Perovskite solar cells: a review

Supreeth A¹, Shreya Y S²
¹² UG Student, Department of Electrical and Electronics Engineering, Vidyavardhaka College of Engineering, Mysore, India.

Abstract - Present photovoltaic systems can be categorized by various aspects such as grid connected, stand alone, rack-mounted, ground-mounted, retrofitted systems etc., these various category uses specific photovoltaic material which is further classified as first, second and third generations. This paper presents feasibility investigation on one of the third generation solar cells called “perovskite solar cells” it comprising of ABX₃ crystal structure, perovskite structure most commonly studied absorber is methylammonium lead trihalide (CH₃NH₃PbX₃) comprising of optical bandwidth of 2.3 eV and 1.6 eV which leads into several advantages over traditional silicon solar cells in simplicity of processing, costs etc. This hybrid organic-inorganic lead or tin based systems leads into cheap, simple manufacturing techniques with relative higher stability and higher energy conversions.

Keywords - perovskite structure, methylammonium lead trihalide (CH₃NH₃PbX₃), optical bandwidth, hybrid, energy conversions.

I. INTRODUCTION

Modern solar cells research includes liquid inks, upconversion, light absorbing dyes, quantum dots, organic/polymer solar cells, adaptive cells and perovskite solar cells. Among these top researches perovskite solar cell stands as a distinct category called emerging photovoltaics. These photovoltaics solar cells belongs to class of third generation which includes a number of thin film technologies. The first and second generation solar cells includes silicon wafers and thin film technologies respectively, which are lesser performance and high cost. The organometallic halide light absorbing system of perovskite solar cell made it as higher efficiency with low processing cost and highly stable characteristics whereas second generation thin film technologies promises a combination of lower cost and fabrication ease.

The general formula for perovskite materials is ABX₃. In this arrangement, 6 ‘X’ anions the ‘A’ and ‘B’ cations coordinate with 12, forming octahedral and cuboctahedral geometries, respectively.

In the recent of modern research the traditional silicon solar cells are recorded with efficiency of 25% but such high efficient cells are expensive to manufacture and hence typical solar cell installation is around 15% efficient. Perovskite solar cells are recorded with 26% efficiency with low processing cost and highly stable characteristics where as, second generation thin film technology results in 12-20% efficient relatively.

II. PROCESSING

Traditional silicon solar cell processing is quite expensive, a multistep process which requires high temperature and vacuum facilities in special clean rooms to produce high purity silicon wafers whereas, and perovskite solar cell processing is simple and cost effective. There are two methods of processing of these solar cells which are variety of solvent techniques and vapour deposition techniques.

SOLUTION PROCESS TECHNIQUE

In solution process technique the deposition of CH₃NH₃PbI₃ perovskite on a mesoporous TiO₂ substrate takes place in two methods that is, one step and two step coating methods. In one step coating method CH₃NH₃I and PbI₂ are dissolved in appropriate protic solvent gamma-butylrolactone (GBL) or dimethyl sulfoxide (DMSO) and this applied as coating solution, the processes like drying and annealing are followed by spin coated methods.

In two step coating method to the TiO₂ substrate PbI₂ solution is coated first to form PbI₂ film and then 2-propanol solution of CH₃NH₃I is added to spinning PbI₂ film.
In order to get high quality perovskite film it is important to adjust coating parameters like temperature, time, spinning rate, viscosity, solution wettability etc.

**VAPOUR ASSISTED SOLUTION PROCESS (VASP)**
This method is different from the solution process and vacuum deposition, by avoiding co-deposition of inorganic and organic species. It takes advantage of the kinetic reactivity of CH$_3$NH$_3$I and thermodynamic stability of perovskite during the in situ growth process and provides films with well-defined grain structure with grain sizes up to microscale, small surface roughness and full surface coverage, suitable for PV applications. Devices based on films prepared from vapour assisted solution process achieved a best power conversion efficiency of 12.1%, so far the highest efficiency of CH$_3$NH$_3$PbI$_3$ with planar structure.

**III. ARCHITECTURE**
Depending upon the role of Perovskite material in the device and the nature of the electrodes used (top and bottom) Perovskite solar cells architecture will be decided. Basically perovskite is a light absorbing layer, usually perovskite are built around dye sensitized solar cell (DSSC) architecture. Positive charges are extracted by the transparent bottom electrode (cathode), which is predominantly be divided into 'sensitized' and charge transport occurs in thin-film, majority hole or electron transport occurs in the bulk of the perovskite itself. Similar to the sensitization in dye-sensitized solar cells, the perovskite material is coated onto a charge-conducting mesoporous scaffold-most commonly TiO$_2$ – as light-absorber. The generated electrons are transferred from the perovskite layer to the mesoporous TiO$_2$ sensitized layer through which they are transported to the electrode and extracted into the external circuit.
IV. CONCLUSION
In modern research silicon solar cell is recorded with efficiency of 25% but it is expensive to manufacture of such high efficiency cells and typical solar cell installations are around 15% efficient.

Perovskite solar cells are recorded with 26% efficiency with low processing cost and high stable characteristics where as, second generation thin film technology results in 12-20% efficient relatively. The perovskite inspired material is quite easy to fabricate and easy to manufacture via printing process relying on liquid precursor.

To capture different portions of light spectrums perovskite materials can be easily tuned and cost of fabrication of such super efficiency solar cells will eventually get reduced.

V. REFERENCES


