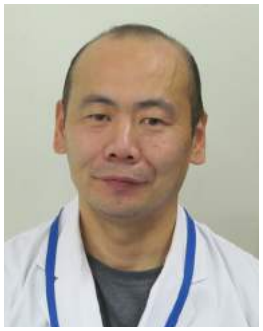
Oral presentations for Session 3.3.5 | Thursday, 27 October | Room 3912 / 3913

Session Chair:
Satoshi UCHIDA (The University of Tokyo, Japan)
Fabrizio GIORDANO (EPFL, Switzerland)



3.3.5a Invited Talk (14:00 - 14:15)
Prof Seigo Ito
University of Hyogo, Japan

Stability of Perovskite Solar Cells against Light and Heat

S. ITO[1]
[1] University of Hyogo, Japan

Abstract
Organic-inorganic hybrid perovskite (CH3NH3PbI3) solar cells have been studied intensively for new energy resource of our future society, due to the high conversion efficiency. However, the CH3NH3PbI3 perovskite is quite unstable material. In this presentation, the efforts to improve and understand the stability issue of perovskite solar cells will be summarized. Specially, results of thermal stabile perovskite solar cells at 100 °C will be presented.

Biography
Seigo Ito received his Ph.D. from the University of Tokyo (Japan) at 2000, with a thesis that was the first to discuss Grätzel-type dye-sensitized solar cells in Japan. He worked in the Laboratory of Professor Shozo Yanagida (Osaka University, Japan) for two years, and in the Laboratory of Professor Michael Grätzel, at the Swiss federal Institute of Technology (EPFL) in Lausanne as a postdoctoral scientist for over three years, where his efforts focused on the progress of high-efficiency dye-sensitized solar cells. He is currently professor at University of Hyogo from 2007, making new printable cost-effective solar cells, including non-vacuum-processed silicon solar cells and perovskite solar cells. He has published around 100 papers with total citation over 11,600.

3.3.5b (14:15 - 14:30)
Dr Teck Ming Koh
Nanyang Technological University, Singapore

Nanostructuring Mixed-Dimensional Perovskites: A Route Towards Tunable, Efficient Photovoltaics

T. M. KOH[1], N. MATHEWS[1], S. MHAISALKAR[1]
[1] Nanyang Technological University, Singapore

Abstract
Organic-inorganic halide perovskite solar cells attract a lot of attention due to the high power conversion efficiencies and unique properties. Despite the exciting progress in this area, the use of the most popular materials (CH3NH3PbI3 and HC(NH2)2PbI3) raise concerns regarding the stability. A commonly proposed approach involves the use of 2D perovskites, where the higher degree of flexibility in the organic cation choice allows a self-sealing effect of the material. However, these alternatives present a higher bandgap and poor charge transport, which keep the achieved power conversion efficiencies low. Here, we demonstrate high performance lower dimensionality perovskite photovoltaics with (IC2H4NH3)2(CH3NH3)n-1PbnI3n+1 based solar cells. An efficiency >9% is enabled by means of a combined improvement of optical and electrical properties. At the same time, the charge transport is improved with a nanostructured strategy, which allows an infiltration of the hole transporting material within the absorber nanostructure.

Biography
Dr. Koh Teck Ming is currently a research fellow in Energy Research Institute @ NTU. His research interest includes perovskite nanomaterials, scalable optoelectronics, charge transfer dynamics at organic-inorganic halide perovskite interfaces and multidimensional perovskites for high performance solution-processed photovoltaics and light-emitting devices.

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3.3.5c (14:30 - 14:45)
Mr Swee Sien Lim
Nanyang Technological University, Singapore

Charge Transfer from CH3NH3PbI3 to residual PbI2 in Perovskite Thin Films

S. S. LIM[1], N. YANTARA[1], J. CHUA[1] et al.
[1] Nanyang Technological University, Singapore

Abstract
The explosive growth of CH3NH3PbI3 perovskite research has pushed the efficiency of perovskite photovoltaics to a record of more than 20%. However, there are still gaps in the understanding of fundamental phenomena, in particular, the excited-state photophysics. In this study, we aim to study the effects of PbI2 in the perovskite film, which was shown to lengthen recombination lifetimes. In an attempt to determine the origins of the lengthening, ultrafast optical spectroscopy was employed to investigate the carrier dynamics in the perovskite. We found that, recombination lifetimes of the sample with 30mol% excess PbI 2 is longer, with the exception of one of the lifetime components. This particular lifetime component was attributed to the charge transfer with PbI2 phases within the perovskite. These results also serve to further our knowledge of the intrinsic photophysical processes in these perovskites.

Biography
Swee Sien received his B.S. degree in Applied Physics from NTU in 2013 and continued as a Ph.D. candidate under the supervision of A/P Tze Chien Sum. His research focuses on probing the ultrafast charge carrier dynamics in perovskite solar cells and understanding the intrinsic photophysical properties of perovskites.

3.3.5d (14:45 - 15:00)
Mr Atthaporn Ariyarit
Keio University, Japan

Study The Thickness And Crystalline Of Perovskite Solar Cell By Using Kriging Model Method

A. ARIYARIT[1], I. TAKENAKA[1], R. YOSHIKAWA[1] et al.
[1] Keio University, Japan

Abstract
Lead halide perovskite solar cells(PVSCs) have emerged as a new high efficiency solar cell with low fabrication cost, simple fabrication process and low fabrication temperature. To fabricate the high efficiency of PVSCs controlling the surface morphology and thin film thickness is important. In this study, we studied and optimized the condition between film thickness and surface morphology of perovskite surface on tin oxide (SnO2) layer by using Kriging model. We fabricated perovskite layer with 2-step method; first controlling the film thickness of thin film by changing the spin speed and second controlling the surface morphology by changing the dipping time of PbI2 in MAI solvent. Conditions for fabricating perovskite solar cell are randomly chosen by using Latin-Hyper-Cube sampling. After completing the data for experiment, we used Kriging model to observe the best condition and found that solar cell efficiency is strongly dependent on the fabrication condition.

Biography
Atthaporn Ariyarit.is a Ph.D. candidate at Keio University. He received the master degree in solid state electronics engineering from National Chiao Tung University, Taiwan. On that time, his research about metal oxide material for an a-Si solar cell. After graduated the master course, he moved to Keio University. His recently research about the structure of organic and perovskite solar cell.

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3.3.5e (15:00 - 15:15)
Mr KRishnamoorthy Thirumal
Energy Research Institute @ NTU (ERI@N), Singapore

Lead-Free Germanium Iodide Perovskites For Photovoltaic Applications

K. THIRUMAL[1]
[1] Energy Research Institute @ NTU (ERI@N), Singapore

Abstract
Computational screening based on density-functional-theory calculations reveals Ge as an element suitable for replacing Pb in halide perovskite compounds with bandgap values suitable for light harvesting. Experimentally, three AGeI3 (A=Cs, CH3NH3 or HC(NH2)2) halide perovskite materials have been synthesized. These compounds are stable till 150 degree Celcius, and have bandgaps correlated to the A-site cation size. CsGeI3-based solar cells display higher photocurrents, of about 6 mAcm-2, but are limited by poor film forming abilities and oxidising tendencies. The present results demonstrate the strong potential of combining computational screening and experimental efforts to develop lead-free halide perovskite compounds for photovoltaic applications.

Biography
I have been working on perovskite materials for optoelectronic applications. I am holding research scientist position in ERI@N and also doing part-time PhD in the school of physical and mathematical science, NTU.

3.3.5f (15:15 - 15:30)
Dr Annalisa Bruono
Energy Research Institute @ NTU (ERI@N), Singapore

Effect of HCl Additive on the Efficiency of CH3NH3PbI3 Solar Cells Fabricated Under High Relative Humidity

V. L. FERRARA[1], A. BRUNO[2], A. D. MARIA[1] et al.
[1] ENEA, ITALY
[2] Energy Research Institute @ NTU (ERI@N), Singapore

Abstract
The humidity level during the fabrication process of CH3NH3PbI3 solar cells (SCs) is a key issue for achieving high power conversion efficiency (PCE). Here we propose a method to improve the PCE of CH3NH3PbI3 SCs processed in high relative humidity (RH) environment, based on the addition of HCl as stabilizer in the precursor solution. Different concentrations of HCl have been added to the precursor in the fabrication of SCs on mesoporous TiO2 scaffold. We demonstrate a 70% PCE improvement for SCs prepared at 65% RH with respect to devices prepared without HCl. These results open a pathway for improving PCE of perovskite SCs realized in ambient conditions with good promise for future development of large area devices.

Biography
Annalisa Bruno received her B.S., M.S. and Ph.D. Degrees in Physics and Applied Physics from University of Naples Federico II, Italy, where she also worked as a post doc in the Chemical Engineering Department. After, she has been working at Imperial College London for few years, first as a Post Doctoral Research Associate, and then as Visiting Researcher. In 2011 Annalisa become Senior Staff Scientist at Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA). Since 2014 she is also a Senior Scientist at the Energy Research Institute at Nanyang Technological University (ERI@N). Her research focuses on the investigation of spectroscopic proprieties and charge generation processes in photoactive nanostructured materials through optical methods.