance. Consequently, the f-PSCs, with a structure of PEN/ITO/SnO2/Perovskite/Spiro-OMeTAD/Ag, exhibited a power conversion efficiency (PCE) up to 19.51% and a steady output of 19.01%. Furthermore, the f-PSCs showed a robust bending resistance and maintain ~95% of initial PCE after 6000 bending cycles at a bending radius of 8 mm, and they presented an outstanding long-term stability and retained ~90% of the initial performance after >1000 hours storage in air (10% relative humidity) without encapsulation.

**[0006]** Despite significant progress in understanding the stability and degradation of perovskite solar cells, they are not currently commercially viable because of their limited operational lifetimes. The proposed invention focuses on studying the perovskite solar cells for their performance to improve based on size, dimension and flexibility.

**[0007]** Above information is presented as background information only to assist with an understanding of the present disclosure. No determination has been made, no assertion is made, and as to whether any of the above might be applicable as prior art with regard to the present invention.

**[0008]** In the view of the foregoing disadvantages inherent in the known types of perovskite solar cell analysis systems now present in the prior art, the present invention provides an improved system. As such, the general purpose

of the present invention, which will be described subsequently in greater detail, is to provide a new and improved system to predict the efficacy of lightweight and ultrathin perovskite that has all the advantages of the prior art and none of the disadvantages.

# SUMMARY OF INVENTION

**[0009]** In the view of the foregoing disadvantages inherent in the known types of perovskite performance analysis systems now present in the prior art, the present invention provides an improved one. As such, the general purpose of the present invention, which will be described subsequently in greater detail, is to provide a new and improved system to predict the performance of perovskite solar cells that are lightweight and ultra-thin which has all the advantages of the prior art and none of the disadvantages.

**[0010]** The main objective of the proposed invention is to design & implement a framework for analysis of perovskite solar cells. The proposed invention evaluates the performance per weight based on thickness, size and weight of perovskite cells.

**[0011]** Yet another important aspect of the proposed invention is to design & implement a framework for analyzing the ultrathin, lightweight and flexible perovskite solar cells. The proposed invention focuses on utilizing the algorithms of machine learning for the purpose. The results of performance are displayed on display unit.

**[0012]** In this respect, before explaining at least one embodiment of the

invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and to the arrangements of the components set forth in the following description or illustrated in the various ways. Also, it is to be understood that the phraseology and terminology employed herein are for the purpose of description and should not be regarded as limiting.

**[0013]** These together with other objects of the invention, along with the various features of novelty which characterize the invention, are pointed out with particularity in the disclosure. For a better understanding of the invention, its operating advantages and the specific objects attained by its uses, reference should be had to the accompanying drawings and descriptive matter in which there are illustrated preferred embodiments of the invention.

# BRIEF DESCRIPTION OF DRAWINGS

**[0014]** The invention will be better understood and objects other than those set forth above will become apparent when consideration is given to the following detailed description thereof. Such description makes reference to the annexed drawings wherein:

Figure 1 illustrates the schematic view of analyzing the performance of ultrathin, lightweight and flexible perovskite solar cells with an excellent power per weight performance, according to the embodiment herein.

# DETAILED DESCRIPTION OF INVENTION

**[0015]** In the following detailed description, reference is made to the

accompanying drawings which form a part hereof, and in which is shown by way of illustration specific embodiments in which the invention may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the invention, and it is to be understood that the embodiments may be combined, or that other embodiments may be utilized and that structural and logical changes may be made without departing from the spirit and scope of the present invention. The following detailed description is, therefore, not to be taken in a limiting sense, and the scope of the present invention is defined by the appended claims and their equivalents.

**[0016]** While the present invention is described herein by way of example using several embodiments and illustrative drawings, those skilled in the art will recognize that the invention is neither intended to be limited to the embodiments of drawing or drawings described, nor intended to represent the scale of the various components. Further, some components that may form a part of the invention may not be illustrated in certain figures, for ease of illustration, and such omissions do not limit the embodiments outlined in any way. It should be understood that the drawings and detailed description thereto are not intended to limit the invention to the particular form disclosed, but on the contrary, the invention covers all modification/s, equivalents and alternatives falling within the spirit and scope of the present invention as defined by the appended claims. The headings are used for organizational purposes only and are not meant to limit the scope of the description or the

claims. As used throughout this description, the word "may" be used in a permissive sense (i.e., meaning having the potential to), rather than the mandatory sense (i.e., meaning must). Further, the words "a" or "a" mean "at least one” and the word “plurality” means one or more, unless otherwise mentioned. Furthermore, the terminology and phraseology used herein is solely used for descriptive purposes and should not be construed as limiting in scope. Language such as "including," "comprising," "having," "containing," or "involving," and variations thereof, is intended to be broad and encompass the subject matter listed thereafter, equivalents, and any additional subject matter not recited, and is not intended to exclude any other additives, components, integers or steps. Likewise, the term "comprising" is considered synonymous with the terms "including" or "containing" for applicable legal purposes. Any discussion of documents, acts, materials, devices, articles and the like are included in the specification solely for the purpose of providing a context for the present invention.

**[0017]** In this disclosure, whenever an element or a group of elements is preceded with the transitional phrase "comprising", it is understood that we also contemplate the same element or group of elements with transitional phrases "consisting essentially of, "consisting", "selected from the group consisting of”, "including", or "is" preceding the recitation of the element or group of elements and vice versa.

**[0018]** Perovskite-phase metal oxides exhibit a variety of interesting physical

properties which include ferroelectric, dielectric, pyroelectric, and piezoelectric behaviour. Specifically, linear dielectric materials exhibit linear polarization behaviour as a function of applied field.

**[0019]** Researchers achieved world record 32.5% efficiency for a perovskite tandem solar cell. A group of researchers from Helmholtz-Zentrum Berlin (HZB) has achieved a new world efficiency record for a silicon-perovskite tandem solar cell, with a certified efficiency of 32.5%. The proposed invention focuses on analyzing the performance of perovskite solar cells that are ultrathin, light-weight and flexible.

**[0020]** Reference will now be made in detail to the exemplary embodiment of the present disclosure. Before describing the detailed embodiments that are in accordance with the present disclosure, it should be observed that the embodiment resides primarily in combinations arrangement of the system according to an embodiment herein and as exemplified in FIG. 1

**[0021]** Figure 1 illustrates the schematic view of analyzing the performance of ultrathin, lightweight and flexible perovskite solar cells with an excellent power per weight performance 100. The proposed system 100 includes a solar panel 101 which is embedded with perovskite cells of varying size, weight and thickness. The machine learning unit 102 will implement clustering algorithm 103 and predictive unit 104 accordingly. The result of predictive unit 104 will be displayed on display unit 105.

**[0022]** In the following description, for the purpose of explanation, numerous

specific details are set forth in order to provide a thorough understanding of the arrangement of the system according to an embodiment herein. It will be apparent, however, to one skilled in the art that the present embodiment can be practiced without these specific details. In other instances, structures are shown in block diagram form only in order to avoid obscuring the present invention.

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On behalf of Applicant Digitally Signed

Date: 30/01/2023

# WE CLAIM

1. Analyzing the performance of ultrathin, lightweight and flexible perovskite solar cells with an excellent power per weight performance comprises of Machine learning unit;

Display unit and Predictive unit.

1. Analyzing the performance of ultrathin, lightweight and flexible perovskite solar cells with an excellent power per weight performance, according to claim 1, includes a machine learning unit, wherein the machine learning unit will analyse the various properties of perovskite solar cells.
2. Analyzing the performance of ultrathin, lightweight and flexible perovskite solar cells with an excellent power per weight performance, according to claim 1, includes a display unit, wherein the display unit will display the results of predictive unit.
3. Analyzing the performance of ultrathin, lightweight and flexible perovskite solar cells with an excellent power per weight performance, according to claim 1, includes a predictive unit, wherein the predictive unit will evaluate the performance of perovskite solar cells.

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# ABSTRACT

**ANALYZING THE PERFORMANCE OF ULTRATHIN, LIGHTWEIGHT AND FLEXIBLE PEROVSKITE SOLAR CELLS WITH AN EXCELLENT POWER PER WEIGHT PERFORMANCE**

Analyzing the Performance of Ultrathin, Lightweight and Flexible Perovskite Solar Cells with an Excellent Power per Weight Performance is the proposed invention. The proposed invention focuses on analyzing the performance of perovskite cells for achieving excellent power per weight performance. The invention aims at analyzing ultrathin, lightweight and flexible perovskite solar cells.

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