IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

A Mini Review On The Latest Development In The Area Of Perovskite Solar Cell On The Basis Of Power Conversion Efficiency And Stability.

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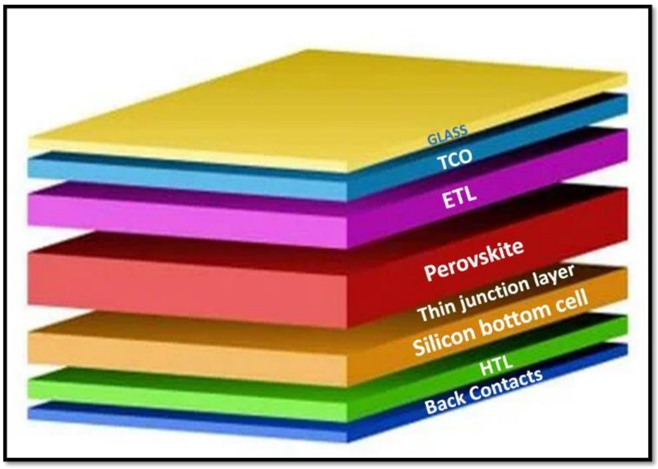
Abstract: The thin film peroskites are now overpowering the photovoltaic devices and are being under tremendous research. In this mini review we have extensively discussed thin film perovskites solar cells (PSCs)on the basis of the recent developments during the last decade in the area of power conversion efficiencies (PCE), open circuit Voltage (VOC), close circuit current (ISC), and optimization for the trade-off between the PCE and absorber and thin film thickness for the observer layer. Present trends is now going towards the stability analysis of the perovskite material that is also covered in this paper. Versatile availability for the combination of heterogeneous materials and there integration produces a wide range of perovskite solar cell. This mini review is a brief discussion to gives an insight on this emerging field in a compact form.

Keywords: Thin film; Perovskite; Power conversion efficiency, Open circuit voltage, closed circuit current.

1. Introduction: Development in the solar cell technology started from 1954 [1]. So far, many distinct kinds of solar cells are reported like monocrystalline solar cell, polycrystalline solar cell, CIGS solar cell, CdTe-based solar cells, quantum dot sensitized solar cell and perovskite solar cells. The thin film solar cell technology started back at 1972 with minimum reported efficiency of 6% [2] in p-CdTe–n-CdS heterojunction solar cell. The development and emerging researches in the solar cell fabrication technology gives birth to the novel perovskites category. First perovskite solar cell was reported in 2009 with 3.81% efficiency, utilizing Organometallic perovskites CH3NH3PbI3 and CH3NH3PbBr3 as sensitizer in dye sensitized solar cell (DSSC) [3]. After introducing TiO2 surface preparation, a highly efficient quantum dot sensitized solar cell using CH3NH3PbI3 nanoparticles is reported in the year 2011 with power conversion efficiency of 6.5% [4]. In 2012, the conventional liquid based hole transport material (HTM), is replaced with new solid state Spiro-MeOTAD for pore filling as a result Mesoporous TiO2 film thickness is reduced with Spiro-MeOTAD and the Power conversion efficiency of solar cell has increased to 9.7% [5]. In the year 2014 solar cell based on halide perovskite report efficiency of 17.9% [6]. 22.1% efficiency is achieved in 2016 [7] and now it is surpassed beyond 25.5% [8]. The advancement in this field gear up with the discoveries of new material and structure for every passing year to give latest reported efficiency 29.8 % in tandem (hetrojunction) based silicon cell [9]. The power conversion efficiency and cost of material play a significant role in solar cell commercialization. Perovskite solar cell becoming more popular than conventional solar cell due to their simpler production method, cheaper cost and higher flexibility.

(a)



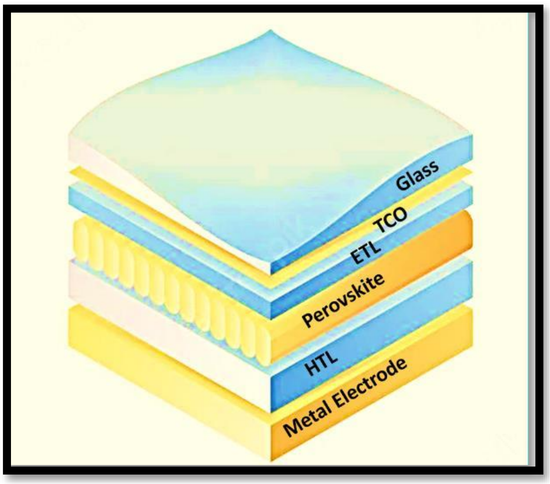


Figure 1. (a)Thin film perovskite solar cell (b) Perovskite on silicon tandem solar cell

2. Factors affecting Stability of Perovskite solar cell

2.1. Effect of humidity and moisture on cell performance.

Numerous external environmental factors results in degradation of the solar cells as shown in figure 1, which greatly depends on the site location [10] w.r.t. the tropic of cancer, exposure time, spectral band and diffraction angle [11] Among all, the humidity and moisture adversely effects the performance by reducing the efficiency to approx 1.5 to 4.9% per year, prominently due to the breaking of ionic bonds in the presence of moisture, oxygen and UV-radiation, that catalysis the HYDROLYSIS, PbL2 conversion, or forming precursors [12]. Recent studies reported that the degradation of solar cells is approx. 0.6 to 0.7 % per year [13, 14].

In 2015 studied that various environmental factors like humidity, oxygen, temperature and Ultra-violet radiation affects the performance of solar cell. These factors leads to the degradation of solar cell the chemical process that is involved when perovskite solar cell is exposed to moisture is represented by various equation shown below.

In 2015, it was reported that oxygen in the form of superoxide could initiate the degradation process in perovskite solar cells. Later on Iodide is replaced by thiocynate group in halide perovskite for enhancing moisture stability. [15].

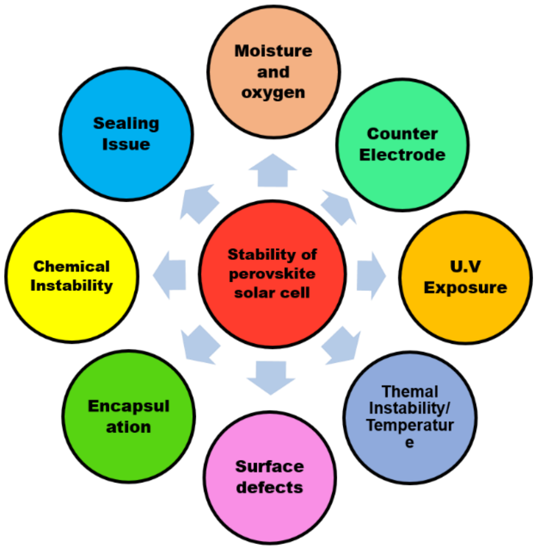


Figure 2. Various factors affecting stability of Perovskite solar cell.

2.2. Effect of corrosion & dicoloration on cell performance.

Other factors besides environment factors that can lead to degration in solar cell are corrosion, hot spots, discoloration and delamination [16, 17]. Corrosion is a factor that causes ribbon discoloration of photovoltaic modules [18, 19]. Corrosion occurs due to salt & water from produced from EVA encapsulant degradation [20-22]. While others reported that main cause of corrosion is acetic acid formation by the hydrolysis and pyrolysis process occurs in solar cell when exposed to high temperature [23, 24]. Some researchers studied and proved that discoloration of solar cell occurs due to water exceeding temperature 50 degree Celsius [25]. Solar cell consist of various layer adhesion loss occurs between the encapsulation polymer, windshield and solar cell. This adhesion loss occurs due to moisture diffusion into the equipment. [26-27].

2.3. Effect of hotspots & cracks on cell performance.

Hotspot occurs when the current cannot flow through the shaded cells. In this condition solar consume electricity instead of generating. According to some researcher causes of hotspot are cellular interference, mismatch in structure and broken connection between the cells [28]. If the PV cell fails in the case of a short circuit, the voltage will reverse and become equal to and opposite to that of the other cells in the series. This defective solar cell burdens the other cells by creating comparatively high heat-dissipation sites, resulting in hotspots. [29, 30]. A broken polycrystalline PV odule cannot deliver good energy for a very Hotspot, diffraction angle, location, intensity of radiations, and other environment factors like presence of Oxygen, moisture, exposure to UV radiation etc. on the optimum performance. Hence, stability is the biggest challenge which needs to be addressed, to prevent long time. This builds the danger of electric shock and humidity penetration. Cracks and fractures are accompanied by various sorts of degradation, for example delamination, solar cell discoloration. [32]

Conclusion

This review article has presented a critical summary of gradual development in the field of perovskite solar cell on the basis power conversion efficiency. We have briefly given the effect of various factors like the solar cell degradation, in order to improve the efficiency, life span, maintenance and commercialization.

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