Development and Demonstration of a Cost Effective Process to Fabricate a Solar Photovoltaic Panel at Local Level

Rahul Arya, Jitendra Kumar Bhartiya

Abstract— **Solar panels are widely utilized to transform solar energy in to electrical energy or simply electricity. Hence solar panels can play their vital role in electricity generation for rural and backward areas. In India, solar panels are mostly manufactured in metro cities and hence their reach from there to small towns and villages becomes very costly. On the other hand, Manufacturers also fail to provide after sales services to their customers residing in such backward and rural areas. This results in very limited use of solar panels in such areas. The technology with which this study deals could enable the fabrication of homemade solar panels with high working efficiency. The solar panels manufactured by this technology can compete with the modern company made solar panels and also requires comparatively less space for their production. These features of this technology makes it fit to serve small towns and villages of our country. The raw materials and equipments required for the fabrication of such solar panels are also easily available at local level. This fabrication process also incorporates the encapsulation process to tackle the problems of corrosion and dust settlement on the solar panels by providing them electrical or mechanical support.**

Index Terms— PV module fabrication, solar energy, encapsulation, acrylic sheet.

I. INTRODUCTION

There are normally two types of solar panel. First of which is company made solar panel and second is homemade solar panel. We have developed a solar panel in this process which has the qualities of both panels. Which has the qualities of company made solar panel and cheap as homemade solar panel. We have added encapsulation process in this solar panel. Fabrication, in which we are going to use EVA sheet (ethyl vinyl acetate). To protect EVA encapsulation, we have used acrylic sheet both the sides. That will play the role of superstrate and substrate layer. Acrylic sheet is transparent and unbreakable. We have used a frame to convert solar cells into grouping. With the help of this frame solar cells are easily converted into series and equal distance can be measured between them. And some equipments and machinery involve of this solar panel fabrication process for improve the quality of solar photovoltaic panel but only one time investment.

Manuscript received April 28, 2014.
Rahul Arya, *Department of Mechanical Engineering, Madhav Institute of Technology & Science, (e-mail:arya.rahul341@gmail.com). Gwalior, India, 9425754016*
Jitendra Kumar Bhartiya, *Department of Mechanical Engineering, Madhav Institute of Technology & Science, Gwalior, India, 9425341456., (e-mail: jit.bharti@gmail.com).*

II. OBJECT

- Electricity .by this women can maintain their living style. They can not only change their present but also future.
- The handmade thing can be treated to the country and foreign and we can strong our country state and villager can play their special part in agriculture and they get their maximum outfit.
- With the help of night school the non-literate farmer can become literate even their family can also take. In night school by the medium of Projector the production of agriculture is increase not in a better but best way.
- By the help of street light they can stop crimes and they can protect them self from hash and hazardous animals.
- Irrigation facility going to a new level by this.

All process divided into steps because of work are fast and quality will improve of solar photovoltaic panel.

A. Step 1

On solar cell apply the flux and connect the 2mm wide tab ribbon with the help of solder and I left same size ribbon to connect next solar cell .and same process apply to each solar cell.

B. Step 2

After that each solar cell fix in a frame. This frame being one time fix up to seven solar cell. The frame being basically use to easily connect the solar cell in series. It makes work very fast so that only one worker is enough to complete whole process and this work have completed then test the each series With the help of voltmeter.

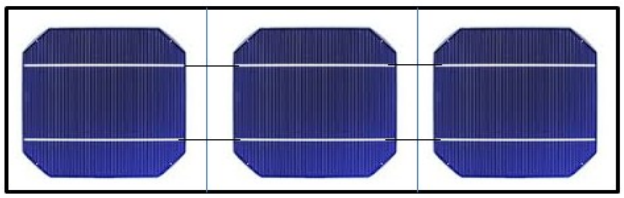

Figure1: solar cells convert in series. [9]

C. Step 3

After that each series to hold the vacuum holder and drop the frame and the using of 5mm wide bus ribbon to connect the

ISSN: 2278 – 7798

all series and convert the +ve and –ve link With the help of solder.

D. Step 4

All the solar cells hold the vacuum holder and drop the polymer layer and apply the Encapsulants process.

E. Step 5

The whole assembly to hold and drop the semi automatic laminator with in 15 minute and 50 to 80°C temperature and according to need and with the help of semi automatic laminator to remove all air from between them And perfect set the polymer layer .

F. Step 6

After that whole assembly testing and after testing to apply the framing work and provide the superstrate and substrate layer.

G. Step 7

After completed the framing work to connect the junction box behind the solar panel and again do the final test Then dispatch.

III. The Schematic Packaging Assembly of a Typical Solar Panel

Superstrate: The covering which is exposed to the sunlight providing protection for the PV materials from environmental impact and degradation whilst allowing the maximum transmission of the appropriate wavelengths of the light spectrum. Typically Acrylic Sheet is used as superstrate.

PV cell: The most essential component which is responsible for converting sunlight into electricity. It is commonly made of crystalline silicon with silver conductor lines on it.

Encapsulants: The protective optical coupling for electrically connected solar cells. It is commonly made of ethyl vinyl acetate (EVA).

Soldering Ribbon: A soldering string which connects the PV cells in series allowing the aggregate current to flow in one direction. The ends are connected to junction box terminals with positive and negative ends; usually, it is made of lead or silver.

Substrate: Placed at rear of the encapsulated solar cell to provide physical rigidity as well as protecting the panel from the environment.

Frame: Gives structural support to the complete assembly. It is generally made of anodized aluminum.

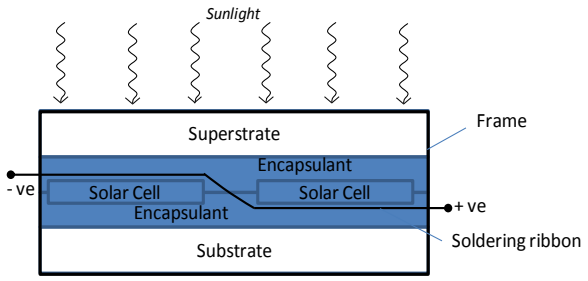

Figure2: Schematic cross section of a solar panel assembly. [8]

IV. Production Line Needs the Following Machine and Equipment's

SR. NO.	MACHINERY NAME	QUANTITY
	Semi–Automatic Laminator	1
	Cell soldering table	1
	Assembling table	1
	Soldering iron	1
	Solar cell	As per requirement
	Junction box	As per requirement
	Flux	As per requirement
	Silicon sealant	As per requirement
	Tab ribbon 2mm wide	As per requirement
	Bus ribbon 5mm wide	As per requirement
	Aluminum Angle bar	As per requirement
	Diodes	As per requirement
	Terminal Blocks	As per requirement
	Acrylic Sheet.	As per requirement
	Pneumatic glue gun	As per requirement

Table1: List of equipments and machine [8]

V. Describe Following Equipments and Material and Machines

Diodes: A diode is a small electronic component that, ideally, has a very low resistance to electrical current in one direction and a very high resistance to flow in the other direction.

Bus ribbon and tab ribbon: Bus ribbon is a very specialized interconnects that is used for photovoltaic modules. Much like tabbing ribbon, bus ribbon is made up of a copper ribbon, or flat wire, that is coated in solder. The solder protects the surface of the copper from oxidation and provides a layer of solder to form the solder joint. These solder-coated copper strips are used to collect the electricity from the strings. Both bus and tabbing ribbon are specified in the same way.

The main difference between these two interconnect materials is that bus ribbon is a bit wider and sometimes thicker than tabbing ribbon. Imagine tabbing ribbon as a road that travels across the solar cell. The bus ribbons serve as the highways to connect and tie them together. Bus ribbon is larger in cross-section because it has more electrical power to carry. To give you an idea of the size, bus ribbon is generally 5 mm-6 mm wide, although some applications require bus ribbon to be more than twice as wide.

Flux: Solder fluxes are used with tabbing ribbon to form a solder connection with the metallization paste. Flux dissolves

ISSN: 2278 – 7798

the oxides present on the surface of the tabbing ribbon as well as the silver metallization bonding strips on the top and bottom of the solar cell. Fluxes are typically liquid and consist of a chemical activator package, rosin or synthetic resin, and a solvent system.

Pneumatic glue gun: Gluing the gel for the framer and junction box by the compressed air. Glue the gel high–speed and even.

Soldering iron: A soldering iron is a hand tool used in soldering. It supplies heat to melt the solder so that it can flow into the joint between two work pieces. A soldering iron is composed of a heated metal tip and an insulated handle. Heating is often achieved electrically, by passing an electric current (supplied through an electrical cord or battery cables) through a resistive heating element.

Silicon sealant: Silicone is used to seal joints between two surfaces.

Solar cell: A solar cell, or photovoltaic cell, is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect.

There are three types of solar cells, Polycrystalline, Monochrystalline, and Amporphous.

Semi – Automatic Laminator: laminator machine is of fundamental importance in curing the EVA, to join the layers that form the module and remove all air from between them.

Acrylic Sheet: acrylic sheet is a material with unique physical properties and performance characteristics. It weighs half as much as the finest optical glass. Yet is equal to it in clarity and is up to 17 times more impact resistant. Acrylic sheet is made in over 250 colors, in thicknesses from .030" to 4.25'. And can transmit ultraviolet light or filter it out, as required.

Terminal Blocks: A screw terminal is a type of electrical connector where a wire is held by the tightening of a screw.

Junction box: An electrical junction box is a container for electrical connections, usually intended to conceal them from sight and deter tampering.

Requirement of work area:

Building area	2000 square feet
Building height	4 meters

Table2: Requirement of work area [8]

VI. WORK TIME

I have used steps in making time study method with the help of this method to exact time found for making the solar panels in one shift.

NO. OF SHIFT FOR DAY	PER SHIFT
Work days for week	6 days
No. of hours for shift	8 hours
No. of work day for year	300 days
No. of modules per day	3 modules
No. of modules per year	900 modules
No. of operator for shift	11 operator 1 shift

Table3: Work time [8]

VII. FLOW CHART OF PROCESS

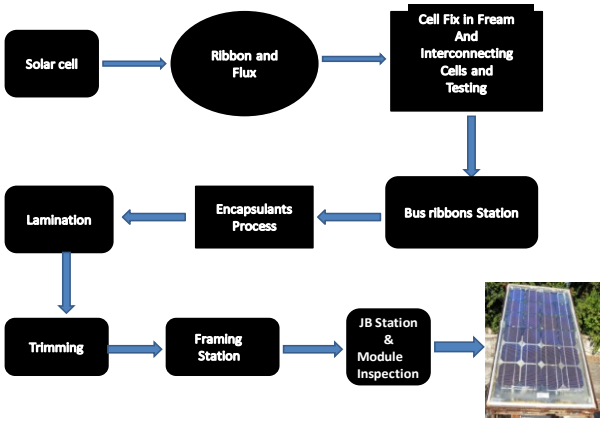

Figure3: Flow chart of Production line

VIII. CONCLUSION

Due to the availability on low cost of solar panel it is used in house and maximum people can use natural energy. Many possibilities occur in business and employment. The level of study approaches to next level in villages.

REFERENCES

[1], "A low cost PV panel assembly targeted at rural energy supply in developing nations". P. K. Hardy, C. S. Malvi, M.K. Gaur, W. Dixon-Hardy and R. Crook SWC-2011, Berlin, Germany.

[2] "Cost Effective Fabrication of a Solar PV Panel for LED Lighting" J. K. Bhartiya, A. Patra, C. S. Malvi. University of Leeds, UK.2012, (ISSN 2250-2459, Volume 2, Issue 6, June 2012.

[3] "Encapsulation of PV modules using ethylene vinyl acetate copolymer as a pottant": Czanderna, A.W. and F.J. Pern, A critical review. Solar Energy Materials and Solar Cells, 43(2): 1996 p. 101-181.

[4] "Technical feasibility study on polycarbonate solar panels. Solar Energy Materials and Solar Cells", Hackmann, M.M., et al. 2004, 84(1-4): p. 105-115.

[5] "Luminescence and absorption characterization of ethylene-vinyl acetate encapsulant for PV modules before

ISSN: 2278 – 7798

and after weathering degradation". Pern, F.J. 1993 Polymer Degradation and Stability, 41(2): p. 125-139.

[6] "Use of plastics in solar energy applications". Blaga, a Solar Energy, 1978. 21(4): p. 331-338.

[7] How to Make a Solar Panel – YouTube.

[8] Anjali Ventures Limited Solar line.

[9] "Development of New Low-Cost, High-Performance, PV Module Encapsulant/Packaging Materials" S.C.Agroand R.T.Tucker. March 2004. NREL/SR-520-35683.

[10] "Providing electricity access to remote areas" MR Nouni, SC Mullick, TC Kandpal.

[11] In India: an approach towards "identifying potential areas for decentralized electricity supply". Renewable and Sustainable Energy Reviews 2008; 12:1187e220.

RAHUL ARYA is a research scholar pursuing M.Tech. In Production Engineering from Madhav institute of technology and science (MITS) Gwalior (M.P) India. The degree of B.E. secured in Mechanical Engineering from NRI Institute of Technology & management, Gwalior (M.P) India .

Jitendra Kumar Bhartiya presently working as Junior Research Fellow in Mechanical Engineering at Madhav institute of technology and science (MITS) Gwalior (M.P) India. He is working on DST solar project.

ISSN: 2278 – 7798