The Solar Energy Society

13th Photovoltaic Science, Applications & Technology

Conference C98

# PVSAT-13

Bangor University

Bangor, Wales

Wed 6th to Fri 8th April 2017

# PROGRAMME

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## EXHIBITORS

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# GUEST SPEAKERS PVSAT-13

## Principle Guest Invited Speaker

Prof Christophe Ballif is the Director of the PV laboratory at Ecole Polytechnique Fédérale de Lausanne (EPFL) and Director of PV Development at Centre Suisse d' Electronique et de Microtechnique (CSEM) in Neuchâtel. Christophe won the Becqurel Prize in 2016 for scientific, technical or managerial accomplishments in the development of solar energy

## Guest Invited Speakers

Prof Hongwei Han is based at Huazhong University of Science & Technology and Wuhan National Laboratory for Optoelectronics, China. In 2015 his group fabricated 7m$^2$ fully printable mesoscopic perovskite solar module. He will present a key-note lecture at the Sêr Solar workshop on Printed Photovoltaics.

Dr Karsten Walzer is Senior Research Scientist and Project Manager at Heliatek GmbH, a company that is commercialising the roll-to-roll production of solar cells based on organic oligomers. Karsten will talk on the success and challenges of OPV technology scale-up from the lab to industrial production.

Dr Jeff Kettle based at the School of Electronic Engineering at the University of Bangor. His research interests cover semiconductor device fabrication, characterisation and modelling. Jeff will give the host lecture and present aspects of PV research at University of Bangor.

Dr Marco Raugei is Senior Research Fellow in the Department of Mechanical Engineering and Mathematical Sciences at Oxford Brookes University and currently visiting scientist at the Centre of Life Cycle Analysis at Columbia University (USA). Marco will present his work on the Energy Return on Investment Analysis (EROI) for PV Systems.

Dr Ian Forbes is Reader in Photovoltaic in the Department of Physics and Electrical Engineering Research at Northumbria University. Ian will present the latest developments, performance and prospects for the CZTS family of solar cells.

Prof Paul Meredith is Senior Research Fellow in the School of Mathematics and Physics and director of the Centre for Organic Photonics and Electronics at The University of Queensland. He is a member of The Queensland Governments Climate Change Council and co-founder of Xerocoat Pty Ltd. Paul will present a key-note lecture at the Sêr Solar workshop on Printed Photovoltaics.

Prof Henry Snaith - invited pending conformation

# GUEST SPEAKERS PVSAT-13

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|---|---|---|
| 09:00 | Optional visit to Dinorwig pumped hydro storage power station | |
| 12:00 | Lunch | |
| 13:00 | Opening Session | Chair: Nigel Mason, PV Consulting Ltd |

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|---|---|---|
| Welcome | Pro VC<br>*Bangor University* | Pro VC welcome to Bangor University |
| | Nigel Mason<br>*PV Consulting* | Conference chair welcome |
| | Alex Cole<br>*Centre for Process Innovation* | Programme chair welcome |
| Invited | Jeff Kettle<br>*Bangor University* | Stability of Organic PVs |
| Invited | Marco Raugei<br>*Oxford Brookes University* | Net Energy Analysis of Photovoltaics: potential, limits and suggestions for improvement |

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| 14:30 | Poster Session A | Chair: Ralph Gottschalg, Loughborough University |
| 15:30 | Coffee break | |
| 16:00 | Session 1 | Chair: Nicola Pearsall, Northumbria University |

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| Invited | Karsten Walzer<br>Heliatek GmbH | Organic solar films: From the lab to vacuum roll-to-roll manufacturing for building-integrated photovoltaics |
| Contributory | Simone Meroni<br>Swansea University | Novel deposition method to print binder-free inks on large scale perovskite solar cell modules |
| | Michael Owen-Belini<br>Loughborough University | Thermo-mechanical stresses of Silicon Photovoltaic Modules |
| | Silvia Mariotti<br>Liverpool University | Reversible water catalysed CsPbI2Br perovskite phase change and device performances |
| | Exhibitor | Exhibitor Presentations |

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|---|---|---|
| 17:15 | Short break | |
| 17:30 | Session 2 | Chair: Jeff Kettle, Bangor University |

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| Contributory | Tom Baines<br>Liverpool University | Development of Cu-free back contact structures for CdTe substrate cells |
| | Luke Wright<br>Loughborough University | Fabrication of CZTS thin films via ultrasonic spray deposition |
| | Souray Khanna<br>Exeter University | Optimization of PV-PCM systems for South-West UK climate |
| | James McGettrick<br>Swansea University | Understanding the Photoelectron Spectroscopy of Perovskites for Photovoltaics |
| | Liyang Yue<br>Bangor University | Light absorption in perovskite solar cell: Fundamentals and plasmonic enhancement of infrared band absorption |

18:30 Time to check-in at your accommodation

19:30 Reception Drinks at Bangor University followed by dinner

09:00 Session 3 Chair: Trystan Watson, Swansea University

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|---|---|---|
| Invited | Ian Forbes<br>Northumbria University | tbd |
| Contributory | Matthew Carnie<br>Swansea University | Perovskite-silicon tandem cells utilizing a semitransparent silver nanowire composite electrode |
| | Laurie Phillips<br>University of Liverpool | CuSCN interlayer for high efficiency CdTe solar cells with improved back-contacts |
| | Stuart Irvine | New mechanism in proton irradiated CdTe solar cells revealed by SCAPS modelling |
| | Husyira Alhusna<br>Loughborough University | Influence of Spectral Variations on Photovoltaic Module Energy Rating |

10:30 Coffee Break

11:00 Session 4 Chair: Alex Cole, Centre for Process Innovation

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| Contributory | Dan lamb<br>Swansea University | First Flight Test of a Thin Film Cadmium Telluride Solar Cell on Cover Glass in Space |
| | Steve Ransome<br>SCRL | Optimum Use of The Loss Factors Model (LFM) for Improved PV Performance Modelling |
| | John Hodgkinson<br>University of Salford | Highly Effective TiO2-x Electron Transport Layers via Atmospheric Pressure Plasma Enhanced CVD |
| | Katherine Hooper<br>Swansea University | Characterisation and optimisation of processing time for perovskite solar cells |
| | Chris Kershaw<br>Bangor University | Understanding and controlling electron transfer between sensitizer and electrolyte |

12:15 Lunch

13:15 Poster Session B Chair: Ian Forbes, Northumbria University

14:15 Session 5 Chair: Dame Mary Archer, UK-ISES

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| Invited | Henry Snaith<br>Oxford University | tbd |
| Contributory | Phoebe Pearce<br>Imperial College London | SiGeSn as a 1.0eV component sub-cell in III-V multi-junction solar cells |
| | Petar Igic<br>Seansea University | Advanced Magnetic Sensors Dedicated to Gavanic Current Monitoring of Power Devices in PV Inverters |
| | Rolf Crook<br>University of Leeds | Impact of stratospheric aerosol geoengineering on PV and CPV output |

15:30 Coffee Break

16:00 Session 6 Chair: Stuart Irvine, Swansea University

Sêr Solar Symposium – Printed Photovoltaics

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| Invited | Hongwei Han<br>Huazhang University | Stable fully printable mesoscopic perovskite solar cells |
| | Paul Meredith<br>University of Queensland | Scaling Physics of Thin Film Solar Cells |

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| Contributory | Trystan Watson<br>Swansea University | Designing the fabrication route for perovskite solar cells: From spin-coating to slot die |
| | James Bishop<br>Sheffield University | Spray-cast multilayer perovskite solar cells with an active-area of 1.5cm2 |
| | Tba<br>Oxford University | tba |

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| 18:30 | Buses leave for Anglesea |
| 19:00 | Reception Chateau Rhianfa |
| 20:00 | Gala Dinner Chateau Rhianfa |
| 23:00 | Buses depart for return journey |

External view of the Chateau Rhianfa

Interior of the Chateau Rhianfa

09:00 Session 7 Chair: Rolf Crook, Leeds University

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|---|---|---|
| Contributory | Martin Bliss<br>Loughborough University | Uncertainty Contributions in Photocurrent Linearity Measurements of PV Devices using a Flash Solar Simulator |
| | PJ Yates<br>University of Liverpool | Antimony Selenide – Microstructure and Photovoltaic Devices |
| | Xinya Xu<br>Northumbria University | Flexible Cu2ZnSn(S,Se)4 solar cells made from nanoparticle inks |
| | Elana Koubli<br>Loughborough University | Remote monitoring and failure detection for distributed small-scale PV systems |
| | Joel Troughton<br>Swansea University | Very high humidity fabrication of planar perovskite solar cells and modules |
| | Arunima Sethi<br>Trinity College Dublin | Synthesis of single crystalline Au and Ag nanorods for plasmonic luminescent devices in PV application |

10:30 Coffee Break

11:00 Session8 Chair: Steve Ransome, SRCL

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|---|---|---|
| Principal Invited | Christophe Ballif<br>CSEM, EPFL | On sea, in the air and on land: when will everything become solar? |
| Contributory | Diane Palmer<br>Loughborough University | Satellite or Ground-based Irradiation Data: Which is closer to reality? |
| | Phoebe Pearce<br>Imperial College London | Agent-based modelling of the effect of government policy on the adoption of domestic photovoltaic systems in Great Britain |
| | Giray Kartopu<br>Swansea University | Development of ZnO/CdS/CdTe core-shell nanorod-based solar cells with an extremely thin absorber |
| | Ross Hatton<br>University of Warwick | Enhanced Efficiency and Stability in Tin Perovskite Photovoltaics |

13:00 Closing Remarks

13:15 Lunch

14:00 Conference Close

Poster Session A: Wednesday 6th April 13:30 – 14:30 Chair: Ralph Gottschalg, Loughborough Uni

| Poster Ref. No | Paper Title | Authors | Affiliation |
|---|---|---|---|
| **D1-1** | MOCVD of SnS with large grains and stoichiometry control for thin film photovoltaics | Andrew J. Clayton, Stuart J. C. Irvine, Peter Siderfin and Cecile M. E. Charbonneau | Swansea University |
| **D1-2** | Degradation mechanisms of perovskite solar cells based on a triple all-printable mesoporous stack | F. De Rossi, J. Baker, K. Hooper and T.M. Watson | Swansea University |
| **D1-3** | A Novel Concentrated Photovoltaic- Phase Change Material (CPV-PCM) Water Heating System for Buildings in Hot Climate of UAE | Ahmed Hassan, Ali Shah and Hamza Alnoman | United Arab Emirates University |
| **D1-4** | A Simple Optical Setup for Current Mapping of Small Area PV Devices Using Different Sampling Strategies | G. Koutsourakis, M. Cashmore, S. R. G. Hall and R. Gottschalg | Loughborough University |
| **D1-5** | Degradation analysis of Perovskite Absorber Layers and Solar Cells using Spectral Filtration, Encapsulation and Concentrated Sunlight | Vasil Stoichkov, Dr Jeff Kettle, Dr Ashwin Ambrose, Dr Iris Visoly-Fisher and Prof Eugene Katz | Bangor University |
| **D1-6** | Accelerated weathering test study of series of different “encapsulants on steel substrate” and their potential application in building integrated PV | Sanjay Ghosh, Vasil Stoickov, Luke Haponow, Jeff Kettle, Ana L. Martínez, David Gómez and Pascal Sánchez | Bangor University |
| **D1-7** | Sr4Al14O25: Eu, Dy as a potential downconverter for crystalline-silicon solar cells | Joseph Day, S. Senthilarasu and Tapas K Mallick | University of Exeter |
| **D1-8** | The effect of annealing time and ambient pressure on the formation of Cu2ZnSnS4 (CZTS) thin films based on mixed powder precursors | Mehrnoush Mokhtarimehr, Ian Forbes and Nicola Pearsall | Northumbria University |
| **D1-9** | Water Vapour Transmission Rate of Ethylene Vinyl Acetate (EVA) Encapsulant with different Curing Levels | Jiang Zhu, Christina Ng, Daniel Montiel-Chicharro, Thomas R. Betts and Ralph Gottschalg | Loughborough University |
| **D1-10** | Outdoor degradation, performance analysis and software modelling of Organic Photovoltaics (OPVs) fixed to a building prototype | Vasil Stoichkov, Jeff Kettle, Tracy Sweet and Eugene Katz | Bangor University |
| **D1-11** | Dye sensitized Schottky barrier devices on steel | N. Ryall, R. Crook and J. Weinstein | University of Leeds |
| **D1-12** | Evaluation of Charge Carrier Lifetime of Thin Film Solar Cells using Transient Photovoltage Decay Measurements | V. Tsai, G. Koutsourakis, M. Bliss, T.R. Betts and R. Gottschalg | Loughborough University |

Poster Session A: Thursday 7th April 13:30 – 14:30 Chair: Ian Forbes, Northumbria University

| Poster Ref. No | Paper Title | Authors | Affiliation |
|---|---|---|---|
| **D2-1** | Analysis of Luminescent Solar Concentrator Performance Using a Ray Tracing Algorithm: Modelling, Optimization and Validation | M. Rafiee, S. Chandra, H. Ahmed and S. J. McCormack | Trinity College Dublin |
| **D2-2** | Crystalline silicon photovoltaic parameter calculation using the Levenberg-Marquardt method | F. Ghani, T. S. O'Donovan, M. Hofmann, and M. Zaglio | Heriot-Watt University |
| **D2-3** | Triple-Junction Concentrator Photovoltaic-Thermoelectric Hybrid Receivers: Robustness, Validation and Preliminary Reliability Studies | Matthew Rolley, Tracy Sweet, Vasil Stoichkov, Jeff Kettle and Gao Min | Cardiff University |
| **D2-4** | Influence of the S amount on the Cu2ZnSnS4 absorber on thin film solar cells | S. Mazzamuto, S. Dale, L.M. Peter, N.M. Pearsall and I. Forbes | Northumbria University |
| **D2-5** | In-situ metrology of solar cell processing and lifetime | Peter J. Holliman, Leo Furnell, Rosie Anthony, Arthur Connell, Eurig W. Jones and Christopher P. Kershaw | Bangor University |
| **D2-6** | A comparison of selenisation configurations for solution processed Cu(In,Ga)(S,Se)2 solar cells | S. Uličná, P. Arnou, C. S. Cooper, L. D. Wright, A. V. Malkov, J. M. Walls and J. W. Bowers | Loughborough University |
| **D2-7** | U-value calculation of CdTe thin film PV glazing using indoor characterization | Hameed Alrashidi, Aritra Gosh, Walid Issa, Nazmi Sellamil, Sundaram Senthilarasu, Townley Stuart and Mallick Tapas | University of Exeter |
| **D2-8** | Mixed dimensions silver nanowire thin, flexible, transparent and conducting electrodes with improved optical and physical properties | D. Kumar, V. Stoichkov, S. Ghosh, G.C. Smith and J. Kettle | Bangor University |
| **D2-9** | Spray coated zinc oxide for solar cell applications | Tiago Carneiro Gomes, Neri Alves and Jeff Kettle | Bangor University |
| **D2-10** | Large Area Deposition of CH3NH3PbI3 Films in a Single-Step Using Aerosol-Assisted Chemical Vapour Deposition | Heather M. Yates and Mohammad Afzaal | University of Salford |
| **D2-11** | Plasmon-active silver nanohole films as light-catching electrodes for organic photovoltaics | Jaemin Lee and Ross. A. Hatton | University of Warwick |
| **D2-12** | Thermal Cyclic Testing of Perovskite Photovoltaic Celle | S. Abdelbaqi, A. Hassan and A.H. Shah | United Arab Emirates University |
| **D2-13** | Process Development of Sublimated Cu-free CdTe Solar Cells | C. Potamialis, F. Lisco, B. Maniscalco, M. Togay, J. W. Bowers and J. M. Walls | Loughborough University |

# OVERVIEW PVSAT-13

| | WEDNESDAY | THURSDAY | FRIDAY |
|---|---|---|---|
| 09:00 | Dinorwig Power Station visit | Session 3 | Session 7 |
| 09:15 | | | |
| 09:30 | | | |
| 09:45 | | | |
| 10:00 | | | |
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| 10:30 | | coffee break | coffee break |
| 10:45 | | | |
| 11:00 | | Session 4 | Session 8 |
| 11:15 | | | |
| 11:30 | | | |
| 11:45 | | | |
| 12:00 | lunch | | |
| 12:15 | | lunch | |
| 12:30 | | | |
| 12:45 | | | closing remarks |
| 13:00 | Opening Session | | lunch |
| 13:15 | | Poster Session B | |
| 13:30 | | | |
| 13:45 | | | |
| 14:00 | | | CONFERENCE CLOSE |
| 14:15 | | Session 5 | |
| 14:30 | poster session A | | |
| 14:45 | | | |
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| 15:30 | coffee break | coffee break | |
| 15:45 | | | |
| 16:00 | Session 1 | Session 6 Ser Solar Printed PV | |
| 16:15 | | | |
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| 17:00 | | | |
| 17:15 | short break | | |
| 17:30 | Session 2 | | |
| 17:45 | | | |
| 18:00 | | | |
| 18:15 | | | |
| 18:30 | accommodation check-in | Buses to Chateau Rhianfa | |
| 18:45 | | | |
| 19:00 | | Reception Drinks | |
| 19:15 | | | |
| 19:30 | Reception Drinks | | |
| 19:45 | | | |
| 20:00 | Dinner | Gala Dinner | |
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| 23:00 | | Buses return to University | |
| 23:30 | | | |