Oral presentations for Session 3.3.6 | Thursday, 27 October | Room 3912, 3913

Session Chair:
Seigo ITO (University of Hyogo, Japan)

3.3.6a (16:00 - 16:15)
Dr SM Iftiquar
Sungkyunkwan University, South

High Efficiency Multijunction Solar Cell with a Methyl-Ammonium Lead Halide Perovskite Sub-Cell

SM. IFTIQUAR[1], J. YI[1]
[1] Sungkyunkwan University, South Korea

Abstract
Methyl ammonium lead halide (CH3NH3PbI3) perovskite material has been found to be one of the most promising materials for high efficiency solar cells. Its recent application as optical absorber layer in a solar cell and a phenomenal rise of reported efficiency has attracted attention to many experimental and theoretical investigations, although this perovskite material and devices have their own limitations like rapid degradation, hysteresis, possible health hazard etc. Our theoretical investigation is of a tandem structure of a solar cell consisting of the perovskite top cell and silicon heterojunction bottom cell. In this, the thickness of the perovskite layer was varied from 50 nm to 400 nm. We used an ordinary heterojunction Si solar cell of thickness 500 micro-meters. Our investigation shows that a very high device efficiency can be achieved with this type of tandem cell structure where the efficiency can be higher than 26% or more.

3.3.6b (16:15 - 16:30)
Mr Biplab Ghosh
Nanyang Technological University, Singapore

Tuning Intrinsic Defects In Bismuth-Based Perovskite For Photovoltaics

B. GHOSH[1], H. K. MALMUDI[2], N. MATHEWS[1] et al.
[1] Nanyang Technological University, Singapore
[2] Australian National University, Australia

Abstract
Inorganic-organic lead perovskite materials have been emerged as one of the most promising class of materials for solar cell absorber in recent years. However, toxicity and atmospheric stability remain major challenges in large scale development of these materials for solar cell applications. Replacement of lead with suitable less toxic cations serves as an alternative solution for viable commercialization of these materials. This study focuses on the exploration of one of the key compounds of bismuth family, Cs3Bi2I9 for the application in PV technology as light absorber materials. The compound exhibits excellent atmospheric stability and nearly zero toxicity and could be a possible for replacement of lead-based perovskites. Preliminary studies on PV devices suggest that the PV performance of this material is limited by poor photocurrent density which may be due to presence of defects. First principle studies were carried out to further characterize the defect properties and possible remedies.

Biography
Second year PhD student at ERIAN and Interdisciplinary Graduate Studies (Nanyang Technological University) under the supervision of Prof. N. Mathews. Completed Masters' from AcSIR, India and bachelor's studies in Metallurgy and Materials engineering from Bengal Engineering and Science University (BESU), India. Current research interests includes optoelectronic properties of perovskite materials and its applications as well as development of novel materials for PV applications.

Oral presentations for Session 3.3.6 | Thursday, 27 October | Room 3912, 3913

3.3.6c (16:30 - 16:45)
Ms Eunchong Kim
Chonbuk National University, South

In-depth Study On The Solvent Engineering For High-Performance Perovskite Solar Cells

E. KIM[1], M. J. CHOI[1], S. M. KWON[1] et al.
[1] Chonbuk National University, South Korea

Abstract
In recent years, the perovskite solar cells have been getting a lot of attention due to their higher power conversion efficiency (up to 20%), solution processability, and low manufacturing cost. The perovskite solar cells are generally fabricated by spin-coating process, which is one of the simplest and fastest thin film manufacturing process. However, it is difficult to form uniformly a perovskite thin film. Because the perovskite materials are consisted metal cations and halogen anions with a different solubility and crystal growth rate. The film morphology of the perovskite solar cell is an important factor to determine the device performance. In this work, we tried to form a uniform and dense perovskite thin film using various polar solvent to control solubility and crystal growth rate, and analyzed the surface morphology, electrical properties, and correlation with the photovoltaic parameters. As a result, we demonstrated high-performance perovskite solar cells by solvent engineering.

3.3.6d (16:45 - 17:00)
Mr Jia Haur Lew
Nanyang Technological University, Singapore

Characterization Of TiO2 Blocking Layer In Perovskite Solar Cells

A. PRIYADARSHI[1], J. H. LEW[2], H. X. TAN[2] et al.
[1] Energy Research Institute at NTU (ERI@N), Singapore
[2] Nanyang Technological University, Singapore

Abstract
Perovskite solar cell performances have improved significantly over the past 5 years. Despite high efficiencies exceeding 20% in lab scale devices, one main issue hindering the realization of large perovskite modules is the quality of the compact TiO2 layer over large areas. Screen printing is a cost effective and reproducible process for upscaling of perovskite solar cells. This paper aims to study the effects of hydrolysis process of TiCl4 in improving the quality of compact layer film obtained by screen printing. Characterization methods used includes 4 point probe resistance testing, cyclic voltammetry and differential pulse voltammetry, and Atomic Force Microscopy. Dark current testing and solar simulation measures the effectiveness of the compact layer in actual devices. Best results come from a combination of pre and post TiCl4 treatment of the printed film, which has a good interfacial contact with FTO and also a low RMS value that suggests little defects.

Biography
Lew Jia Haur is a project officer at ERI@N. Prior to his job, he was a student in Nanyang Technological University studying Materials Science and Engineering, where he graduated with an honors degree in 2015. He is mainly focusing on scale-up efforts in perovskite solar cells with carbon based electrode, achieving more than 10% efficiency in a 70cm2 module.

Oral presentations for Session 3.3.6 | Thursday, 27 October | Room 3912, 3913

3.3.6e (17:00 – 17:15)
Dr Natalia Yantara
Nanyang Technological University, Singapore

Evaluating The Advantages Of Excess PbI2 On Perovskite Film Deposited Via One Pot Solution Method
N. YANTARA[1], N. MATHEWS[1], S. MHAISALKAR[1]
[1] Nanyang Technological University, Singapore

Abstract
The effect of non-stoichiometry precursor solution, particularly excess PbI2, in the CH3NH3PbI3 film were scrutinized in one pot solution process to circumvent additional processing that could mask the impacts. Bulk properties of CH3NH3PbI3 film deposited from various excess PbI2 precursors were examined from morphological, optical, and electrical point of view. Excess PbI2 in precursor solution enhances the surface coverage of CH3NH3PbI3 film on top of mesoporous TiO2. Comparable bandgap, photoluminescence peak, grain size, and bulk recombination rates were observed for CH3NH3PbI3 films regardless of the existence of excess PbI2. Efficiency improvement were observed when 5% excess PbI2 were added to the precursor solutions due to enhancement on the CH3NH3PbI3 coverage, charge injection, and charge collection which give rise to higher photo-current.

Biography
Dr. Natalia Yantara is currently a research fellow in Energy Research Institute @ NTU. Her research interest includes the application of organic-inorganic metal halide perovskite material for optoelectronic applications.

3.3.6f (17:15 – 17:30)
Dr Herlina Arianita Dewi
Energy Research Institute at NTU (ERI@N), Singapore

Bi-facial Semi-Transparent Perovskite Solar Cells for Building Integrated Photovoltaics
H. A. DEWI[1], F. SUHAIMI[1], N. MATHEWS[1]
[1] Energy Research Institute at NTU (ERI@N), Singapore

Abstract
The gaining interest in perovskite-based building integrated photovoltaics (BIPV) has resulted in many efforts to demonstrate the application of semi-transparent perovskite into glass-to-glass modules, which can be extended into the glass façade of a building. In this work, the first step taken was to integrate transparent conducting electrodes (TCE) to the perovskite solar cell to improve the device transparency. Two design approaches, Top-down and Bottom-up, were taken where each had varying integration method (mechanical lamination vs. sequential layer deposition) and TCE used in the architecture (TCE fabric vs. sputtered ITO). Both approaches had comparable device efficiencies to devices with the typical gold back electrode. However, the Bottom-up approach has the higher device efficiency (13.5%) and better bi-facial properties, attributed to lower parasitic absorbance. An inverted device architecture approach was also explored to improve the overall transparency and bi-facial feature but further process optimization is still needed for better device performance.

Biography
Herlina Arianita Dewi received her Ph.D. from NTU in 2014. Currently she is working as a research fellow in Energy Research Institute @NTU (ERI@N) Singapore. Her main research interest is focused on organometallic halide perovskites for photovoltaic applications.