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Spray on Solar Window New Technology ready to revolutionise Solar Industry

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Abstract**—**This paper is meant to drag an attention towards a revolutionise idea of spray on photovoltaic cells which easily replaces earlier solar thin films due to restricted use of the latter. Now with the introduction of spray on photovoltaic cells by New Energy Technologies, US many spheres of thin films are simplified such as manufacturing, cost effectiveness, applicability etc. and has thus broadened it significantly. It uses plastic polymer spray applied to a thin film as compared to thin films made of silicon with a better capacity to absorb photons from sunrays. Also the silicon which is used in solar cells is heavier and rigid and therefore limits its use to only steel sheets. with the increasing demand of energy worldwide and roaring foreign oil prices and the with the silicon based solar cells, spray on solar cells are the need of an hour.it not only provides flexibility but also eases the cost burden and manufacturing time.

Keywords:**—**Solar Window, copper-indium -gallium-selenide(CIGS), solar cells, New Energy Technologies US, organic plastic polymer, Solar inverter

1. INTRODUCTION

Photovoltaic devices converting solar energy into electricity are called SOLAR CELLS. The solar cells operate on four simple steps. Those are

- Absorbing sunlight to create electron-hole pairs (carriers)
- Carriers diffusing to different paths
- Electrons and holes separation
- Collection of carriers at solar collector

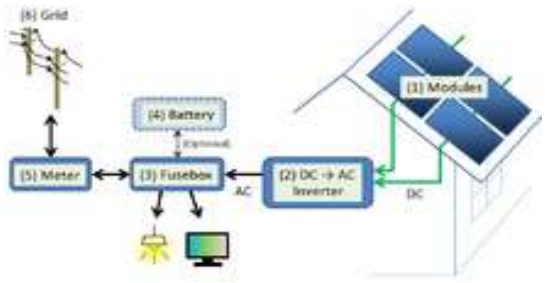
The spray on solar cell technique is now very popularly being practiced by various solar firms, as the process is unique and simple. This technology can make the windows, roofs, facades, etc. of your edifice energy-producing units. The spray on technology is not limited to buildings only but can also be sprayed onto your clothes to power your small wireless gadgets like cell phones, iPods, etc. Alternatively, a thin coating of the same could be applied on your EV that can recharge the car's battery.

1.1 The advantages:

The spray-on solar cells are much more efficient than the conventional solar panels and can generate sufficient electricity. There will be no hassle in installing this solar technology as the solar ink can be effectively sprayed on any of the exposed surfaces with an ease, producing portable electricity. The most extraordinary advantage of the spray on solar films is that they can harness even the infrared rays from the sun and therefore the clouds cannot now hinder in the production of green electricity.

1.2 The impact:

Earlier, the solar technologies faced the high price, less efficient and maintenance disadvantage and therefore few people installed solar panels on the rooftops. Now, with the introduction of spray on solar cells, which are cost effective and more economical, the solar technology is being widely accepted. The most favourable quality of the spray on solar technology is the ability of generating power even on a cloudy day. The popularity of this groundbreaking technology will be on air unless a better technology that eliminates the drawbacks of spray-on cells is discovered.



After this a solar inverter which converts the variable direct current (DC) output of a photovoltaic (PV) solar pane into a utility frequency alternating current (AC) that can be fed into a commercial electrical grid or used by a local, off-grid electrical network. It is a critical component in a photovoltaic system, allowing the use of ordinary commercial appliances. Solar inverters have special functions adapted for use with photovoltaic arrays, including maximum power point tracking and anti-islanding protection.

1.3 Classification of Solar inverters :

Stand-alone inverter, used in isolated systems where the inverter draws its DC energy from batteries charged by photovoltaic arrays. Many stand-alone inverters also incorporate integral battery charger to replenish the battery from an A source, when available. Normally these do not interface in any way with the utility grid, and as such, are not required to have anti-islanding protection.

Grid-tie inverter, which match phase with a utility-supplied sine wave. Grid-tie inverters are designed to shut down automatically upon loss of utility supply, for safety reasons. They do not provide backup power during utility outages.

Battery backup inverters are special inverters which are designed to draw energy from a battery, manage the battery charge via an onboard charger, and export excess energy to the utility grid. These inverters are capable of supplying AC energy to selected loads during a utility outage, and are required to have anti-islanding protection.

1.4 Maximum Power Point Tracking

Solar inverters use *maximum power point tracking* (MPPT) to get the maximum possible power from the PV array. Solar cells have a complex relationship between solar irradiation, temperature and total resistance that produces a non-linear output efficiency known as the *I-V curve*. It is the purpose of the MPPT system to sample the output of the cells and determine a resistance (load) to obtain maximum power for any given environmental conditions.

The fill facto, more commonly known by its abbreviation *FF*, is a parameter which, in conjunction with the open circuit voltage and short circuit current of the panel, determines the maximum power from a solar cell. Fill facto is defined as the ratio of the maximum power from the solar cell to the product of Voc and Isc.

There are three main types of MPPT algorithm: perturb-and-observe, incremental conductance and constant voltage. The first two methods are often referred to as *hill climbing* methods; they rely on the curve of power plotted against voltage rising to the left of the maximum power point, and falling on the right.

1.5 Anti-islanding Protection

In the event of a power failure on the grid, it is generally required that any grid-tie inverter attached to the grid turn off in a short period of time. This prevents the inverters from continuing to feed power into small sections of the grid, known as "islands". Powered islands present a risk to workers who may expect the area to be unpowered, but equally important is the issue that without a grid signal to synchronize to, the power output of the inverters may drift from the tolerances required by customer equipment connected within the island.

Detecting the presence or lack of a grid source would appear to be simple, and in the case of a single inverter in any given possible physical island (between disconnects on the distribution lines for instance) the chance that an inverter would fail to notice the loss of the grid is effectively zero. However, if there are two inverters in a given island, things become considerably more complex. It is possible that the signal from one can be interpreted as a grid feed from the other, and vice versa, so both units continue operation. As they track each other's output, the two can drift away from the limits imposed by the grid connections, say in voltage or frequency.

There are a wide variety of methodologies used to detect an islanding condition. None of these are considered fool-proof, and utility companies continue to impose limits on the number and total power of solar power systems connected in any given area. However, many in-field tests have failed to uncover any real-world islanding issues, and the issue remains contentious within the industry.

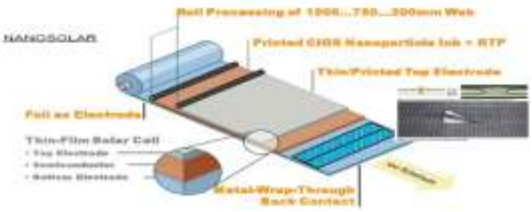
Since 1999, the standard for anti-islanding protection in the United State has been UL 1741, harmonized with IEEE 154. Any inverter which is listed to the UL 1741 standard may be connected to a utility grid without the need for additional anti-islanding equipment, anywhere in the United States or other countries where U standards are accepted.

Similar acceptance of the IEEE 154 in Europe is also taking place, as most electrical utilities will be providing or requiring units with this capability.

Since 15 years and more solar windows used thin solar films made from amorphous silicon, copper-indium-gallium-selenide (CIGS), and cadmium telluride for producing electricity by converting light energy into electrical energy by capturing sun rays. However for manufacturing these types of films require high-vacuum and high-temperature production techniques, and are many times thicker than New Energy’s ultra-small solar cells. Now let us see how the solar window works by the following picture.

2. PROBLEMS WITH CURRENTLY USED SOLAR THIN FILMS

- It can only be used under natural light.
- It requires high-temperature or high-vacuum production methods which is costlier as compared to organic thin films
- It is thicker and less transparent as compared to organic thin films
- It is less efficient and cumbersome as compared to organic thin films
- The Nano solar thin film has many coatings making it reasonably thicker, brittle and thus limiting its applications as seen in the picture below.



3. TO OVERCOME THE ABOVE MENTIONED LIMITATIONS THE NEW ORGANIC THIN FILM SOLAR CELLS HAVE FOLLOWING ADVANTAGES TO OFFER

- Make use of the world's smallest functional organic solar cells, which measure less than ¼ the size of a grain of rice, and have been shown to successfully produce electricity in a published peer-reviewed study in the Journal;
- Do not require expensive high-temperature or high-vacuum production methods, but rather, can be sprayed on to glass at room temperature;
- Generate electricity from both natural and artificial light sources, outperforming today's commercial solar and thin-film technologies by as much as 10-fol; and
- Measure less than 1/10th the thickness of 'thin' films (only 1/1000th the thickness of human hair).

4. MATERIALS AND METHODS USE TO PREPARE THIN FILM AND SPRAY SOLAR CELLS

4.1 Thin Films

Ceramic thin films are in wide use. The relatively high hardness and inertness of ceramic materials make this type of thin coating of interest for protection of substrate materials against corrosion, oxidation and wear. In particular, the use of such coatings on cutting tools can extend the life of these items by several orders of magnitude.

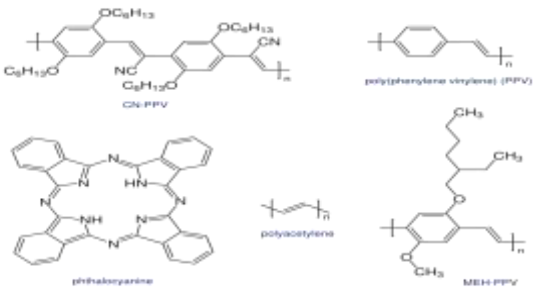
4.2 Spray Solar Cells

An organic solar cell or plastic solar cell is a type of polymer solar cells that uses organic electronic, a branch of electronics that deals with conductive organic polymers or small organic molecules, for light absorption and charge transport to produce electricity from sunlight by the photovoltaic effect.

Organic Photovoltaic Cells

A photovoltaic cell is a specialized semiconductor diode that converts visible light into direct current (DC) electricity. Some photovoltaic cells can also convert infrared (IR) or ultraviolet (UV) radiation into DC. A common characteristic of both the small molecules and polymer (Fig 1) used in photovoltaic is that they all have large conjugated system. A conjugated system is formed where carbon atoms covalently bond with alternating single and double bonds; in other words these are chemical reactions of hydrocarbons. These hydrocarbons' electrons pz orbital delocalize and form a delocalized bonding π orbital with a π* antibonding orbital. The delocalized π orbital is the highest occupied molecular orbital (HOM), and the π* orbital is the lowest unoccupied molecular orbital (LUM). The separation between HOMO and LUMO is considered the band gap of organic electronic materials. The band gap is typically in the range of 1–4 e.

When these materials absorb a photo, an excited stat is created and confined to a molecule or a region of a polymer chain. The excited state can be regarded as an electron-hole pair bound together by electrostatic interactions, i.e. exaction. In photovoltaic cells, exactions are broken up into free electron-hole pairs by effective fields. The effective fields are set up by creating a heterojunction between two dissimilar materials. Effective fields break up exactions by causing the electron to fall from the conduction band of the absorber to the conduction band of the acceptor molecule. It is necessary that the acceptor material has a conduction band edge that is lower than that of the absorber material



Solar cells cheaply using mass manufacturing methods like roll-to-roll printing (as with newspaper presses) or spray-coating (similar to automotive painting)

5. FIRST-OF-ITS-KIND ORGANIC SOLAR ARRAY

New Energy's Solar Window™ technology utilizes an organic solar array composed of a series of ultra-small solar cells measuring less than ¼ the size of a grain of rice each. They are fabricated using environmentally-friendly hydrogen-carbon based materials, and successfully produce electricity, as demonstrated in a published peer-reviewed study in the Journal of Renewable and Sustainable Energy of the American Institute of Physic.

New Energy's organic solar array has:

Better absorbing capacity to 'absorb photons' to generate electricity, and transparency through the innovative use of conducting polymers as compared to silicon;

Development of an ultra-thin film, only 1/1000th the thickness of a human hair, or 1/10th of a micrometre; and

6. ECONOMIC VIABILITY OF NEW ENERGY'S ORGANIC SOLAR ARRAY

Solar Window™ Electricity	
Technology	**Annual Value of Electricity Produced**
Copper Indium Gallium DiSe-lenide (CIGS) Solar Thin Film	$ 19,260.10
Cadmium Telluride Solar Cell	$ 16,897.36
Triple Junction Amorphous	$ 11,334.44
Solar Window™ (Basis: R&D Measured 08/06/10)	$ 29,354.26
Solar Window™ (Basis: Advancement of Lab Prototype)	$ 48,923.84
Solar Window™ (Increased Power, Improved Cell Configuration)	$ 81,539.74
Solar Window™ (Basis: Max. High-Power Theoretical)	$ 153,729.59

7. RECENT BREAKTHROUGHS

January 21, 201 – New Energy's has achieved compatibility of the Solar Window™ architecture with a variety of active layer electricity-generating coatings.

December 16, 201 – New Energy's Solar Window™ technology received the Energy Business Review's Energy Innovation Award 2013.

October 30, 201 – New Energy announced that the Company plans to unveil the next generation, high performance in first quarter, 2014.

September ***9, 201*** – New Energy announced that the Company has expanded the use of its Solar Window™ coatings to include two new product lines.

July 17, 201 – New Energy announced that we have successfully achieved a total of 21 new patent filings for protection of its proprietary Solar Window™ technology, more than doubling the portfolio in only 12 months.

July 15, 201 – New Energy released a new introduction sketch video to Solar Window™ technology.

June 4, 201 – New Energy announced advancements in our design, architecture, and transparency goals for our electricity-generating coatings.

May 09, 201 – New Energy announced a breakthrough in our spray-on fabrication techniques with USF.

April 30, 201 -New Energy's VP of Business and Technology Development was accepted to present an overview of Solar Window™ at the Advanced Energy 2013 Conference in New York, NY.

April 3, 201 -New Energy's Principal Scientist, Dr. Scott Hammond, presented on OPV research at the 2013 MRS Spring Meeting.

March 6, 201 -New Energy announced that we entered in a Phase 2 CRADA with the U.S. Department of Energy's National Renewable Energy Laboratory to advance Solar Window™ technology.

June 18, 201 -New Energy announced an improvement in its manufacturing technique that should lead to higher speed, lower costs and greater durability.

8. CONCLUSION

This new technology can prove highly beneficial if installed in schools, colleges, commercial buildings by simply leveraging extra requirement of electricity. By being fast, cost effective, less bulky, extensively applicable it really promises a lot in today's scenario.

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