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Synthesizing and characterization of Perovskite solar cells from recycled car batteries

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ABSTRACT

Recently Perovskite solar cells (PSCs) have been higher efficiency compare to polymer solar cell from 9.65 % to 20.1 %. But it does not having stability on the outdoor application under different atmosphere conditions due to chemical stability. so that this paper focused the stability improvement of Perovskites of Morphological Structure by using Metallurgical Microscope Instrument, and the characterization of DRS in Absorbance mode and Transmittance mode, Transform Infrared Spectroscopy at the Chennai atmosphere temperature. The characterization of DRS in Absorbance mode, found that 2% increase in the absorbance property of the material after annealing and band gap as to be 2.31 eV. Transmittance mode 7.68% decreases after annealing when compared to before annealing due to improved mechanical properties. The characterization of Fourier Transform Infrared Spectroscopy (FTIR) shown that Transmittance 6.5% percentage increases after annealing when compare to before annealing due to transmission of the electrons increases.

KEY WORDS: Organic solar cells, efficiency model, Absorbance, transmittance.

1. INTRODUCTION

The Global environmental concern and quick depleting the fossil fuels increasing demand for these energies results in a rise within the utilization of renewable energy. It provides a renewable energy and free from environmental impact. Solar power is principally supported the electrical phenomenon impact. The electrical phenomenon impact is that the creation of voltage or electrical phenomenon during a material upon exposure to light-weight. During this paper targeted on utilization of lead-acid batteries in to star panels. Utilization of lead acid batteries is eco-friendly and might be simply recycled to a cloth called 'PEROVSKITE'. Perovskite material could be a hybrid organic-inorganic lead material which might be utilized in a solar array. It's super physical phenomenon, charge ordering, magneto electric machine resistance, high thermo power etc. it Apply on high ionic physical phenomenon, super physical phenomenon and its low value in comparison to semiconductor materials. Perovskite will absorb materials like methyl group ammonia or formamidinium Lead salt area unit extraordinarily low cost to supply and easy to manufacture.

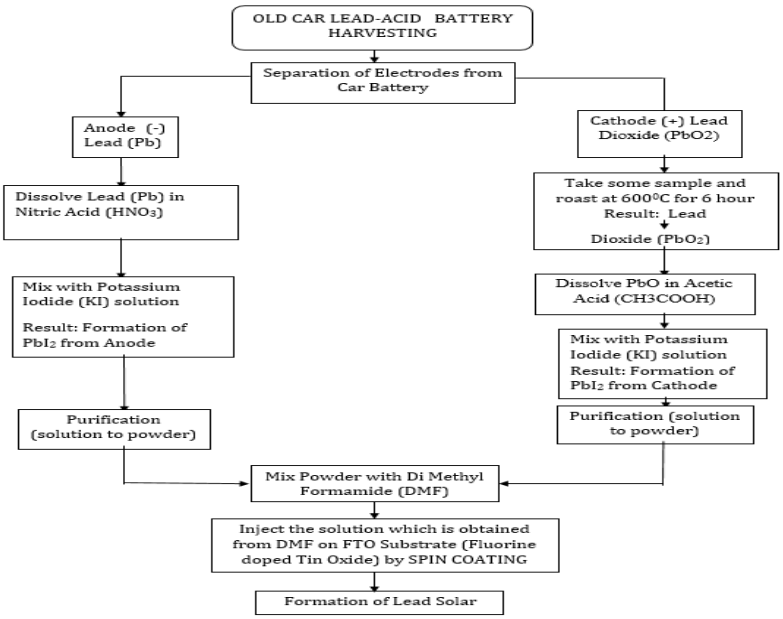

Fig.1. Perovskites flowchart

2. EXPERIMENTAL PROCEDURE

First disconnect the car battery with metal cutter. The acid electrolyte was poured out and carefully collected, and the electrodes as well as the inner wall of car battery were rinsed several times by clean water. The electrolyte contains concentrated sulfuric acid (H_2SO_4).The obtained car battery was dried in the ambient condition for 3 days. The dry car battery was disassembled from the top lid and then sawed from the sides to extract the electrode panels. After disassembling, the lead-derived materials were scratched off i.e. Lead (anode) and Lead Dioxide (cathode)

from the current collectors separately, and washed with dilute HCl (Hydrochloric Acid) and clean water sequentially. The collected materials were ground into powders for further synthesis. Lead Dioxide (PbO_2) is to be convert into lead oxide (PbO) by roasting it at 600^OC for 5 hours by placing lead Dioxide (PbO_2) in a Muffle furnace by using Ceramic Crucible. After heating Lead Dioxide at 600^OC for 5 hours it has to be cooled at room temperature. The color of the powder was changes from dark brown to yellow color. Lead and lead oxide crystals are to pulverize into a fine powder by using ball milling. A ball mill works on the principle of impact size reduction is done by impact as the balls drop from near the top of the shell. Small steel balls are used in this process to pulverize the material. The material is to be pulverizing for 30 minutes at 300 rpm in ball milling process steel balls are used in such a way that 10 grams of balls are used for 1 gram of material. Preparation of Lead Iodide from Lead Acetate, dissolve 3gms of PbO (Lead Oxide) in 5 ml of Acetic Acid. Preparation of Lead Iodide from Lead Nitrate, dissolve 3 gm of Pb (Lead) in 5 ml of Nitric Acid by constant stirring in a magnetic stirrer then Dissolve 10 ml of potassium iodide, Potassium iodide is act as a catalyst for to increase the rate of reaction. Stirring the solutions for 30 minutes at 500 rpm by using magnetic stirrer. Leaving the solution in aerobic condition for 1 day then purify the solution by using centrifuge machine, The solution has to be filled in a centrifuge tubes then add Deionized water to the solution then centrifuge the solution at 5000 rpm for 5 minutes, repeat the procedure for 3 times for to remove the acidic concentration completely, due to density variation the precipitate will settle down then the acidic concentration has to be removed.

After centrifuging the solution, the solution has to be dried in aerobic condition during the entire procedure the solution has to be placed in a fume hood or fume cupboard. A fume hood or fume cupboard is a type of local ventilation device that is designed to limit exposure to hazardous or toxic fumes, vapors or dusts. Lead Iodide Perovskite material is coated on the FTO glass substrate by using Spin Coater. Before using of FTO glass substrate, FTO glass has to be cleaned with IPA (Isopropyl Alcohol) by dipping FTO glass in IPA (Isopropyl Alcohol) for 30 minutes. After FTO glasses cleaned with IPA solution then FTO glasses are cleaned with ultrasonicator. Lead iodide powder is then mixed with DMF solution for to form a Perovskite material. A 2ml of DMF is added into a 924mg of lead iodide. The solution is to be kept at 80ºC under constant stirring by using magnetic stirrer. Fill it in ink filler and inject on the FTO plates during Spin Coating process. The substrates are then rotated at 2000 rpm for 1 minute in order to spread the coating material by centrifugal force. Now an FTO substrate plate is annealed at a temperature of 90ºC and then dipping the two substrates i.e. before and after annealing in methyl ammonium iodide for making of Lead Solar Cell.

Negative plate reaction: $Pb\,(s) + HSO_4^-\,(aq) \rightarrow PbSO_4\,(s) + H^+\,(aq) + 2e^-$

Positive plate reaction: $PbO_2\,(s) + HSO_4^-\,(aq) + 3H^+\,(aq) + 2e^- \rightarrow PbSO_4\,(s) + 2H_2O\,(l)$

The total reaction can be written as

$$Pb\,(s) + PbO_2\,(s) + 2H_2SO_4\,(aq) \rightarrow 2PbSO_4\,(s) + 2H_2O\,(l)$$

$$PbO + 2CH_3COOH \longrightarrow Pb(CH_3COO)_2 + H_20$$

Lead Oxide Acetic Acid Lead Acetate

$$Pb(CH_3COO)_2 + 2KI \longrightarrow PbI_2 + 2KCH_3COO$$

Lead Acetate Potassium Iodide Lead Iodide Potassium Acetate

Characterization of Perovskite material is done by the following methods

a) Morphological Structure by using Metallurgical Microscope Instrument.
b) Diffuse Reflectance Spectroscopy (DRS).
c) Fourier transforms Infrared spectroscopy (FTIR).

3. RESULT AND DISCUSSION

Morphological Structure by using Metallurgical Microscope Instrument: Morphology is the identification, analysis, and description of the structure of a given material. The purposes of studying morphology have the internal structure of the material and the segmentation.

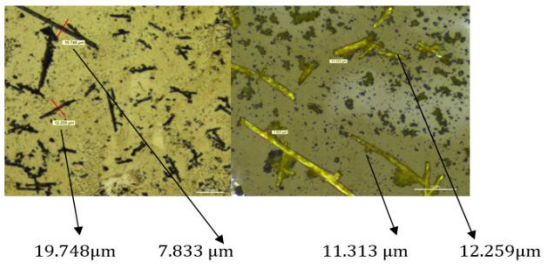

Figure.2. Before and after Annealing

From the morphological images of metallurgical microscope found that structure of the Lead Iodide material on FTO substrate plates shows identical morphological structures after annealing. This picture was shown the difference between the before annealing and after annealing. Before annealing the lead iodide material size was

19.748µm and 7.833µm. The surface micro structure was irregularly. After annealing the lead iodide material size was 11.313 µm and 12.259 µm. The surface micro structure was regular due to material porosity properties improved.

Material Characterization of absorbance Vs wavelength: This graph was shown the relation between the wavelength Vs absorbance. After annealing of PbI_2 absorbance was 0.7 a.u but before annealing of PbI_2 absorbance was 0.3 a.u. As a result, the absorbance has more after annealing when compared to before annealing, after annealing of the lead iodide the absorbance of the material increases by 2 percentages when compare to before annealing due to material porosity properties improved. The 400nm wavelength gave before annealing absorbance 0.2726 after annealing absorbance 0.6768 and difference was 0.4042.

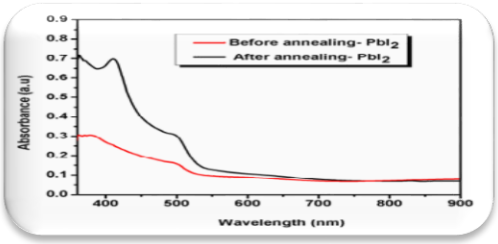

Figure.3. Characterization of absorbance Vs wavelength

Material Characterization of transmittance Vs wavelength: A graph shows the relation between transmittance percentage and wavelength, the black line shows Transmittance on after annealing of the material and the red line shows the Transmittance before annealing of the material. As a result, the transmittance percentage decreases after annealing when compared to before annealing. Because of the materials porosity improved. The Transmittance percentage decreases after annealing by 7.68% when compared to before annealing. The 400nm wavelength gave before annealing transmittance 26.52 after annealing transmittance 17.05 difference was 9.47.

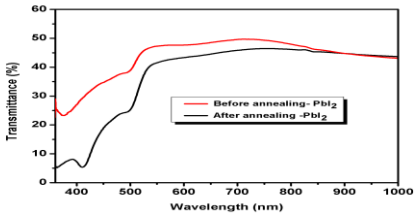

Figure.4. Characterization of transmittance Vs wavelength

Material Characterization of Band gap energy vs electron volt: The band gap could be a major issue deciding the electrical conduction of a solid. Smaller band gaps square measure semiconductors, whereas conductors either have very little band gaps or none, as a result of the valence and physical phenomenon bands overlap. Smaller band gaps area unit usually semiconductors whereas the semiconducting material has band gap of 2-4 electron volt. Band gap energy Vs electron volt graph shown the band gap a pair 2.31 electron volt, when it hardening. As a result, it will conclude that the Perovskite material has wonderful visible radiation absorption material.

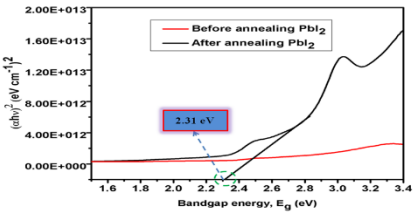

Figure.5. Characterization of Band gap energy vs electron volt

Material Characterization of Wave number vs transmittance: This graph shown between Transmittance% vs wave number ($cm^{-}1$), the red line shows Transmittance percentage after annealing and the black line shows Transmittance percentage before annealing. The 500nm wave number gave before annealing transmittance 124 after annealing transmittance 270 and difference was 146. After annealing PbI_2 gave better transmittance compare to before annealing process due to electron band gab 2.31 eV and material porosity.

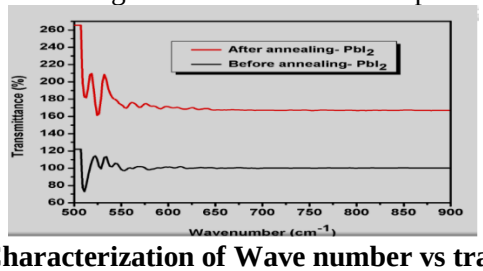

Figure.6. Characterization of Wave number vs transmittance

4. CONCLUSION

Before annealing the lead iodide material size was 19.748 µm and 7.833 µm. The surface micro structure was irregularly. After annealing the lead iodide material size was 11.313 µm and 12.259 µm. The surface micro structure was regular due to material porosity properties improved. The absorbance has more after annealing when compared to before annealing, after annealing of the lead iodide the absorbance of the material increases by 2 percentages when compare to before annealing due to material porosity properties improved. The Transmittance percentage decreases after annealing by 7.68% when compared to before annealing. Band gap energy Vs electron volt graph shown the band gap a pair 2.31 electron volt, when it hardening. As a result, it will conclude that the Perovskite material has wonderful visible radiation absorption material. From the experiment result the 500nm wave number gave before annealing transmittance 124 after annealing transmittance 270 and difference was 146. After annealing PbI2 gave better transmittance compare to before annealing process due to electron band gab 2.31 eV and material porosity.

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