A Review on Solar Cell Crystal Silicon

Mukesh Choudhary[1], Manish Kumar[2], Pankaj Kumar [3]

[1]B.Tech Scholar, department of Mechanical Engineering, Arya Institute of Engg. & Technology, Rajasthan, India
[2]B.Tech Scholar, department of Mechanical Engineering, Arya Institute of Engg. & Technology, Rajasthan, India
[3]Assistant Professor, department of Mechanical Engineering, Arya Institute of Engg. & Technology, Rajasthan, India

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Abstract - *Due to the abundance and the maturity of production Of the solar cell and increment in the area wise prices, the prices have made them premium and due to the vast skill set on the photovoltaic cells. But due to the lower efficiency and outputs from old solar cells new crystal silicon type solar cells are successfully, Since the 16th Photovoltaic Specialists Conference, the focus of the Crystalline Silicon Solar Cell Task at the Solar Energy Research Institute (SERI) has narrowed somewhat. Responsibility for silicon material preparation and ribbon growth were consolidated at the Jet Propulsion Laboratory (JPL) at the end of FY 1983. Five subcontracts were awarded under RFP No. RB-2-02090, "Research on Basic Understanding of High Efficiency in Silicon Solar Cells" JPL and Oak Ridge National Laboratory are also working on high efficiency solar cell research under SERI subcontract. Reports of past solar cell improvements have prompted appreciable interest in the physical, chemical, and electrical transport properties of grain boundaries and other electrically active defects. Studies to achieve better understanding of the hydrogen passivation process are being conducted at various subcontractors, and our research continues Cell thicknesses in the range of 200 µm or even less are now the industrial standard which is well beyond the old standard of 330 µm. This development has been made possible by tremendous efforts in automation and process technology.*

Keyword— Photovoltaic, Crystal, Automation, SERI

1. INTRODUCTION

In some way due to decrement or due to the scarcity of the silicon raw materials, it has proven a good effect on the market officially because whenever shortage of raw material and increment in technology increases the market benefits. The ever-increasing electronic quality of silicon ingots has been an important lever for improving efficiencies of c-Si solar cells. Elemental silicon (Si) can't be found by itself anywhere in nature. It must be extracted from quartz ($SiO2$) using carbon (C) and heat (from an electric arc) in the "carbothermic" (carbon + heat) reduction process called "smelting." ($Si02 + 2C = Si + 2CO$) Several carbon sources are used as reluctant in the silicon smelting plant, which requires ~20 MWh/t of electricity, and releases CO – resulting in up to 5 - 6 t of CO2 produced per ton of metallurgical grade (mg-Si) silicon smelted. [1] Thus, the old solar cells new crystal silicon photovoltaic first step of solar PV production is gathering , transporting successfully since the 16 photovoltaic specialist conference and burning millions of tons of coal, coke and petroleum coke-along with charcoal and wood chips made from hardwood trees - to smelt > 97% pure mg-Si from quartz - "ore" (silica rocks) [2] [3] [4] [5][6][7][8][9][10].

2. SURFACE PASSIVATION

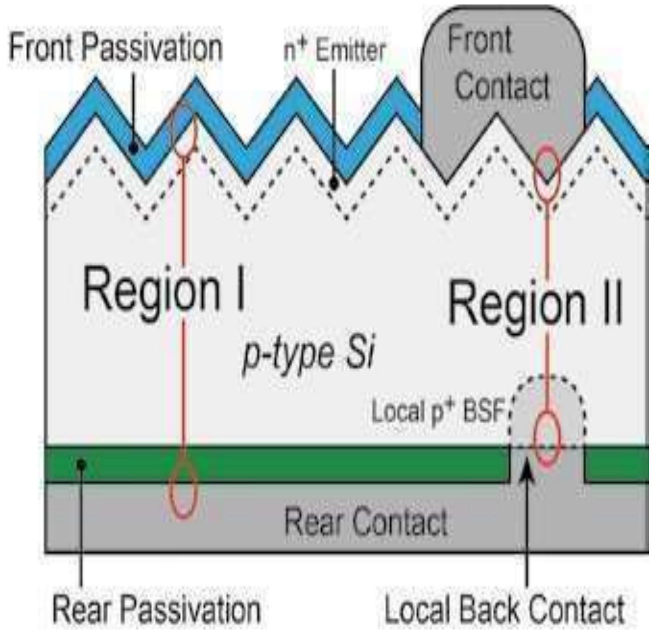
This process "surface passivation" doesn't change the properties of the semiconductor when the air and other particles are interacted with the surface and edges of crystal. Surface passivation has become an essential factor for translating high efficiency crystalline silicon solar cell concepts into industrial production schemes. In photovoltaics, a widespread method to determine the surface recombination is to measure the effective charge carrier lifetime from the photo conductance of symmetrically passivated silicon wafers in transient or quasi static mode there are two fundamentally different types of surfaces in a c-Si solar cell: metallized and non-metallized surfaces. Metal silicon interfaces feature very high SRVs and hence need to be carefully designed to avoid excessively large recombination losses. Similarly, to ensure a good response of cell and illuminated non-metallized surface regions need to be well passivated and not too heavily doped to avoid the formation of a dead layer. In the case of laboratory c-Si cells, the importance of the passivation of both cell surfaces is well recognized [11].

3. FRONT SURFACE PASSIVATION

Front surface passivation was attained with thermal SiO_2 and TiO_2 fabricated by atmospheric chemical vapor deposition. Thermal growth of silicon oxide is the most effective c-Si. The technique for solar cell of surface passivation, but the technique is not suitable for low-cost industrial processes as it requires very high temperature (above 1,000 C) treatment. The bulk life is being degraded by high temperature as akin to the stability of passivated surface [12]. But for SiO_2, it has very low refractive index that affects the antireflection performance of the crystal. And about the TiO_2, it does not provide any electronic surface passivation for crystal. And In the past two decades, various research efforts have been devoted to the development of a more industrially convenient solution, in particular, on passivation layers deposited at low temperature (B400 C) onto the c-Si surface.

4. REAR SURFACE PASSIVATION

An effective reduction of surface and usage of thinner wafers recombination losses are increasingly important for low-cost highly efficient silicon solar cells. Hence the recent trend in silicon-wafer-based PV industries is toward thinner wafers (200 lm). But the use of thinner wafers increases the rear surface recombination [13]. To increase the efficiency in solar cells usually the internal reflection should be high enough to generate the high-quality performance. And now a days in solar cells dielectric passivation layer is used in rear to increase the efficiency. And moreover, we can achieve the high optical quality due to this assurance of rear surface passivation. Keeping in mind the above attributes a good number of rear surface passivation techniques were developed over the years; among them atomic layer deposition (ALD)-assisted Al_2O_3, wet oxidation process using pyrogenic steam, passivation by stack of a-Si:H/SiO_2 or Al_2O_3/SiN_x and passivation by phosphorus-doped a- SiC_xN_y:H(n) alloys are the most notable rear side passivation techniques for crystalline silicon solar cells. Recent research results on these rear surface passivation techniques are aggregated below. with rising cell efficiencies surface passivation has become increasingly more important to reduce carrier loss at the cell surface that would otherwise limit absolute efficiencies. Extremely low surface recombination levels can be achieved when both chemical and field effect passivation are utilized effectively at the surface.



5. PASSIVATION BY Al2O3

Atomic-layer-deposited Aluminum oxide (Al_2O_3) is applied as rear-surface-passivating dielectric layer to passivated emitter and rear cell (PERC)-type crystalline silicon (c-Si) solar cells. The excellent passivation of low-resistivity p-type silicon by the negative-charge-dielectric Al_2O_3 is confirmed on the device level by an independently confirmed energy conversion efficiency of 206%. The best results are obtained for a stack consisting of a 30nm Al_2O_3 film covered by a 200nm plasma-enhanced chemical-vapor-deposited silicon oxide (SiO_2) Atomic-layer deposited aluminum oxide (Al_2O_3) is applied as rear-surface passivating dielectric layer to passivated emitter and rear cell (PERC)-type crystalline silicon (c-Si) solar cells. The excellent passivation of low- resistivity p-type silicon by the negative charge-dielectric Al_2O_3 is confirmed on the device level by an independently confirmed energy conversion efficiency of 206%. The best results are obtained for a stack consisting of a 30nm

Al_2O_3 film covered by a 200nm plasma-enhanced-chemical vapor- deposited silicon oxide (SiO_x) layer, resulting in a rear surface recombination velocity (SRV) of 70cm/s. Comparable results are obtained for a 130nm single-layer of Al_2O_3, resulting in a rear SRV of 90cm/s.) layer, resulting in a rear surface recombination velocity (SRV) of 70cm/s. Comparable results are obtained for a 130nm single-layer of Al_2O_3, resulting in a rear SRV of 90cm/s. Recently that aluminum oxide (Al_2O_3) thin films of grown by atomic layer deposition (ALD) provide an excellent level of surface passivation on p- and type silicon wafers, as determined from carrier life time Measurements [14].

6. DOPED AMORPHOUS SILICON

By doping hydrogenated amorphous silicon with phosphorus or boron we can get the electron or hole selective to form film for the creation of junction and the back side of solar cell. Hydrogenated amorphous silicon (a-Si:H) was first explored as heterojunction with crystalline silicon by Fuhs et al. in 1974 [15]. The key challenges associated with this technology are degradation of the passivation at temperatures above 300 C, parasitic optical absorption in the intrinsic and doped a-Si:H layers, and process complexity (e.g., number of deposition steps, precise thickness requirements, special surface preparation steps, more expensive metal contact pastes) [16].

7. CONCLUSION

Solar cell made by crystalline silicon having very low efficiency so, it is necessary for optimization of solar cells by certain improvements and particular material selection at better quality and high performance. So again, by highly efficient process and improving processing conditions. And our goal is set on to choose better material of efficient properties that can evaluate the process and the output. Our focus was to review the advances in existing surface passivation techniques in an industrial process line as well as in the research laboratories over the world. Every c-Si solar cell fabricated to date features one or more of these surface passivation methods. High-efficiency cell structures help to reduce the costs of photovoltaic energy generation in two ways: (i) through increasing the efficiency or by the output are of silicon cell or (ii) through the use of thinner wafers achieving same level or even improved efficiency and hence the power output per volume or per weight. However, in order to allow for an industrial production of high-efficiency silicon solar cells, several design or technology limitations have to be addressed. This paper has discussed four important aspects associated with high-efficiency cells, that is, (i) metal contacts, (ii) the surface passivation, (iii) cell structure, and (iv)material quality.

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[4] "The Use and Market for WOOD in the electrometallurgicalIndustry"https://www.fs.usda.gov/treesearch/pubs/23800 (4) [woodchips are used in smelters]...to provide a large surface area for chemical reaction to take place more completely and at improved rates…To maintain a porous charge, thereby promoting gentle and uniform - instead of violent - gas venting…To help regulate smelting temperatures…To keep the furnace burning smoothly on top…To reduce conductivity…To promote deep electrode penetration…To prevent bridging, crusting, and agglomeration of the mix…To reduce dust, metal vapor, and heat loss; and as a result to improve working conditions near the furnace.

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[6] What Terrible Injustices Are Hiding Behind American Energy Habits? By Itai Vardi • Friday, November 16, 2018 (link) (6) "There is a clear 'consumer blindness' and citizens and residents are often unaware of where the fuel they consume is coming from and what injustices were inflicted on communities within those sites of fossil fuel extraction," said Healy. "Exposing these injustices of energy 'sacrifice zones' — like [the Cerrej� open - pit coal mine] in La Guajira, Colombia …— could be critical for future energy policy decision making."

[7] 2017/06/18/why-this-part-of-coal-country-loves-solar-power-215272 (7)"the seam in Whitley County [Kentucky] is an even more valuable variety of metallurgic coal known as "blue gem."..."You need the blue gem to make the solar panels, and that's what people don't know," Moses told me, articulating a simple truth: "Without Coal Valley, there's no Silicon Valley"

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