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# Perovskite solar cells: a review

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***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 $ABX_3$ crystal structure, perovskite structure most commonly studied absorber is methylammonium lead trihalide ($CH_3NH_3PbX_3$) comprising of optical bandwidth of 2.3ev and 1.6ev 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 ($CH_3NH_3PbX_3$) , optical bandwidth, hybrid, energy conversions.**

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## 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 power conversion efficient along with low material costs.

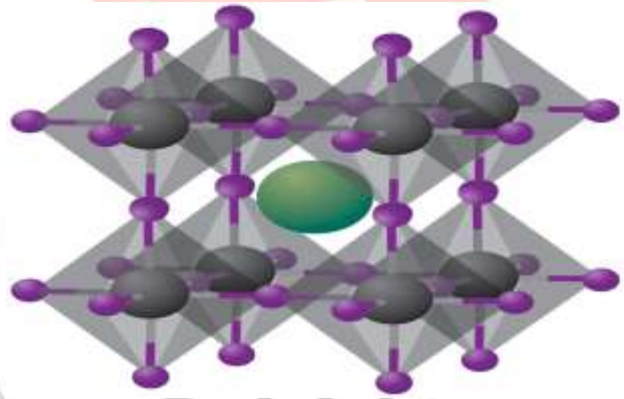

Figure 1: Crystal lattice of the methylammonium lead halide (CH3NH3- PbX3) perovskite structure

Solar cell technologies which are silicon based offers a combination of properties like high temperature stability, low cost ,ease of surface passivation and hardness have made themselves fascinated in applications of photovoltaics. For replacement of silicon ,recent technologies promises a combination of lower cost and fabrication ease.

The general formula for perovskite materials is $ABX_3$. 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 vaccum 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 $CH_3NH_3PbI_3$ perovskite on a mesoporous $Tio_2$ substrate takes place in two methods that is, one step and two step coating methods. In one step coating method $CH_3NH_3I$ and $PbI_2$ are dissolved in appropriate protic solvent gamma-butyrolactone (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 $TiO_2$ substrate $PbI_2$ solution is coated first to form $PbI_2$ film and then 2-proponol solution of $CH_3NH_3I$ is added to spinning $PbI_2$ film.

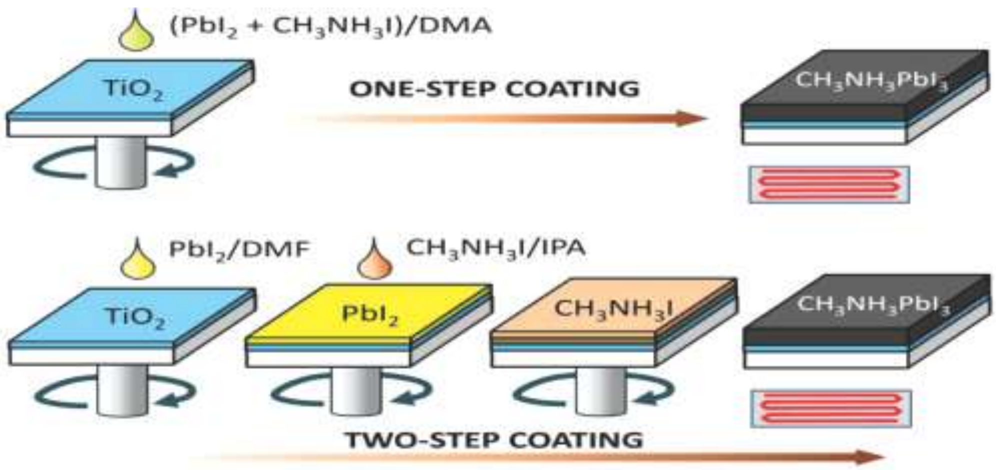


Figure 2.1: Flow of solution process technique

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 $CH_3NH_3I$ 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 $CH_3NH_3PbI_3$ with planar structure.

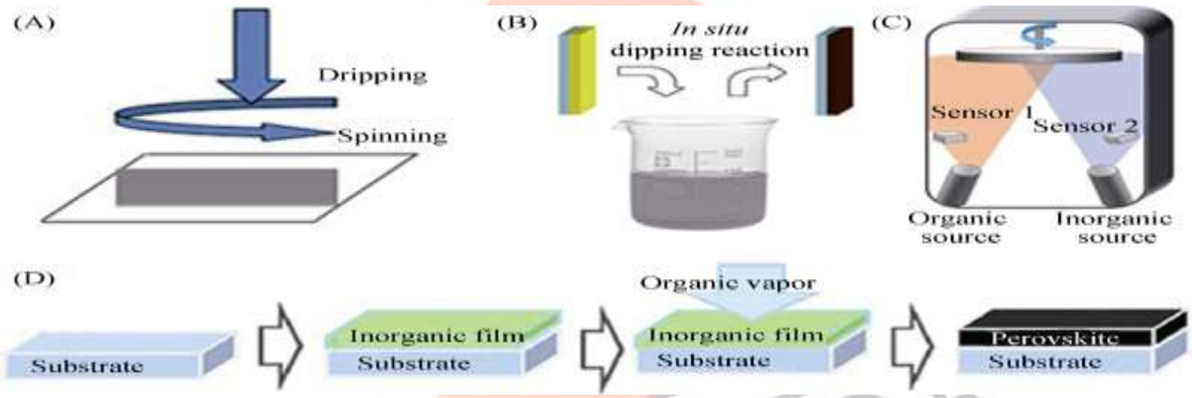


Figure 2.2: Flow of vapour assisted solution process

The problem with thermal evaporation technique is it requires high vacuum condition which leads into costlier conditions and restricts mass production. This problem can be solved with vapour assisted technique whereas spin coated lead halide is annealed in the presence of methyl iodide vapour at 150ºc temperature for flexible operation. The multi stacked thin films are obtained over large area which is applicable for production of multi junction cells.

## 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.

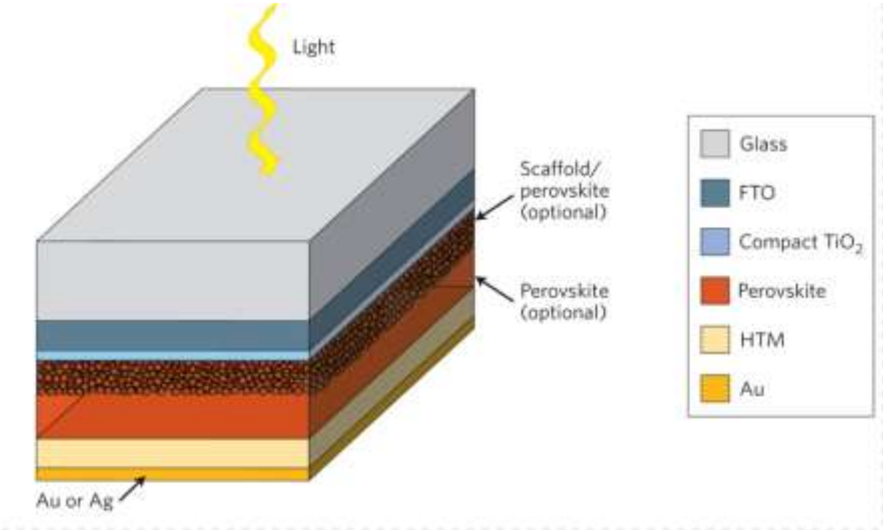


Figure 3.1: Basic layout of perovskite solar cell

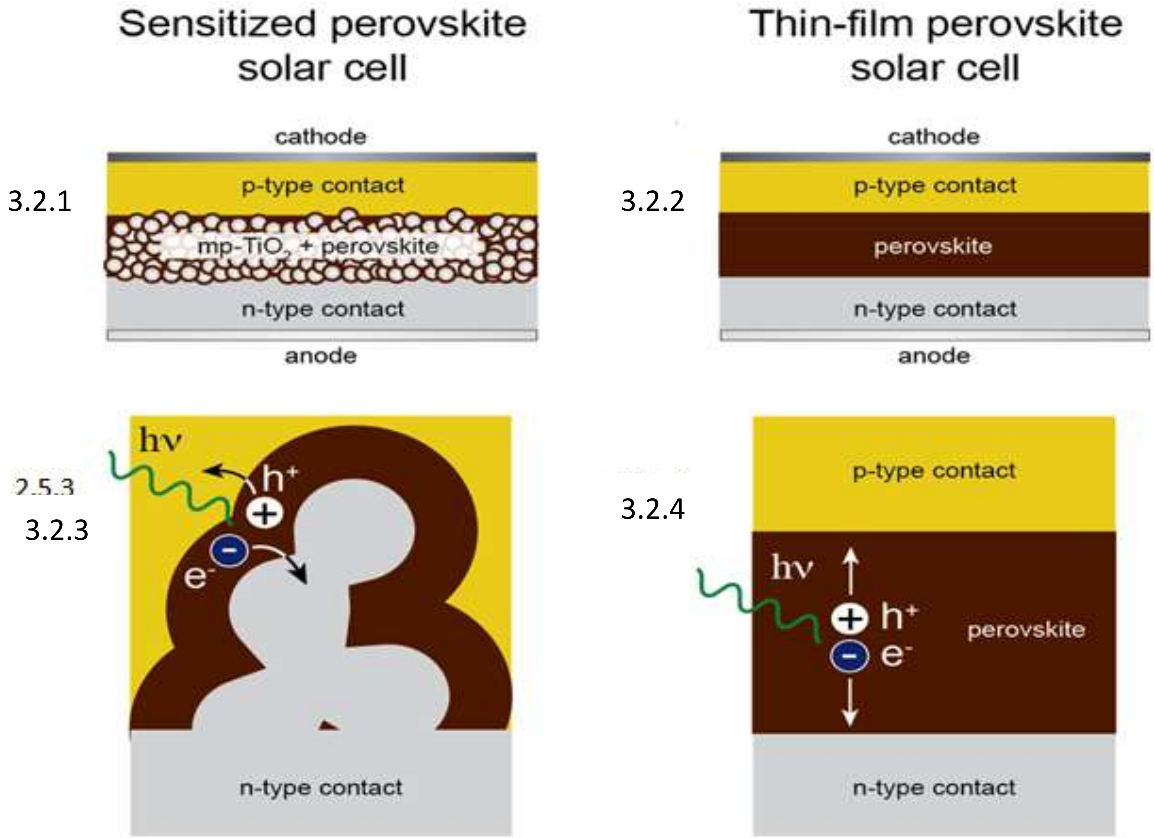


Figure 3.2.1 and Figure 3.2.2: Schematic of a sensitized perovskite and thin film perovskite
Figure 3.2.3 and Figure 3.2.4: Charge generation and extraction in sensitized and thin film architecture

## 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 eassy 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.

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