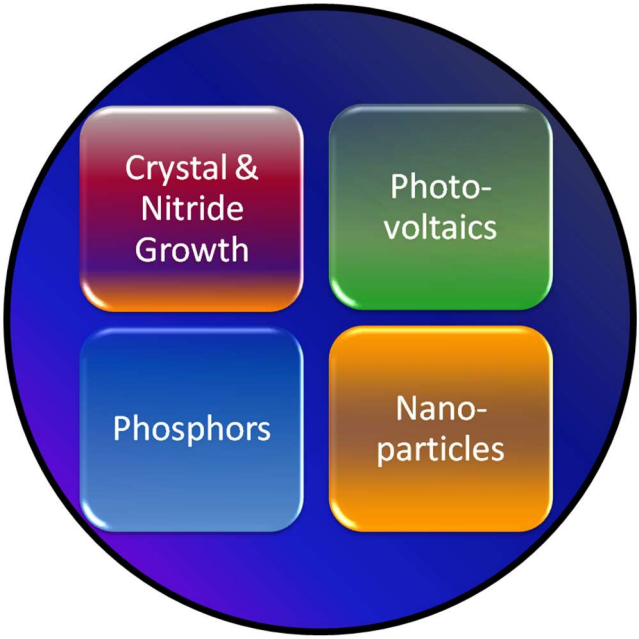
FRIEDRICH-ALEXANDER
UNIVERSITÄT
ERLANGEN-NÜRNBERG

TECHNISCHE FAKULTÄT

Department of Materials Science and Engineering

# Materials for Electronics and Energy Technology




# ANNUAL REPORT 2018/2019

Prof. Dr. Christoph J. Brabec
Prof. Dr.-Ing. Peter Wellmann
Prof. Dr. Wolfgang Heiß
PD Dr. Miroslaw Batentschuk
Prof. Dr. rer. nat. Albrecht Winnacker

Lehrstuhl Materialien der Elektronik und der Energietechnologie
Universität Erlangen-Nürnberg
Martensstraße 7
91058 Erlangen

Telefon: +49 (0)9131 85-27633
Fax: +49 (0)9131 85-28495
E-Mail: i-MEET@ww.uni-erlangen.de

Homepage: www.i-meet.ww.fau.de

# Table of Contents

# 1. Vorwort

Herzlichen Dank an unsere Studenten, Doktoranden, Mitarbeiter und Gruppenleiter für ihr überdurchschnittliches Engagement und ihre herausragenden Leistungen in 2018 & 2019. Mit der Durchführung der Next Generation Solar Energy Conference im Dezember in Nürnberg hat das i-MEET sein 10 jähriges Jubiläum gefeiert, im Beisein vieler Alumni und Kooperationspartner. An der FAU hat sich das i-MEET als einer der Forschungshochburgen etabliert, das mit einer überdurchschnittlichen Anzahl an hoch-zitierten Publikationen in höchst angesehenen Journalen, einer großen Anzahl an Doktoranden von denen viele bereits eine außerordentlich erfolgreiche Karriere durchlaufen und einer großen Anzahl an Drittmittelprojekten dazu beiträgt, dass die FAU in den nationalen und internationalen Rankings kontinuierlich aufsteigt.

Ein prägendes Ereignis war für uns alle die Überführung Teile unserer Forschungsaktivitäten in die Helmholtzgemeinschaft. Durch die Unterstützung aller Beteiligten, insbesondere der Kollegen vom Helmholtz Institut Erlangen-Nürnberg (HI-ErN), dem bayerischen Staatsministerium und dem Vorstand des Forschungszentrum Jülich ist uns ein erfolgreicher Aufbau der Abteilung Hochdurchsatzmethoden in der Photovoltaikforschung gelungen. Seit September 2018 forschen wir mit einem Team von ca 25 Personen an der Entwicklung von automatisierten und auch autonomen Laboren für die Halbleiterforschung als auch an bildgebenden Messmethoden, die gemeinsam mit Auswertealgorithmen des maschinellen Lernens die Photovoltaiktechnologie nachhaltiger, planbarer und kostengünstiger gestalten sollen.

Besonders herzlichen Dank an unser Verwaltungsteam und unsere technischen Angestellten – ohne sie wäre es nicht möglich, das i-MEET so erfolgreich zu führen. Ihnen allen, den Kooperationspartnern und Unterstützern des i-MEET danke ich für die erfolgreiche Zusammenarbeit in 2018/2019 und wünsche viel Spaß beim Lesen unseres Tätigkeitsberichts.

# Preface

Many thanks to our students, doctoral candidates, staff and group leaders for their above-average commitment and outstanding performance in 2018 & 2019. I-MEET celebrated its 10th anniversary with the holding of the Next Generation Solar Energy Conference in Nuremberg in December in the presence of many alumni and cooperation partners. I-MEET has established itself as one of FAU's research strongholds. With an above-average number of highly-cited publications in most respected journals, a large number of doctoral students, many of whom already having started extraordinarily successful academic careers, and a large number of externally funded projects, i-MEET has contributed to FAU's continuous rise in national and international rankings.

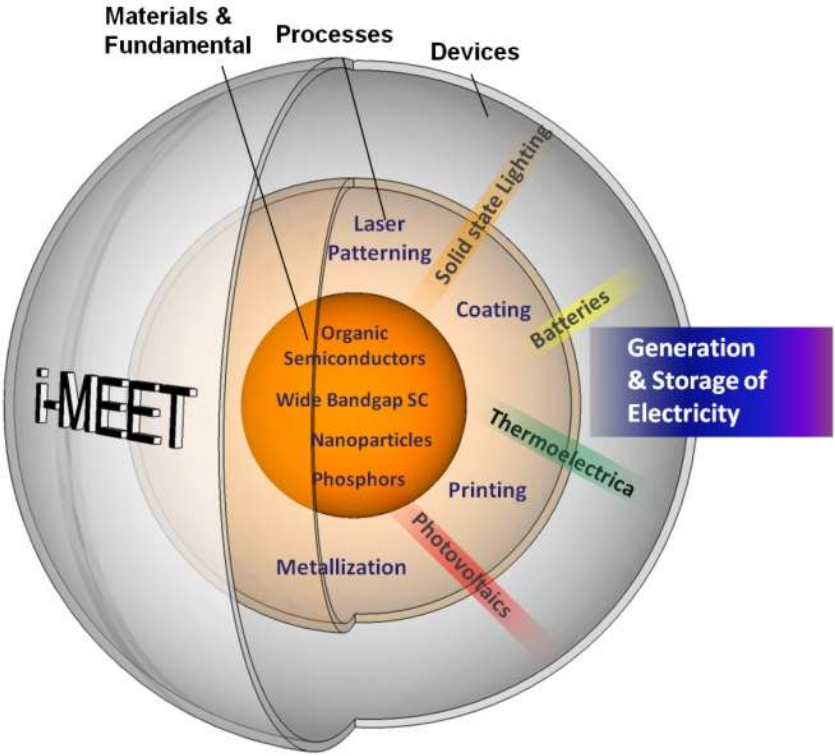
A formative event for all of us was the transfer of parts of our research activities into the Helmholtz Association. Thanks to the support of all those involved, in particular our colleagues from the Helmholtz Institute Erlangen-Nuremberg (HI-ErN), the Bavarian State Ministry for Economy and the Board of Directors of Forschungszentrum Jülich (FZJ), we were able to successfully establish the Department of High Throughput Methods in Photovoltaics Research. Since September 2018 we are researching with a team of about 25 people on the development of automated and also autonomous laboratories for semiconductor research as well as on imaging measurement methods, which, together with evaluation algorithms from machine learning, will make photovoltaic technologies more sustainable, more predictable and more cost-effective.

Special thanks to our administrative team and our technical staff - without them it would not be possible to run i-MEET so successfully. To all of you, the cooperation partners and supporters of the i-MEET I would like to thank you for the successful cooperation in 2018/2019 and I hope you enjoy reading our activity report.

Best, Christoph Brabec

Please note that some of our highlights can be found on i-MEET's youtube channel i-MEET Lab.
(https://www.youtube.com/channel/UC6RHRl5xyzL1b-lcJ6FG3PA).

Please note also our alumni network at LinkedIn (Institute i-MEET).




(Christoph J. Brabec) (Peter Wellmann) (Wolfgang Heiß)

(Albrecht Winnacker) (Miroslaw Batentschuk)

Erlangen, August 2020

# 2. Members of the Chair

## Professors

Prof. Dr.
Christoph J. Brabec
Head of the chair

Prof. Dr.-Ing.
Peter Wellmann

Prof. Dr.
Wolfgang Heiß

## Secretaries

Manuela Baumer

Elisabeth Henneberger

Ulrike Knerr

Claudia Koch

Sandra Wehlmann

## Academic administration

PD Dr. Miroslaw Batentschuk

## Professors emeritus

Prof. Dr. rer. nat.
Georg Müller

Prof. Dr. rer. nat.
Albrecht Winnacker

## Associate Professors

Prof. Dr. Dr.-Ing. habil.
Michael Thoms

## Assistant lecturer

Dr.rer.nat.
Christian Camus

Dr.
Hans-Joachim Egelhaaf

Dr.-Ing.
Ulrike Künecke

## Technical staff

Elena Epelbaum

Tina Foth

Felix Holler

Leonid Kuper

Edeltraud Völkel

Helena Waldau

Corina Winkler

Ronald Wirth

Joshua Kirsch

Dr. Anastasia Barabash

## Solar and Semiconductor Devices (SSD)

(Scientifical staff, doctoral candidates)

Prof. Dr.
Christoph J. Brabec
Group leader

PD Dr.
Miroslaw
Batentschuk
Group leader

Dr. rer. nat.
Karen Forberich
Group leader

Dr.-Ing.
Thomas Heumüller
Group leader

Dr.
Ning Li
Group leader

Dr. Dipl.-Ing.
Gebhard Matt
Group leader

Dr.
Andres Osvet
Group leader

Research of the device group is devoted to the design, simulation, processing and analysis of modern innovative semiconductors, electronic materials as well as advanced devices. Next generation concepts for electronic devices and future light harvesting techniques complete our research focus.
Development of low cost, long lived and highly efficient printed solar cells is one major vision of this research group. This includes the development of stable and efficient materials, the development of printed multilayer tandem technologies, ternary sensitization and controlling microstructure formation. Advanced organic semiconductors, p-type & n-type interface layers, printed transparent / opaque electrodes, flexible substrates and low cost barriers are further activities of this research group.
Organic semiconductors, perovskite hybrid composite semiconductors as well as colloidal quantum dots are the material fundament of our device engineering and process development activities. Further activities include low temperature processed chalcogenides and kesterites.

Amjad Ali
MSc
Doctoral candidate
i-MEET

Osbel Almora Rodríguez
MSc
Doctoral candidate
i-MEET

Klaus Burlafinger
Dipl.-Phys.
Doctoral candidate
i-MEET

Haiwei Chen
MSc
Doctoral candidate
i-MEET

Shi Chen
MEng
Doctoral candidate
i-MEET

Liudmyla Chepyga
MSc
Doctoral candidate
i-MEET

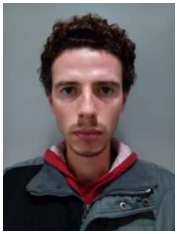
Andrej Classen
MSc
Doctoral candidate
i-MEET

Lirong Dong
MSc
Doctoral candidate
i-MEET

Dr.
Xiaoyan Du
Postdoc
i-MEET

Jack Elia
MSc
Doctoral candidate
i-MEET

Shuai Gao
MSc
Doctoral candidate
i-MEET



José Garcia Cerrillo
MEng
Doctoral candidate
i-MEET

Ening Gu
MEng
Doctoral candidate
i-MEET

Yakun He
MEng
Doctoral candidate
i-MEET

Huiying Hu
MSc
Doctoral candidate
i-MEET

DongJu Jang
MSc
Doctoral candidate
i-MEET

Simon Kahmann
MSc
Doctoral candidate
i-MEET

Violetta Kalancha
MSc
Doctoral candidate
i-MEET

André Karl
MSc
Doctoral candidate
i-MEET

Laraib Khanzada
MEng
Doctoral candidate
i-MEET

Mengqin Kong
MSc
Doctoral candidate
i-MEET

Christian Kupfer
MSc
Doctoral candidate
i-MEET

Stefan Langner
MSc
Doctoral candidate
i-MEET

Dr.
Ievgen Levchuk
Postdoc
i-MEET

Chao Liu
MSc
Doctoral candidate
i-MEET

Wei Meng
MSc
Doctoral candidate
i-MEET

J. D. Perea Ospina
MSc
Doctoral candidate
i-MEET

C.O. Ramirez Quiroz
MSc
Doctoral candidate
i-MEET

Dr.
Michael Salvador
Postdoc
i-MEET

Shreetu Shrestha
MSc
Doctoral candidate
i-MEET

Marc Steinberger
MSc
Doctoral candidate
i-MEET

Xiaofeng Tang
MSc
Doctoral candidate
i-MEET

Albert These
MSc
Doctoral candidate
i-MEET

Josua Wachsmuth
MSc
Doctoral candidate
i-MEET

Rong Wang
MSc
Doctoral candidate
i-MEET

Jonas Wortmann
MSc
Doctoral candidate
i-MEET

Chen Xie
MSc
Doctoral candidate
i-MEET

Junyi Xu
MSc
Doctoral candidate
i-MEET

Heyi Zhang
MEng
Doctoral candidate
i-MEET

Chaohong Zhang
MSc
Doctoral candidate
i-MEET

Dr.
Yicheng Zhao
Postdoc
i-MEET

## Solution-Processed-Semiconductor-Materials (SOPSEM)

(Scientifical staff, doctoral candidates)

Prof. Dr.
Wolfgang Heiß
Group leader

Solution processed semiconductor materials are synthesized as a basis for the development of electronic devices. The materials include colloidal nanocrystal quantum dots, organic pigment materials, and metal-halide perovskites. Recent achieved milestones include the use of organic pigments as electrophotocatalysts for the environmental friendly generation of hydrogen peroxide, and the clarification of galvanic exchange reactions in metal nanoparticles protected by metal-oxide shells. Largely improved infrared detecting materials have been obtained by merging the advantages of PbS nanocrystals with that of metal-halide perovskites semiconductors. As a novel type of ligands for nanocrystals, zero-dimensional perovskite clusters have been introduced by us, enabling the formation of an epitaxial ligand shell during a simple ligand exchange procedure. The epitaxial shell is proven to provide several advantages in optoelectronic devices, due to the good surface passivation, the formation of a semiconducting matrix, and the appealing electronic properties of the nanohybrid materials.

Hany Elsayed
MSc
Doctoral candidate
i-MEET

Niall Killilea
MSc
Doctoral candidate
i-MEET

Oleksandr Mashkov
MSc
Doctoral candidate
i-MEET

Dr.
Mykhailo Sytnyk
Postdoc
i-MEET

Amir YousefiAmin
MSc
Doctoral candidate
i-MEET

# Crystal Growth Lab (CGL)

(Scientifical staff, doctoral candidates)

Prof. Dr.-Ing. Peter Wellmann
Group leader

The research activities in the crystal growth lab of Prof. Dr.-Ing. Peter Wellmann at the electronic materials and energy technology (i-meet) division of the materials department (University of Erlangen-Nürnberg) are devoted to modern topics in semiconductor technology and include crystal growth, epitaxy and characterization of various electronic materials. In the current focus of research and development are materials for energy saving: (i) Silicon carbide for power electronic devices is a key player for energy saving. (ii) The CIGSSe thin film solar cell materials recently have reached a maturity that allows the realization of commercial solar panels. CZTSSe is believed to play the role of a succeeding thin film solar cell material. (iii) Printed electronic layers offer a great potential of a wide range of (opto-)electronic and photovoltaic device applications. (iv) In the field of characterization a large variety of electrical, spectroscopic and structural techniques are used which serve the better understanding of materials processing. Special emphasis is put on topographic methods. (v) In all fields service for industrial and institutional partners may be provided.

Matthias Arzig
MSc
Doctoral candidate
i-MEET

Tim Freund
MSc
HiWi
i-MEET

Manuel Kollmuss
MSc
Doctoral candidate
i-MEET

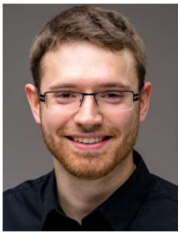
Dr. Dipl.-Ing
Ulrike Künecke
Scientifical staff
i-MEET

Saskia Schimmel
MSc
Doctoral candidate
i-MEET

Michael Schöler
MSc
Doctoral candidate
i-MEET

Philipp Schuh
MSc
Doctoral candidate
i-MEET

Matthias Schuster
MSc
Doctoral candidate
i-MEET



Johannes Steiner
MSc
Doctoral candidate
i-MEET

## Bavarian Center for Applied Energy Research

(ZAE, doctoral candidates, postdocs)

The Bavarian Center for Applied Energy Research (ZAE Bayern) is a registered, non-profit association. The association was founded in December 1991 to promote energy research as well as education, further training, consultation, information and documentation in all fields significant to energy research. The association supports a scientific research institute with divisions in Würzburg, Garching, Erlangen, Nuremberg and Hof, employing more than 200 scientists, technicians, administrative personnel and students. Since the founding of ZAE Bayern in 1991, ZAE has become a both nationally and internationally recognized research institute.

ZAE Bayern works on the interface between evidence-based fundamental and applied industrial research. Every year the institute performs a great number of projects with the industry, from SME to large groups, as well as with university and non-university research partners. The core competences of the ZAE location in Erlangen with its subsidies in Nürnberg and Hof/Arzberg are renewable energies, with a strong focus on photovoltaics. Competences in materials science, theoretical understanding, and fundamental developments are linked in a knowledge- based chain of value with i-MEET. The close cooperation between i-MEET as well as further partners from FAU allows the ZAE Bayern in Erlangen to concentrate on finding effective solutions to remove the barriers on our way towards a green, sustainable and renewable future.

Christian Berger
MSc

Dr.
Josef Bogenrieder

Iftikhar Channa
MEng

Dr.
Manuel Dalsass

Bernd Doll
MSc

Dr.
Frank Fecher

Sarmad Feroze
MSc

Johannes Hepp
MSc

Dr.
Philipp Maisch

Dipl.-Phys.
Markus Pröll

Dipl.-Phys.
Arne Riecke

Christoph Stegner
MSc

Kai Cheong Tam
MPhil

Dipl.-Ing.
Stephan Wittmann

# External doctoral candidates

Benedikt Adelmann
MSc

Hermann Bechert
MSc
Osram

Fabian Carigiet
MSc
ZHAW

Sarah Deumel
MSc
Siemens Healthineers

Rene Fischer
MSc
Siemens

A. Heinrichsdobler
MSc
Osram

Tobias Hübner
MSc
Osram

Tobias Kötter
MEng
Siemens

Montenegro Benavides
Cindy Alexandra
Dipl.-Ing
Siemens

Tobias Sauermann

Dipl.-Ing
Belectric

Philipp Schwamb

MSc
Osram

# Visitors

**09. – 16.05.2018**
**Adam Budniak** (Technion-Israel Institute of Technology, Israel)

**Sept. 2017 – Feb. 2018**
**Dr. Baobing Fan** SCUT (SCUT project)

**09. – 14.04.2018**
**Prof. Yiriy Zorenko** (Institute of Physics of Kazimierz Wielki University in Bydgoszcz, Bydgoszcz, Poland)

**18.07.2018**
**Dr. habil. Tayebeh Ameri** (Ludwig-Maximilians-University Munich Department of Chemistry)

**31.08.2018**
**Tonio Buonassisi** (MIT, USA)

**18. – 23.09.2018**
**Benjamin Sanchez-Lengeling** (Harvard, USA)

**Sept. 2018 – Mar. 2019**
**Kang An** SCUT (SCUT project)

**Sept. 2018 – Mar. 2019**
**Dr. Tack Ho Lee** UNIST (UNIST scholarship)

**Nov. 2018 – Apr. 2019**
**Dr. Jingyang Xiao** SCUT (Guangzhou "Jingying Scholarship")

**Dec. 2018 – Oct. 2019**
**Dr. Youyu Jiang** HUST (HUST project)

**Dec. 2019 – Nov. 2020**
**Dr. Li Nian**

**14-17. Jan. 2019**
**Prof. Dr. Hin-Lap Yip**

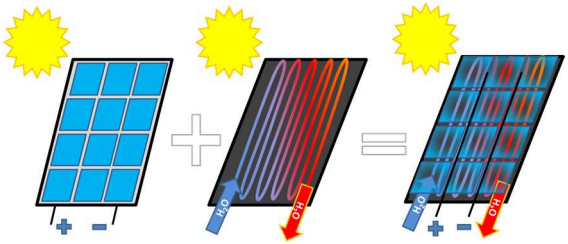
**14-17. Jan. 2019**
**Dr. Guichuan Zhang**

**25. – 28.06.2019**
**Prof. Dr. Yiriy Zorenko** (Institute of Physics of Kazimierz Wielki University in Bydgoszcz, Bydgoszcz, Poland)

**25.11.2019**
**Dr. Christos Chochos, Advent Technologies SA**

# 3. Highlights 2018-2019

## New project CESSY funded by the ZIM initiative




i-MEET has been granted a new research project called CESSY, which focuses on the development hybrid solar collectors which combine photovoltaic power generation with solar thermal hot water generation. Thereby, these devices have the potential of not only increasing the overall energy efficiency and of generating but also an economic benefit. However, nowadays these devices are usually optimized with respect to only one of the tow technologies. In CESSY, i-MEET strives, together with an SME partner, which is specialized in thermal engineering, for developing a system which is optimized with respect to both its overall energy and economic efficiency. CESSY is funded by the ZIM initiative (Zentrales Innovationsprogramm Mittelstand) of the Federal Ministry for Economic Affairs and will run throughout October 2019.

## Ning published in Energy and Environmental Science an industrial Figure of Merit allowing to comprehensively rationalize the application potential of novel donor polymers in conjunction with non-fullerene acceptors

In the manuscript “Analyzing the efficiency, stability and cost potential for fullerene-free organic photovoltaics in one Figure of Merit” Ning effectively combined the prediction of efficiencies with experimentally determined stability data to analyze and forecast the commercial potential of a NFA-based OPV product. Assuming that NFAs dominate the blend near IR absorption, the efficiency limit of OPV devices is predicted to be close to 20% and is found to be insensitive to the donor bandgap. With the excellent photo-stability observed for state-of-the-art NFA-based OPV devices, it is suggested that the corresponding customized donors with promising processing properties, excellent environmental stability and low synthesis complexity be designed as realistic material pairs for large-scale production and commercialization. Most surprising, the combination of “good old” P3HT with IDTBR was identified as one of the outstanding combinations of industrial products.

Energy & Environmental Science

ANALYSIS

View Article Online
View Journal | View Issue



Cite this: *Energy Environ. Sci.*, 2018, **11**, 1355

# Analyzing the efficiency, stability and cost potential for fullerene-free organic photovoltaics in one figure of merit†

Ning Li, [a] * Iain McCulloch [bc] and Christoph J. Brabec *[ad]

Received 15th January 2018,
Accepted 16th March 2018

DOI: 10.1039/c8ee00151k

rsc.li/ees

The power conversion efficiencies (PCEs) of solution-processed organic photovoltaic (OPV) devices continue increasing towards the 15% milestone. Recently-emerging non-fullerene acceptors (NFAs) have significantly accelerated this development. Most of the efficiency analyses performed previously are based on a fullerene acceptor without considering its contribution to the enhancement of photo-absorption and PCE. Moreover, the stability and cost potential of OPV devices are usually not discussed, which sometimes makes the efficiency prediction less representative for broad interest. In this work, we effectively combine the prediction of efficiencies with experimentally determined stability data to analyze and predict the commercial potential of a NFA-based OPV product. Assuming that NFAs dominate the blend near IR absorption, the efficiency limit of OPV devices is predicted to be close to 20% and is found to be insensitive to the donor bandgap. With the excellent photo-stability observed for state-of-the-art NFA-based OPV devices, it is suggested that the corresponding customized donors with promising processing properties, excellent environmental stability and low synthesis complexity be designed as realistic material pairs for large-scale production and commercialization.

**Broader context**

The success of a photovoltaic technology is determined by an optimal combination of its efficiency, lifetime and production cost. It is generally accepted that a module efficiency of $>10\%$ in combination with an operational lifetime of $>10$ years and a production cost of $\ll 1$ € per $W_{peak}$ is suggested for industrial production of organic solar cells (OSCs). Great progress has been made over the last few years in developing highly efficient and stable OSCs with device performances exceeding 12%. Recently-emerging non-fullerene acceptors have significantly accelerated this progress and boosted the performance of OSCs towards the 15% milestone. However, apart from the performance and stability, the production cost, especially the material cost, plays an essential role in determining the success and industrial viability of OSCs. In this analysis, we analyze step-by-step the efficiency, stability and cost potential for OSCs in one figure of merit, which allows us to directly compare the industrial viability of OSCs based on various material systems. Moreover, the analysis clearly suggests that organic semiconductors with low synthetic complexity, such as **P3HT**, would be the preferred choice for large-scale production and commercialization, if a promising and compatible acceptor is available.

## 1. Introduction

After two decades of rapid development, organic photovoltaic (OPV) technologies have reached a respectable scientific level of understanding with excellent power conversion efficiencies (PCEs) of over 13% for solution-processed lab-scale devices, approaching a tipping point for large-scale production and commercialization.[1–8] The advantages of OPV devices, such as light weight, semi-transparency, low cost and easy manufacturing on a large-scale, make OPVs a very attractive technology for non-grid connected applications.[9] To further stimulate the market growth of the OPV technology, its potential has to be analyzed in terms of efficiency, stability and cost, in particular for recently emerging non-fullerene acceptors (NFAs).

Solution-processed fullerene derivatives, such as phenyl-$C_{61}$-butyric acid methyl ester (**PCBM**), have been predominately used as acceptors in bulk-heterojunction (BHJ) organic solar cells (OSCs) since the mid-1990s, boosting the efficiency of OSCs

[a] *Institute of Materials for Electronics and Energy Technology (i-MEET), Friedrich-Alexander University Erlangen-Nürnberg, Martensstraße 7, 91058 Erlangen, Germany. E-mail: ning.li@fau.de, christoph.brabec@fau.de; Fax: +49 (0)9131-8528495; Tel: +49 (0)9131-8527634*

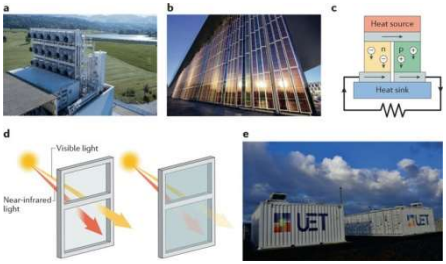
[b] *King Abdullah University of Science and Technology, KSC, Thuwal 23955-6900, Saudi Arabia*

[c] *Department of Chemistry and Centre for Plastic Electronics, Imperial College London, London SW7 2AZ, UK*

[d] *Bavarian Center for Applied Energy Research (ZAE Bayern), Immerwahrstraße 2, 91058 Erlangen, Germany*

† Electronic supplementary information (ESI) available. See DOI: 10.1039/c8ee00151k

## Daniel´s and Alan´s review “Accelerating the discovery of materials for clean energy in the era of smart automation” went online in Nature Reviews Materials




Daniel´s and Alan´s review “Accelerating the discovery of materials for clean energy in the era of smart automation” which is based on the Mission Innovation Conference in Mexico City, September 2017,just went online in Nature Reviews Materials.

The discovery and development of novel materials in the field of energy are essential to accelerate the transition to a low-carbon economy. Bringing recent technological innovations in automation, robotics and computer science together with current approaches in chemistry, materials synthesis and characterization will act as a catalyst for revolutionizing traditional research and development in both industry and academia. This perspective provides a vision for an integrated artificial intelligence approach towards autonomous materials discovery, which, in our opinion, will emerge within the next 5 to 10 years. The approach we discuss requires the integration of the following tools, which have already seen substantial development to date: high-throughput virtual screening, automated synthesis planning, automated laboratories and machine learning algorithms. In addition to reducing the time to deployment of new materials by an order of magnitude, this integrated approach is expected to lower the cost associated with the initial discovery. Thus, the price of the final products (for example, solar panels, batteries and electric vehicles) will also decrease. This in turn will enable industries and governments to meet more ambitious targets in terms of reducing greenhouse gas emissions at a faster pace.

# Accelerating the discovery of materials for clean energy in the era of smart automation

*Daniel P. Tabor, Loïc M. Roch, Semion K. Saikin, Christoph Kreisbeck, Dennis Sheberla, Joseph H. Montoya, Shyam Dwaraknath, Muratahan Aykol, Carlos Ortiz, Hermann Tribukait, Carlos Amador-Bedolla, Christoph J. Brabec, Benji Maruyama, Kristin A. Persson and Alán Aspuru-Guzik*

Abstract | The discovery and development of novel materials in the field of energy are essential to accelerate the transition to a low-carbon economy. Bringing recent technological innovations in automation, robotics and computer science together with current approaches in chemistry, materials synthesis and characterization will act as a catalyst for revolutionizing traditional research and development in both industry and academia. This Perspective provides a vision for an integrated artificial intelligence approach towards autonomous materials discovery, which, in our opinion, will emerge within the next 5 to 10 years. The approach we discuss requires the integration of the following tools, which have already seen substantial development to date: high-throughput virtual screening, automated synthesis planning, automated laboratories and machine learning algorithms. In addition to reducing the time to deployment of new materials by an order of magnitude, this integrated approach is expected to lower the cost associated with the initial discovery. Thus, the price of the final products (for example, solar panels, batteries and electric vehicles) will also decrease. This in turn will enable industries and governments to meet more ambitious targets in terms of reducing greenhouse gas emissions at a faster pace.

Advanced materials affect most, if not all, aspects of life today. They are crucial for technologies ranging from energy generation, transmission and storage to water filtration, power electronics, transportation and aerospace[1–6]. These areas all require materials that satisfy increasingly demanding performance specifications. Innovation is imperative to reach these goals and can be stimulated by the development of novel integrated artificial intelligence (AI) algorithms and robotics into fully autonomous platforms.

The timelines for materials discovery, development and deployment are long, and the process is capital intensive. Typically, new materials technologies reach the market after 10–20 years of basic and applied research[7]. Platforms that integrate AI with automated and robotized synthesis and characterization have the potential to accelerate the entire materials discovery and innovation process to reduce this time by an order of magnitude.

The transformation of the current materials discovery pipelines into the proposed integrated platforms requires commitment from key players, ranging from governments and academic research institutions to large industries and capital providers[8]. Knowledge transfer across different specialized industries represents a challenge to bring in industry and private sector players. However, this is not only a challenge but also an opportunity. As the discovery processes for advanced materials accelerate, the potential economic benefits will grow exponentially. Thus, private sector stakeholders that join these efforts early will presumably have a first-mover advantage; they will have the know-how to adjust and obtain a larger share of these growing benefits[9].

Building a multidisciplinary workforce for the discovery, production and integration of advanced materials requires efforts and leadership from academia, governments and industry[10–12]. The continuous support of research and development initiatives, such as the Materials Genome Initiative[13,14], will aid in the development and deployment of a discovery workforce that is ready for the challenges ahead. International coalitions around particular topics could advance the agenda and produce results more effectively.

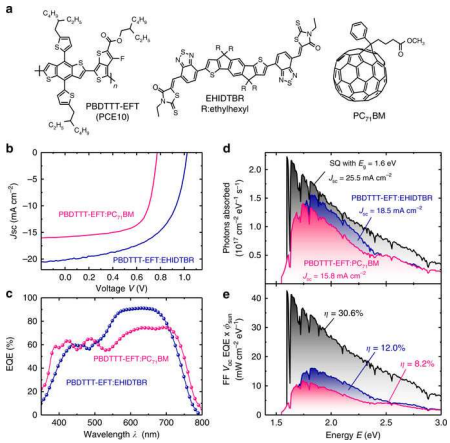
An example of such an international collaboration is Mission Innovation, a coalition of 22 countries plus the European Union that have committed to doubling their investments in clean energy innovation by 2021. Mission Innovation focuses on seven Innovation Challenges: smart grids, off-grid access to electricity, carbon capture use and sequestration, sustainable biofuels, converting sunlight into fuels, clean energy materials, and affordable heating and cooling of buildings. The focus in this Perspective is on the efforts relating to the Clean Energy Materials Innovation Challenge; however, accelerating the discovery of high-performance novel materials is important for all seven of the Innovation Challenges. In line with the Paris Agreement, adopted in December 2015, the aim is to limit the increase in the global average temperature to less than 2 °C (REF.[15]). In this context, clean energy innovations and disruptive technological breakthroughs are essential to meet the reduction targets for greenhouse gas emissions and even more ambitious targets in the near future[16]. The goal of the Clean Energy Materials Innovation Challenge is to propel materials discovery and to develop new high-performance, low-cost clean energy solutions.

In this Perspective, we provide our vision for the next generation of integrated AI approaches towards autonomous materials discovery. Bridging the gaps between independent technologies that are essential to materials discovery and incorporating them into a single platform will alleviate the clash that often happens between theory and experiment.

## Andrew & Iain published an extensive and critical review on Non-Fullerene Acceptors (NFAs) in Chemical Society Reviews


Fullerenes have formed an integral part of high performance organic solar cells over the last 20 years, however their inherent limitations in terms of synthetic flexibility, cost and stability have acted as a motivation to develop replacements; the so-called non-fullerene electron acceptors. A rapid evolution of such materials has taken place over the last few years, yielding a number of promising candidates that can exceed the device performance of fullerenes and provide opportunities to improve upon the stability and processability of organic solar cells. In this review Andrew and Iain explored the structure–property relationships of a library of non-fullerene acceptors, highlighting the important chemical modifications that have led to progress in the field and provide an outlook for future innovations in electron acceptors for use in organic photovoltaics

## Derya publishes Non-Fullerene Acceptor (NFA) – Polymer solar cells with an quantum efficiency approaching unity in Nature Communications




By designing spectrally overlapping composites of polymeric donors with non-fullerene acceptors, Derya demonstrated NFA solar cells with quantum efficiencies approaching unity. The combination of strongly absorbing donors and acceptors allowed to design composites which absorb nearly all light in a wavelength regime between 570 to 700 nm. A near to optimum microstructure arrangement between the two phases enabled conversion of the absorbed light into free carriers with a quantum efficiency close to unity, resulting in short-circuit current densities of about 20 mA $cm^{-2}$.

Chem Soc Rev

REVIEW ARTICLE

View Article Online
View Journal



Cite this: DOI: 10.1039/c7cs00892a

# Critical review of the molecular design progress in non-fullerene electron acceptors towards commercially viable organic solar cells†

Andrew Wadsworth, *[a] Maximilian Moser,[a] Adam Marks,[a] Mark S. Little,[a] Nicola Gasparini,[bc] Christoph J. Brabec,[bd] Derya Baran[c] and Iain McCulloch[ac]

Received 21st December 2017

DOI: 10.1039/c7cs00892a

rsc.li/chem-soc-rev

Fullerenes have formed an integral part of high performance organic solar cells over the last 20 years, however their inherent limitations in terms of synthetic flexibility, cost and stability have acted as a motivation to develop replacements; the so-called non-fullerene electron acceptors. A rapid evolution of such materials has taken place over the last few years, yielding a number of promising candidates that can exceed the device performance of fullerenes and provide opportunities to improve upon the stability and processability of organic solar cells. In this review we explore the structure–property relationships of a library of non-fullerene acceptors, highlighting the important chemical modifications that have led to progress in the field and provide an outlook for future innovations in electron acceptors for use in organic photovoltaics.

## 1. Introduction

Fullerene-based acceptors, such as phenyl-$C_{60}$-butyric acid methyl ester ($PC_{60}BM$), its $C_{70}$ analogue ($PC_{70}BM$) and indene-$C_{60}$ bisadduct (ICBA), have long been the dominant electron accepting materials used in bulk heterojunction solar cells; with promising results being obtained when these acceptors are used in combination with low-bandgap electron donating polymers. Despite their success, however, many problems and limitations still persist in organic solar cells that cannot be addressed without replacing this aging class of acceptors. The emergence of alternatives to fullerene-based electron acceptors has revitalized the field of organic photovoltaics (OPVs) somewhat over the past few years.

Fullerenes possess a number of advantageous properties, allowing them to produce highly efficient solar cells and their initial success in the field of organic photovoltaics. Many of the properties that have allowed fullerene acceptors to excel are derived from the 3D-conjugated cage structure inherent to these molecules. For example, the lowest unoccupied molecular orbitals (LUMOs) of the fullerene acceptors are delocalized across the entire 3D surface of the $C_{60}$ or $C_{70}$ cages, allowing efficient and isotropic electron transport.[1] This delocalisation of the molecular orbitals across the 3D fullerene cages also provides the acceptors with the ability to undergo weak $\pi$–$\pi$ interactions, such that small scale aggregation of the fullerene acceptors can occur forming nanoscale pure and mixed domains in the bulk heterojunction.[2] The formation of domains on the lengthscale of the exciton diffusion length (5–15 nm for organic semiconductor blends) is necessary for efficient exciton splitting and free charge generation in active layer blends.[3,4]

However, the same 3D cage structures are responsible for some of the most significant drawbacks of fullerene acceptors. The highly symmetric nature of the wavefunctions render the optical transitions forbidden, impeding the ability of the fullerenes to absorb photons in the UV-visible region of the solar spectrum, thereby limiting the contribution of the acceptor towards the photogenerated current of the solar cells and condemning them to rely mainly on p-type (Channel-I) excitation. $PC_{70}BM$ was designed to overcome this issue; the lower symmetry of the $C_{70}$ cages leads to a greater number of allowed optical transitions within the molecule, enhancing the ability of the acceptor to harvest photons. It must be noted that this is still dramatically lower in intensity than the absorption of the donor polymer in the UV-visible region of the solar spectrum, and thus Channel-I

[a] Department of Chemistry and Centre for Plastic Electronics, Imperial College London, London, SW7 2AZ, UK. E-mail: andrew.wadsworth11@imperial.ac.uk
[b] Institute of Materials for Electronics and Energy Technology (I-MEET), Friedrich-Alexander-University Erlangen-Nuremberg, Martensstraße 7, 91058 Erlangen, Germany
[c] Physical Sciences and Engineering Division, KAUST Solar Center (KSC), King Abdullah University of Science and Technology (KAUST), KSC Thuwal 23955-6900, Saudi Arabia
[d] Bavarian Center for Applied Energy Research (ZAE Bayern), Haberstrasse 2a, 91058 Erlangen, Germany

† Electronic supplementary information (ESI) available. See DOI: 10.1039/c7cs00892a

nature COMMUNICATIONS

ARTICLE

DOI: 10.1038/s41467-018-04502-3 OPEN

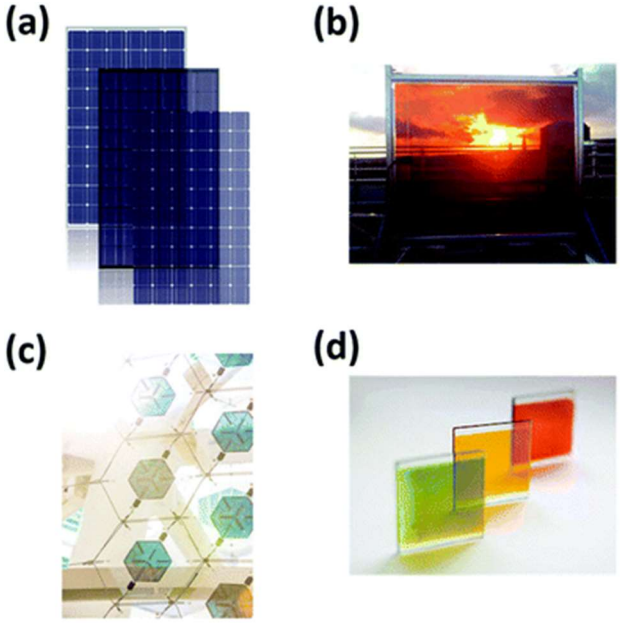
# Robust nonfullerene solar cells approaching unity external quantum efficiency enabled by suppression of geminate recombination

Derya Baran[1], Nicola Gasparini[1,2], Andrew Wadsworth[3], Ching Hong Tan[3], Nimer Wehbe[1,4], Xin Song[1], Zeinab Hamid[3], Weimin Zhang[1], Marios Neophytou[1], Thomas Kirchartz[5,6], Christoph J. Brabec[2,7], James R. Durrant[3,8] & Iain McCulloch[1,3]

Nonfullerene solar cells have increased their efficiencies up to 13%, yet quantum efficiencies are still limited to 80%. Here we report efficient nonfullerene solar cells with quantum efficiencies approaching unity. This is achieved with overlapping absorption bands of donor and acceptor that increases the photon absorption strength in the range from about 570 to 700 nm, thus, almost all incident photons are absorbed in the active layer. The charges generated are found to dissociate with negligible geminate recombination losses resulting in a short-circuit current density of 20 mA $cm^{-2}$ along with open-circuit voltages >1 V, which is remarkable for a 1.6 eV bandgap system. Most importantly, the unique nano-morphology of the donor:acceptor blend results in a substantially improved stability under illumination. Understanding the efficient charge separation in nonfullerene acceptors can pave the way to robust and recombination-free organic solar cells.

[1] King Abdullah University of Science and Technology (KAUST), KAUST Solar Center (KSC), Physical Sciences and Engineering Division (PSE), Thuwal 23955-6900, Saudi Arabia. [2] Institute of Materials for Electronics and Energy Technology (I-MEET), Friedrich-Alexander-University Erlangen-Nuremberg, Erlangen, Germany. [3] Department of Chemistry and Centre for Plastic Electronics, Imperial College London, London SW7 2AZ, UK. [4] King Abdullah University of Science and Technology (KAUST), Core Labs, Thuwal 23955-6900, Saudi Arabia. [5] IEK5-Photovoltaics, Forschungszentrum Jülich, 52425 Jülich, Germany. [6] Faculty of Engineering and CENIDE, University of Duisburg-Essen, Carl-Benz-Straße 199, 47057 Duisburg, Germany. [7] ZAE Bayern, Immerwahrstraße 2, Erlangen 91058, Germany. [8] SPECIFIC IKC, Swansea University, Baglan Bay Innovation Centre, Port Talbot, Swansea SA12 7AX, UK. Correspondence and requests for materials should be addressed to D.B. (email: derya.baran@kaust.edu.sa) or to N.G. (email: nicola.gasparini@kaust.edu.sa)

**Qifan's review on semitransparent PV technologies for electricity harvesting windows went online in Energy & Environmental Science**




Semi-transparent photovoltaic (ST-PV) technologies can be applied to replace facades and roofs in conventional buildings and coatings on vehicles to produce energy from sunlight. The current ST-PV technology is Si-based, but although Si achieves adequate efficiencies, it compromises on aesthetic appeal; its color is intrinsically difficult to tune. However, this presents an opportunity for semi-transparent polymer and perovskite-based PV, the optical properties of which can be modulated easily by tuning its material compositions. In this review article, we summarize recent progress made in the material selection, optical engineering and device architecture design for high-performance, semi-transparent polymer and perovskite solar cells and discuss challenges for the commercialization of these semitransparent solar cells for power-generating applications in windows.

Energy & Environmental Science

REVIEW

View Article Online
View Journal | View Issue



Cite this: *Energy Environ. Sci.*, 2018, **11**, 1688

# Recent advances in semi-transparent polymer and perovskite solar cells for power generating window applications

Qifan Xue,[a] Ruoxi Xia,[a] Christoph J. Brabec*[bcd] and Hin-Lap Yip *[ae]

Received 16th January 2018,
Accepted 24th April 2018

DOI: 10.1039/c8ee00154e

rsc.li/ees

Semi-transparent photovoltaic (ST-PV) technologies can be applied to replace facades and roofs in conventional buildings and coatings on vehicles to produce energy from sunlight. Current ST-PV technology is Si-based, but although Si achieves adequate efficiencies, it compromises on aesthetic appeal; its color is intrinsically difficult to tune. However, this presents an opportunity for semi-transparent polymer and perovskite-based PVs, the optical properties of which can be modulated easily by tuning their material compositions. In this review article, we summarize recent progress made in the material selection, optical engineering and device architecture design for high-performance, semi-transparent polymer and perovskite solar cells and discuss challenges for the commercialization of these semi-transparent solar cells for power-generating applications in windows.

**Broader context**

Integration of semitransparent photovoltaic (ST-PV) products as power generating windows in buildings and automobiles is a new market that will continue to grow owing to the increasing demand for renewable energy. Unlike conventional PV modules whose performance mainly depends on power conversion efficiency, PV systems for solar window applications are evaluated by their color properties, transparency levels and efficiencies. Current ST-PV technology based on silicon may not fulfill the requirements for many window applications as its optical properties are intrinsically difficult to tune. In response to this challenge, polymer solar cells and perovskite solar cells have emerged as new semitransparent PV technologies as the optical absorption of polymer and perovskite semiconductors can be easily tuned through their chemical structures. In addition, they can be printed with low-cost and high-throughput manufacturing processes on plastic substrates, which provide better cost and form factors for this new PV application. In this review article, we summarize recent progress made in the material selection, optical engineering and device architecture design for high-performance semitransparent polymer and perovskite solar cells and discuss challenges for their commercialization. By overcoming these hurdles, we can expect the commercialization of these new semitransparent PV technologies in the near future.

## 1. Introduction

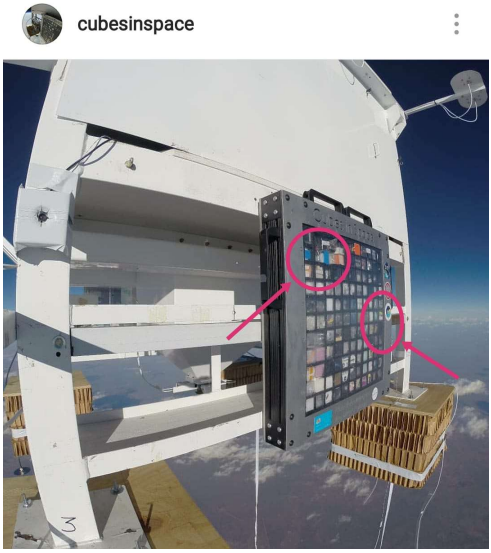
The quest for new sustainable energy sources has become one of the most challenging problems for the scientific community in recent years. Industrialization and the rapid rise in global population growth rates have triggered a search for practical sources of sustainable energy to replace fossil fuels. Due to its cleanliness, abundance and accessibility, solar energy has emerged as one of the most promising candidates for sustainable energy. However, one major barrier to the further growth of solar energy and the widespread adoption of photovoltaic technologies is the relatively low energy density of solar illumination. Given that only ~1% of the worldwide energy demand can be satisfied by the current installed area of PV technologies in remote and sunny regions, it is necessary to further install large areas of PV cells, capable of capturing enough energy to compensate for a significant portion of non-renewable energy consumption.[1] One way to do this would be to integrate semi-transparent photovoltaic modules (ST-PV) onto the under-utilized transparent surfaces of skyscrapers and automobiles or on the window panels of individual homes. It was reported that the total amount of rooftop area suitable for conventional PV installation in the United States is larger than 8 billion $m^2$.[2] Assuming a module power efficiency of 16%, it can be conservatively estimated that rooftop-mounted PV has the potential to cover nearly 40% of

[a] *Institute of Polymer Optoelectronic Materials and Devices, State Key Laboratory of Luminescent Materials and Devices, South China University of Technology, Guangzhou 510640, P. R. China*
[b] *Institute of Materials for Electronics and Energy Technology (I-MEET), Friedrich-Alexander-University Erlangen-Nuremberg, Martensstraße 7, 91058 Erlangen, Germany. E-mail: christoph.brabec@fau.de*
[c] *Bavarian Center for Applied Energy Research (ZAE Bayern), Haberstrasse 2a, 91058 Erlangen, Germany*
[d] *Research (ZAE Bayern), Immerwahrstr. 2, 91058 Erlangen, Germany*
[e] *Innovation Center for Printed Photovoltaics, South China Institute of Collaborative Innovation, Dongguan 523808, P. R. China. E-mail: msangusyip@scut.edu.cn*

## NASA brought Jose´s organic solar cells successful to the outer space


During the last decades, mostly inorganic photovoltaic (IPV) devices have been studied and used for applications in solar energy research on Earth and in space. Due to their physical and chemical properties such as high flexibility, low weight, large-scale and easy production, organic solar cells (OSCs) represent one of the novel branches of photovoltaic (PV) technologies with disruptive potential in Earth and space applications. Upon Jose's initiative to support a social-scientific project developed in Colombia with selected children and teens from public schools, himself, Josua and Thomas developed a non-expensive and complete educational model for the fabrication of the Organic Solar Cells or OSCs (made in Colombia) which was very well received by Colombian kids. Most excitingly, that activity became that popular that it will be followed up by a project launching these OSCs to the stratospheric layer of the Earth. The project was a product of the combination of two programs:

(1) Clubes de Ciencias Cali-Caicedonia (Colombia) 'Acercando el Futuro: Celdas Solares Organicas' within the scientific initiative "Clubes de Ciencia Colombia"; and (2) Cubes in SpaceTM (CiS) Program, as a part of the experiment "Affordable martian livelihoods. Will low-e glass windows resist space extreme conditions?" along with Foundation STELLAM. The solar cells were selected for a near space flight on NASA´s Sift Test Flight mission on a long duration balloon and were launched August 24th from Fort Summer, New Mexico. As part of the "Affordable martian livelihoods - Cubes in Space" project, the solar cells were encapsulated in small low-e glass Cubes and sent to space together with multiple other test objects. We hope that this successful experience of OSCs made in Colombia and sent to the space can inspire these young students and others to become a new generation of scientists and engineers that will support and develop not only research of clean energies on Earth, but also solar electricity in the outer space. And to do that, our joint project with NASA opened the opportunity to invite Colombian school kids to visit the photovoltaics and biomaterials research facilities at the material science department of the Friedrich-Alexander University Erlangen-Nürnberg. José Darío Perea, PhD student at i-MEET and previous physics student at the Universidad del Valle in Colombia has organized this visit together with colleagues from i-MEET, the chair for Biomaterials, HI-ErN, the ZAE @ EnCN.



The second part of their trip was hosted by Prof Antonietti from the Max Planck Institute of Colloids and Interfaces and Nobel Prize Laureate Prof. Gerhard Ertl. Daniel Cruz, PhD student at the Max Planck Institute, organized the second part of the visit. The overarching topic of their visit was our joint project with NASA on the study of organic and hybrid solar cells in outer space. More details on this project can be found on our homepage.

The visit at Erlangen and Berlin was the first international trip for Danna Martinez, Alejandro Quintero, Andrés Lozano, and Laura García, who were accompanied by their supervisor Leidy Díaz. The young Colombians had the opportunity to process their own solar cells at our labs at i-MEET. Under the supervision of our Spanish speaking PhD students Jose Garcia, Osbel Samora and Jose Dario, the children made Perovskites solar cells with an efficiency exceeding 10 %.

## Ning and Baobing reported their molecular fine-tuning for record-breaking OPV performance in Nature Energy

Organic photovoltaic systems have undergone rapid development during the last few years. In most cases, organic solar cells consist of two layers of semiconductors – one acts as the donor by supplying the electrons, and the second acts as an acceptor or electron conductor. In contrast to the silicon conventionally used, which must be drawn from a melt or precipitated in vacuum systems, the polymer layers in this system can be deposited from a solution directly on a supporting film. On the one hand, this means comparably low manufacturing costs, and on the other, these flexible modules can be used more easily than silicon solar cells in urban spaces. For a long time, fullerenes, which are carbon-based nanoparticles, were considered ideal acceptors, however the intrinsic losses of fullerene-based composites still severely limit their potential efficiency. The work carried out at FAU has thus resulted in a paradigm shift. 'With our partners in China, we have discovered a new organic molecule that absorbs more light than fullerenes that is also very durable', says Prof. Dr. Christoph Brabec, Chair of Materials Science (Materials in Electronics and Energy Technology) at FAU.

### Complex standardisation

The significant improvements in performance and durability mean the organic hybrid printed photovoltaics are now becoming interesting for commercial use. However, to develop practical prototypes, the technology must be transferred from laboratory dimensions of a few square millimetres to the standardised dimension of one square centimetre. 'Significant losses frequently occur during scaling', says Dr. Ning Li, a materials scientist at Prof. Brabec's Chair. During a project funded by the German Research Foundation (DFG), Ning Li and his colleagues at SCUT in Guangzhou were able to significantly reduce these losses. In a complex process, they adjusted the light absorption, energy levels and microstructures of the organic semiconductors. The main focus of this optimisation was the compatibility of donor and acceptor and the balance of short-circuit current density and open-circuit voltage, which are important prerequisites for a high output of electricity.

**Certified record efficiency**

'I think the best way to describe our work is by imagining a box of Lego bricks', says Dr. Li. 'Our partners in China inserted and adjusted single molecular groups into the polymer structure and each of these groups influences a special characteristic that is important for the function of solar cells.' This results in a power conversion efficiency of 12.25 percent – a new certified record for solution-based organic single-junction solar cells with a surface area of one square centimetre, where the acceptor does not consist of fullerenes. It is also interesting to note that the researchers succeeded in keeping the scaling losses to such low levels that the highest value in the lab on a small surface was only marginally under 13 percent. At the same time, they were able to demonstrate a stability relevant to production under simulated conditions such as temperature and sunlight.
The next step involves scaling up the model to module size at the Solar Factory of the Future at Energie Campus Nürnberg (EnCN) under the guidance of Dr Hans-Joachim Egelhaaf, before development of practical prototypes begins.

nature energy

ARTICLES

https://doi.org/10.1038/s41560-018-0263-4

# Fine-tuning of the chemical structure of photoactive materials for highly efficient organic photovoltaics

Baobing Fan[1,2], Xiaoyan Du[2], Feng Liu[3], Wenkai Zhong[1,4], Lei Ying[1]*, Ruihao Xie[1], Xiaofeng Tang[2], Kang An[1], Jingming Xin[5], Ning Li[2]*, Wei Ma[5], Christoph J. Brabec[2,6], Fei Huang[1]* and Yong Cao[1]

**The performance of organic photovoltaics is largely dependent on the balance of short-circuit current density ($J_{SC}$) and open-circuit voltage ($V_{OC}$). For instance, the reduction of the active materials' optical bandgap, which increases the $J_{SC}$, would inevitably lead to a concomitant reduction in $V_{OC}$. Here, we demonstrate that careful tuning of the chemical structure of photoactive materials can enhance both $J_{SC}$ and $V_{OC}$ simultaneously. Non-fullerene organic photovoltaics based on a well-matched materials combination exhibit a certified high power conversion efficiency of 12.25% on a device area of 1 cm². By combining Fourier-transform photocurrent spectroscopy and electroluminescence, we show the existence of a low but non-negligible charge transfer state as the possible origin of $V_{OC}$ loss. This study highlights that the reduction of the bandgap to improve the efficiency requires a careful materials design to minimize non-radiative $V_{OC}$ losses.**

By combining new material development, device engineering and morphology control, the power conversion efficiencies (PCEs) of single-junction bulk-heterojunction (BHJ) organic photovoltaics (OPVs) have been boosted to more than 12%[1–5]. Among these record efficiencies, non-fullerene OPVs (NF-OPVs) based on non-fullerene electron-withdrawing materials (acceptors) afford superior PCEs, and their long-term stabilities are more compatible with mass-production requirements than conventional OPVs based on fullerene-derivative acceptors[6–11]. However, high-performance NF-OPVs reported so far are based on a limited category of electron-donating materials (donors)[12–14], whereas most efforts have been devoted to the development of new acceptors. Recently researchers have focused on designing non-fullerene acceptors (NFAs) with narrow optical bandgaps to maximize the use of near-infrared light[15–17]. However, these acceptors generally possess high-lying highest occupied molecular orbitals (HOMOs), which make them less versatile when matching wide-bandgap donors with deep HOMO energy levels. In addition, the deep lowest unoccupied molecular orbitals (LUMOs) of these NFAs would inevitably lead to reduced open-circuit voltage ($V_{OC}$) in the resulting solar cell[18]. Therefore, to simultaneously attain efficient charge transfer (CT) and high $V_{OC}$, the energy levels of the donor and acceptor need to be precisely tuned.

In general, the compatibility between the donor and acceptor is critical for controlling the microstructure morphology of the photoactive layers, which is closely related to the device physical processes, and for the ultimate determination of the overall photovoltaic properties[19]. As the compatibility depends generally on the intrinsic chemical characteristics of the photoactive layer components, the chemical structures of both the donor and acceptor need to be carefully designed[20]. Rather than developing a totally new conjugated skeleton, fine-tuning of the chemical structures via the modification of the side chains or end groups of existing high-performance photoactive materials has proved to be a cost-effective and time-saving strategy to achieve good device results[21,22]. Taking into account various factors, such as light absorption, energy levels and micro-morphologies, we herein systematically investigate various donor:acceptor couples with their chemical structures finely modified, and envisage the performance potential based on further improvement of the best material combination. By screening all of the donor and acceptor combinations, we find the optimal match for P2F-EHp:IT-2F (1:1, wt:wt), which delivers the highest experimental PCE, 12.96%, for a device area of 0.05 cm² and a certified PCE of 12.25% for a device area of 1 cm². The very promising PCEs are measured at two institutions (South China University of Technology, SCUT and Friedrich-Alexander University Erlangen-Nürnberg, FAU), thus demonstrating consistency in the results. By investigating the $V_{OC}$ loss, we provide guidelines to achieve >14% PCE on a single-junction device based on this material combination, thus demonstrating the validity of the approach based on fine-tuning of the chemical structure of the photoactive materials.

## Selection and characterization of photoactive materials

The donors used for this study are derived from the wide-bandgap donor PTzBI that consists of a benzo[1,2-*b*:4,5-*b*′]dithiophene (BDT) electron-donating building block and a pyrrolo[3,4-*f*]benzotriazole-5,7(6*H*)-dione (TzBI) electron-withdrawing structure unit[23]. To match deep the LUMO energy levels of the narrow-bandgap NFAs, we further reduce the HOMO energy levels of the donors by introducing difluorophenyl units in the 3,6 positions of

[1]Institute of Polymer Optoelectronic Materials and Devices, State Key Laboratory of Luminescent Materials and Devices, South China University of Technology, Guangzhou, China. [2]Institute of Materials for Electronics and Energy Technology (i-MEET), Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen, Germany. [3]Department of Physics and Astronomy, Shanghai Jiao Tong University, Shanghai, China. [4]Materials Sciences Division, Lawrence Berkeley National Laboratory, Berkeley, CA, USA. [5]State Key Laboratory for Mechanical Behavior of Materials, Xi'an Jiaotong University, Xi'an, China. [6]Bavarian Center for Applied Energy Research (ZAE Bayern), Erlangen, Germany. *e-mail: msleiying@scut.edu.cn; ning.li@fau.de; msfhuang@scut.edu.cn

## For the sixth and seventh time in a row Christoph was honored as Highly Cited Researcher in 2018 and 2019

9 researchers from the University of Erlangen-Nürnberg made it on the Highly Cited Researchers list, published by Clarivate Analytics. The 2018 Highly Cited Researchers list represents some of the world's most influential minds as determined by a citation analysis of Web of Science data. Three of them, Patrik Schmuki, Aldo R. Boccaccini and Christoph J. Brabec come from the department of material science. For Christoph J. Brabec this represents the 6th consecutive year of being awarded highly cited researcher. This list contains the world's most influential researchers across 21 scientific disciplines. The 2018 list includes 6000 researchers list recognizing world-class researchers selected for their exceptional research performance, demonstrated by production of multiple highly cited papers that rank in the top 1% by citations for field and year in Web of Science. The Highly Cited Researchers List 2019 lists the world's most influential researchers from 21 scientific disciplines. This year, Prof Christoph J Brabec and Prof Patrik Schmuki have again received this most prestigious award. HCR is recognizing the world's most influential researchers of the past decade, demonstrated by the scientific and technological achievements and their ability to publish their key findings in highly-cited papers. Only the top 1% cited researchers in their respective discipline are listed in that ranking. The fact that the material sciences of the FAU, actually the smallest department of the technical faculty, are represented in the HCR list for many consecutive years underlines the innovation and research power of the material sciences. The methodology used to produce the 2018 Highly Cited Researchers list is available on the website of Clarivate Analytics.

## Andrej reports the absence of charge transfer states in single wall Carbon Nanotube : Fullerene composites in Advanced Energy Materials

Andrej reports the absence of charge transfer states in single wall Carbon Nanotube : Fullerene composites in Advanced Energy Materials (DOI:10.1002/aenm.201801913). This allowed him to report the lowest Voc loss in low bandgap organic composites so far. By further analyzing the origin of that low loss we hope to gain better insight how to overcome the bottleneck of charge transfer complexes which may allow designing the next generation of organic PV composites.

Current state-of-the-art organic solar cells (OSCs) still suffer from high losses of open-circuit voltage (VOC). Conventional polymer:fullerene solar cells usually exhibit bandgap to VOC losses greater than 0.8 V. Here a detailed investigation of VOC is presented for solution-processed OSCs based on (6,5) single-walled carbon nanotube (SWCNT): [6,6]-phenyl-C71-butyric acid methyl ester active layers. Considering the very small optical bandgap of only 1.22 eV of (6,5) SWCNTs, a high VOC of 0.59 V leading to a low Egap/q − VOC = 0.63 V loss is observed. The low voltage losses are partly due to the lack of a measurable charge transfer state and partly due to the narrow absorption edge of SWCNTs. Consequently, VOC losses attributed to a broadening of the band edge are very small, resulting in VOC,SQ − VOC,rad = 0.12 V. Interestingly, this loss is mainly caused by minor amounts of SWCNTs with smaller bandgaps as well as (6,5) SWCNT trions, all of which are experimentally well resolved employing Fourier transform photocurrent spectroscopy. In addition, the low losses due to band edge broadening, a very low voltage loss are also found due to nonradiative recombination, $\Delta V_{OC}$,nonrad = 0.26 V, which is exceptional for fullerene-based OSCs.

ADVANCED ENERGY MATERIALS
www.advenergymat.de

# Absence of Charge Transfer State Enables Very Low $V_{OC}$ Losses in SWCNT:Fullerene Solar Cells

*Andrej Classen,* Lukas Einsiedler, Thomas Heumueller, Arko Graf, Maximilian Brohmann, Felix Berger, Simon Kahmann, Moses Richter, Gebhard J. Matt, Karen Forberich, Jana Zaumseil, and Christoph J. Brabec**

**Current state-of-the-art organic solar cells (OSCs) still suffer from high losses of open-circuit voltage ($V_{OC}$). Conventional polymer:fullerene solar cells usually exhibit bandgap to $V_{OC}$ losses greater than 0.8 V. Here a detailed investigation of $V_{OC}$ is presented for solution-processed OSCs based on (6,5) single-walled carbon nanotube (SWCNT): [6,6]-phenyl-$C_{71}$-butyric acid methyl ester active layers. Considering the very small optical bandgap of only 1.22 eV of (6,5) SWCNTs, a high $V_{OC}$ of 0.59 V leading to a low $E_{gap}/q - V_{OC} = 0.63$ V loss is observed. The low voltage losses are partly due to the lack of a measurable charge transfer state and partly due to the narrow absorption edge of SWCNTs. Consequently, $V_{OC}$ losses attributed to a broadening of the band edge are very small, resulting in $V_{OC,SQ} - V_{OC,rad} = 0.12$ V. Interestingly, this loss is mainly caused by minor amounts of SWCNTs with smaller bandgaps as well as (6,5) SWCNT trions, all of which are experimentally well resolved employing Fourier transform photocurrent spectroscopy. In addition, the low losses due to band edge broadening, a very low voltage loss are also found due to nonradiative recombination, $\Delta V_{OC,nonrad} = 0.26$ V, which is exceptional for fullerene-based OSCs.**

## 1. Introduction

In recent years, organic solar cell (OSC) research has seen a strong shift from conventional polymer:fullerene blends to new concepts. Most famously polymer:nonfullerene solar cells,[1–4] but also other types based on small molecule:fullerene[5,6] blends as well as solar cells incorporating single-walled carbon nanotubes (SWCNTs)[7–14] were investigated with increased efforts. All of these new concepts have been introduced to tackle several drawbacks and outstanding issues related to polymer:fullerene solar cells.[15]

Concepts such as small molecule:fullerene active layers aim to use simple, well-defined molecules instead of polymers, which always exhibit a distribution in chain length altering their properties. The application of nonfullerene acceptors allows for more freedom to align the energy levels at the donor–acceptor interface. The incorporation of SWCNTs in OSCs or other organic devices[16–19] (near-infrared (nIR) detectors, nIR light-emitting diodes (LEDs), and field-effect transistors (FETs)) is based on several advantageous key factors that allow to boost device performances. First, SWCNTs have shown to exhibit a high photochemical stability making them superior to conventional polymers. Second, SWCNTs exhibit a very high charge carrier mobility outperforming conventional organic materials by orders of magnitude.[20,21] The high absorption coefficients in the nIR wavelength regime[22,23] make SWCNTs well suited to IR-sensitive OSCs via a ternary concept or in a binary blend with SWCNTs as the main absorber in the IR region.

Previously it was shown that SWCNTs work in a type-II heterojunction scheme acting either as an electron acceptor in combination with a polymer or as the electron donor in combination with $C_{60}$ or [6,6]-phenyl-$C_{61}$-butyric acid methyl ester (PCBM).[24] Concerning the combination with $C_{60}$, it was already demonstrated that charge carrier generation and harvesting is highly efficient with internal quantum efficiencies (IQEs) in the range of 85%.[25] The use of nearly monochiral SWCNTs in a bilayer architecture with $C_{60}$ facilitated high fill factors (FFs) greater than 60% and a high peak external quantum efficiency (EQE) of 43% at 1050 nm. Employing a bulk heterojunction (BHJ) architecture in combination with multichirality SWCNTs achieved a broad absorption in the nIR with power conversion efficiencies (PCEs) surpassing 3% for all-carbon allotrope absorbers.[24,26] In a recent study performed by Shea et al.[27] on nearly single-chirality (6,5)

A. Classen, L. Einsiedler, Dr. T. Heumueller, Dr. S. Kahmann, M. Richter, Dr. G. J. Matt, Dr. K. Forberich, Prof. C. J. Brabec
Institute Materials for Electronics and Energy Technology (i-MEET)
Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU)
91058 Erlangen, Germany
E-mail: andrej.classen@fau.de; christoph.brabec@fau.de
A. Graf, M. Brohmann, F. Berger, Prof. J. Zaumseil
Institute for Physical Chemistry
Ruprecht-Karls-Universität Heidelberg
69120 Heidelberg, Germany
Dr. S. Kahmann
Zernike Institute for Advanced Materials
University of Groningen
Nijenborgh 4, 9747AG Groningen, The Netherlands
Prof. C. J. Brabec
Bavarian Center for Applied Energy Research (ZAE Bayern)
91058 Erlangen, Germany
The ORCID identification number(s) for the author(s) of this article can be found under https://doi.org/10.1002/aenm.201801913.

DOI: 10.1002/aenm.201801913

## Osbel won the “SAOT Student Award 2019”

Osbel has won the SAOT Student Award 2019 in the topic “Optical Materials and Systems” for his work “Discerning Recombination Mechanisms and Ideality Factors through Impedance Analysis of High-Efficiency Perovskite Solar Cells” published in Nano Energy 48 (2018), p. 63-72.

The article presents an exhaustive analysis with original data comprising several types of state-of-the-art perovskite solar cells (PSCs): 3D absorbing layers based on $CH_3NH_3PbI_3$ or mixed $Cs_{0.1}FA_{0.74}MA_{0.13}PbI_{2.48}Br_{0.39}$, and a variety of interlayers with 2D perovskite thin capping. To the knowledge of the authors, this work is to date the completest impedance study reported for these optoelectronic devices, additionally illustrating on the most reliable way to extract ideality factors under light condition for PSCs. Key features in the carrier recombination mechanisms were correlated with performance behavior among different types of high-efficiency PSCs. The evidence suggests particularities on specific architectures, mostly in the carrier dynamics at outer interfaces. We think these are important results that clarify critical points for the PSCs operation modes and orient readers and researchers in their investigations.

**Amir Y. Amin and Niall Killiliea from the SOPSEM group got several awards for their INFRARED TECHSCI efforts.**


Based on their recent investigations on fully printed infrared photodetectors and mid infrared giant nanocrystals, Amir Y. Amin and Niall Killilea proposed the "next generation of infrared sensors", a fully printed sensor with a tunable infrared spectrum. Since the mid of last year, this idea did receive several awards:

(i) it received the 2nd place in the "Falling Walls Lab" innovation competition on July 2018, The Falling Walls Lab is an international forum for the next generation of outstanding innovators and creative thinkers;

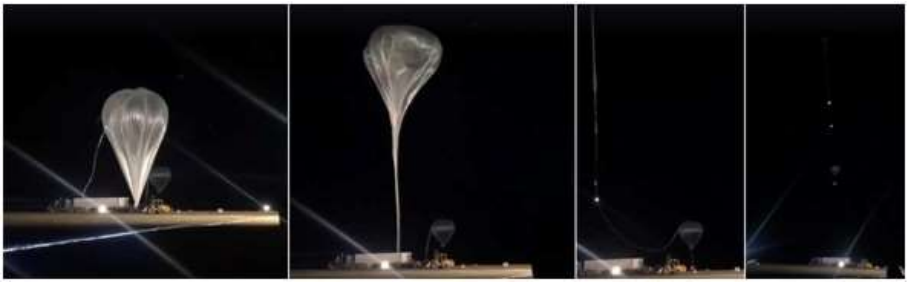
(ii) it was within the last 3 finalists in the "free style prototype" section of the LOPEC competition pitch on March 2019 LOPEC is the leading international event for printed electronics;

(iii) it was among the 10 winners of the EIT Health Boot Camp on June 2019 (EIT Health is a network of best-in-class health innovators, supported by the EU);

(iv) it received one out of 10 prizes from the "FAU sandbox" program on July 2019 (FAU Sandbox is a program offered by the FAU, providing funding for student-initiated business ideas).

## i-MEET (@FAU), ZAE Erlangen and HI-ErN printed solar modules launched to the stratosphere for *in-situ* experiments in a collaborative project with MIT and CSA

A new type of organic solar modules from i-MEET, ZAE and HI-ErN was tested in space (the stratosphere) at 37 km altitude. The flight compatible characterization hardware was developed and built by researchers Dr. **Jose Dario Perea,** Dr. **Aaron Persad,** and Dr. **Nithin Reddy** at the Massachusetts Institute of Technology (MIT), and was launched aboard a high-altitude balloon as part of the STRATOS flight campaign: a joint program between the Canadian Space Agency and the National Centre for Space Studies (CNES, France).
The balloon launched from Timmins, Ontario, Canada on the 31 August at 10pm Eastern and was safely recovered 10 hours later.



A key component of the flight hardware was a new type of organic solar panel developed in collaboration with researchers from the Friedrich Alexander Universität, the Erlangen site of the ZAE Bayern and the Helmholtz Institute Erlangen-Nuremberg (HI-ErN). Jose Perea, whose second affiliation is at the FAU, coordinated the efforts. The MIT & Erlangen researchers were interested in measuring the voltages and currents produced by the solar panel when exposed to the sunlight at high altitudes.

The STRATOS high-altitude balloon uses a sophisticated gondola to house the payloads: the gondola can be remotely oriented during flight such that the specially-made solar panels could be directed toward the Sun during sunrise. The joint research teams now plan to analyze any damage and degradation to the solar panel performance from their 10-hour exposure to space.

Included as part of the MIT & FAU payload were solar cells built by postwar children from Colombia using organic based materials. The children learned to make the solar cells in a STEM initiative to get them involved in space sciences, and to build their confidence in what amazing things they can accomplish. Their logo was also flown to space. Onboard this flight were several Canadian and student payloads from SEDS-Canada's CAN-SBX competition, congrats to the winning teams! The joint research teams wish thank Steeve Montminy and his team at the Canadian Space Agency and at the Timmins Stratospheric Balloon Base for making the flight possible.

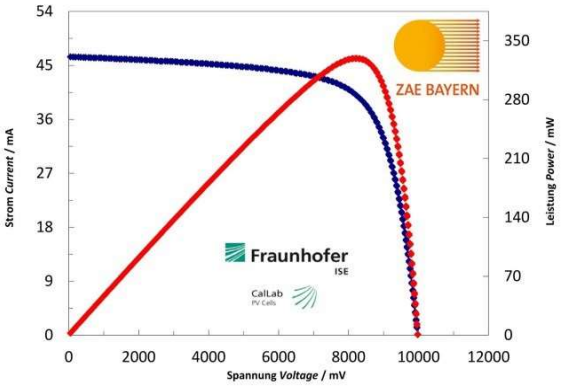
## New World Record Efficiency for Organic Solar Modules!

A research team from Nuremberg and Erlangen has set a new record for the power conversion efficiency of organic photovoltaic modules (OPV). The scientists from i-MEET, ZAE and HI ERN in cooperation with South China University of Technology (SCUT), designed an OPV module with an efficiency of 12.6 percent on an area of 26 square centimeters. The new world record exceeds the previous one of 9.7 percent by 30 percent.


This efficiency of 12.6 percent is the highest value ever reported for an organic photovoltaic module. It was confirmed by a certified calibrated measurement under standard test conditions by the independent certification laboratory of Fraunhofer ISE (Freiburg) in September 2019. The multi-cell module was developed at the "Solar Factory of the Future" at Energie Campus Nürnberg (EnCN) in a coating laboratory with a unique megawatt pilot line for thin-film photovoltaics, which was designed and implemented with the financial support of the Bavarian Ministry of Economic Affairs.

"This breakthrough shows that Bavaria is not only a leader in the expansion of photovoltaic installations, but also occupies a leading position in the development of future technologies," emphasizes Hubert Aiwanger, Bavarian State Minister of Economic Affairs, Regional Development and Energy. Organic solar cells usually consist of two different organic components possessing the necessary semiconductor properties. In contrast to conventionally used silicon, which is manufactured by energy intensive melting processes, organic materials can be applied from solutions directly onto a carrier film or glass carrier.

On the one hand, this reduces manufacturing costs and, on the other hand, the use of flexible, lightweight materials enables new applications, for example in mobile devices or clothing, even if the efficiency is not yet comparable to that of traditional silicon solar cells.




"This milestone in research on organic semiconductors shows that the latest performance developments with certified cell efficiencies of over 16 percent are not limited to the laboratory scale, but can already be scaled up to the level of prototype modules," explains Prof. Christoph J. Brabec.

Due to their design, the efficiency of complete photovoltaic modules is always somewhat lower than that of individual cells. Part of the module area, for example, is always inactive, since this area is used to interconnect the individual cells. With increased module area, the losses caused by the electrical resistance of the electrodes also increase.

The record module consists of twelve cells connected in series and has a geometric fill factor (GFF) of over 95 percent. This part of the module area actively contributes to the power generation. With respect to its active area, the module even achieves 13.2 percent efficiency. The minimization of inactive areas was achieved by means of high-resolution laser structuring, as developed and optimized in recent years at the "Solar Factory of the Future".

Technical data:

| | |
|---|---|
| **Module area:** | 26.129 cm² (± 0.026 cm2) |
| **Power conversion efficiency (PCE):** | 12.60 % (± 0.19 %) |
| **Open-circuit voltage (Voc):** | 9.978 V (± 0.04 V) |
| **Short-circuit current (Isc):** | 46.43 mA (± 0.65 mA) |
| **Fill factor (FF):** | 71.06 % (± 0.38 %) |
| **Interconnection:** | 12 cells in series |
| Geometric fill factor (GFF): | 95.5 % |
| **PCE with respect to the active area of the module:** | 13.2 % |

The news went viral and spreads very quickly. Numerous internet editions have already published our record!

## Congratulations to our colleagues with their PhD defenses

Many i-MEETers have passed their PhD examinations during the 2018-2019 with excellent success and already have made the first step in the professional career. We've shared together this exciting moment that summarized around 4 years of their intensive research and hard work. We cordially congratulate Haiwei Chen (*Interface and composition engineering towards stable and efficient organic-inorganic perovskite solar cells*), Laraib Khanzada (*Low Cost, Abundant, Non- Toxic and Low Temperature Solution Processable lnorganic Seminconductors for Photovoltaic Applications*), Shreetu Shrestha (*Methylammonium Lead Iodide Perovskite for Direct X-ray Detection*), Frank Fecher (*Simulation of thin-film photovoltaic modules: 2D and 3D spatially resolved electrical and electrothermal finite element calculations*), Simon Kahmann (*Photophysics of nanomaterials for opto-electronic applications*), Martin Wilhelm (*Germaniumeinbau in der SiGeC Hetero-Epitaxie*), Atif Makhdoom (*Low Temperature Processing Route of Silicon Nanparticle Layers for Solar Cell Application*), César Omar Ramirez Quiroz (*Efficient perovskite tandem solar-cells: structure, optimization and novel concepts*), Armin Heinrichsdobler (*Tintenstrahldruckprozesse für organische Leuchtdioden*), Saskia Schimmel (*In situ Visualisierung des ammonothermalen Kristallisationsprozesses mittels Röntgenmesstechnik*), Matthias Schuster (*CISe Thin Film Solar Cells with Novel Materials*), Xiaofeng Tang (*Investigation on the material stability of the metal-halide perovskite semiconductors*), Philipp Schuh (*Sublimation Epitaxy of bulk-like Cubic Silicon Carbide*) and Lars Fahlbusch (*Hochtemperaturlösungszüchtung von Siliziumkarbid aus Si-C-Lösungen ohne Zugabe von Metallen nach der vertikalen Bridgman-Methode*) for successfully finishing their PhD studies.

**Haiwei Chen**

**Laraib Khanzada**

**Shreetu Shrestha**

**Frank Fecher**

**Simon Kahmann**

**Martin Wilhelm**

**Atif Makhdoom**

**César Omar Ramirez Quiroz**

**Armin Heinrichsdobler**

**Saskia Schimmel**

**Matthias Schuster**

**Xiaofeng Tang**

**Philipp Schuh**

**Lars Fahlbusch**

**Liudmyla,** the first doctoral candidate under supervision by Miroslaw, finished her PhD thesis successfully and became Dr.-Ing.! The results of her PhD thesis, several conference talks and publications on the topic of phosphor-thermometry are a considerable contribution to the relatively new technique based on the laser-induced luminescence which offers the possibility of non-contact temperature measurement until 1600 K, extensively and promptly with high sensitivity and accuracy. Now, Liudmyla makes her research in the group of Prof. Andries Meijerink at the University of Utrecht, Netherlands

*Liudmyla Chepyga (second from the right) after her defence*

.

*Shi Chen*

*Manuel Dalsass*

*Cindy Alexandra Montenegro Benavides*

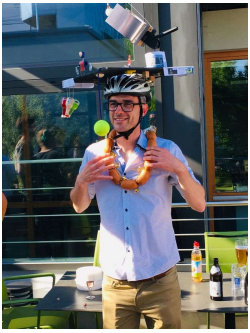
*Philipp Maisch*

**Shi, Manuel, Cindy and Philipp** all passed their PhD examinations during the last weeks with excellent success and already have made the first step in the professional career. Shi has taken up a researcher position in Shenzhen in one of the world´s biggest battery companies. Manuel remains in the photovoltaic business, Cindy is now working for Siemens in Erlangen and Philipp begins a Postdoc position for Hans at the Solarfactory of the Future.

**Jose** Within the last 4 years, Jose was working on the development of computational methods to predict the thermodynamic properties of organic semiconductors. A central aspect of his work was the calculation of the Hansen solubility parameters and the interaction parameter for the design of stable multi-component composites, as for instance required for organic PV. Towards the end, Jose more and more explored AI Methods for the determination of otherwise difficult to access material parameters. Overall, his contributions were exceptional successful and resulted in over 20 publications in highly cited journals. Immediately after finishing his PhD, Jose rushed to Boston and started his new career as a Postdoc at MIT. Jose will further continue working with us as a guest scientist at i-MEET and the HI-ErN and remain his old affiliations. We are very much looking towards this extension of our fantastic cooperation over the last years!

*Jose Dario Perea Ospina*

**Josef and Markus** Two colleagues from ZAE finished their PhD in June. Markus graduated with a thesis on a novel design for combined photovoltaic & solar-thermal collector under mild concentration by a joint simulative and experimental approach. The low concentrating PVT collector was installed in Garching and the data extracted from operation allows to select the geographical sites where this collector will show best performance. Josef performed his PhD thesis in the Hof / Arzberg outpost and developed concepts to shift the typical 12 o´clock peaks from photovoltaic electricty



*Markus Pröll*

*Josef Bogenrieder (in the centre) after his defence*

production into the morning or evening hours by diligent storage algorithms for battery operation. A detailed weather prediction as well as in-depth understanding of the climate depending performance behavior of the various PV technologies were necessary to develop such novel storage strategies. Markus will continue his research at the ZAE Bayern, while Josef already started his training as patent attorney. I wish both of them and their families the best for their future career!

Congratulations to **Klaus** for finishing his PhD studies with distinction. Klaus worked for 5 years on building accelerated setups for lifetime measurements on solar cells, and, demonstrated most impressively the value of these setups by ageing organic solar cells under 300 suns and more. The development of a most intelligent temperature sensor was the breakthrough for his work, and, for the first time in highly accelerated lifetime measurements, Klaus could demonstrate that it is possible to decouple temperature stress from light stress.We will keep his setups "Death Star", "Galactica" and "Enterprise" in best memories and maintain them in best conditions!

*Klaus Burlafinger*

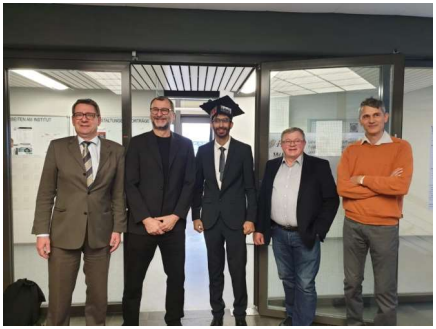
*Ening Gu (second from the right) after her defence*

After almost precisely 4 years at i-MEET **Ening** finished her PhD with very good success. Ening explored novel solution processed semiconductors, among them Pb free as well as Pb containing semiconductors. Understanding and categorizing the solvent – solute interactions was a central part of her research work. Ening made tremendously important progress in rationalizing the solvent / antisolvent interactions for perovskite synthesis by discussing the specific interactions in terms of polar, dispersive and hydrogen bonding forces, allowing her to distinguish between successful and non-successful reactions in terms of Hansen Solubility Parameters (HSP) diagrams. Ening performed most of her work on our robot systems – after having resolved the challenge how to predict the optimum antisolvent strategies for perovskite synthesis, she used the Tecan pipetting robot to create solid state libraries

of 2D perovskites via drop casting. Most importantly, Ening could show that drop cast perovskite layers show representative thin film properties, which opened robot based processing as a most interesting tool to generate large material libraries of solid state 2D perovskites.

**Shuai and Iftikhar** had both worked during their PhD on multilayer coatings, though on very different applications. Iftikhar designed and processed multi-layer barrier coatings for organic electronics, while Shuai developed and demonstrated multilayer dielectric mirrors for vapor sensing and microcavities for organic solar cells. Both works were exceptionally successful. Iftikhar demonstrated the first solution processed multilayer barriers which were directly processed on top of an organic solar cells and Shuai showed for the first time solution processed dielectric mirrors directly coupled to organic solar cells. I want to gratefully thank both for their fantastic work over that many years! Dear Shuai, dear Iftikhar - all the best for your future!

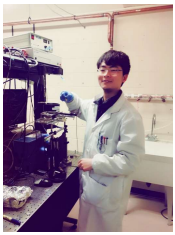
*Shuai Gao (in the centre) after her defence*



*Iftikhar Channa (in the centre) after his defence*

## Welcome to the family!

Many outstanding researchers and PhD students joined i-MEET during these two years. We are happy to greet



***Dr. Yicheng Zhao***

***Dr. Larry Lüer***

***Dr. Fu Yang***

***Dr. Li Nian***

Yicheng, who won a prestigious Humboldt Research Fellowship allowing him to join the i-MEET perovskite research team at FAU. Yicheng joined i-MEET in September 2018 and support our efforts in understanding interface related loss mechanisms in high performance perovskite devices.

Dr. Larry Lüer, Dr. Fu Yang and Dr. Li Nian strengthen i-MEET in 2019.

## *PhD students*

***Hany Elsayed***

***Sarah Deumel***

***Lirong Dong***

***Tim Freund***

***Huiying Hu***

***DongJu Jang***

***Mengqin Kong***

***Christian Kupfer***

***Marc Steinberger***

***Albert These***

***Rong Wang***

***Jonas Wortmann***

***Heyi Zhang***

Dr. Anastasia Barabash and Josua Kirsch have also joined the i-MEET family in 2019.

***Dr. Anastasia Barabash***

***Joshua Kirsch***

At the same time Eggi and Elena retired and Helena joined Fraunhofer-Institut.

***Elena Epelbaum***

***Eggi Völkel***

***Helena Waldau***

# 4. Bachelor Theses

## 2018

**Maximilian Dierner** (Brabec)
*Investigation of the influences of $Mg^{2+}$ and $Si^{4+}$ substitutions on the emission properties of $Y_3Al_5O_{12}$: $Ce^{3+}$ as luminescence converter for white light emitting diodes and solar cells*

**Christof Dobler** (Brabec)
*Synthese und Untersuchung der Lumineszenz von mikro- und nano-kristallen $Tb_3Al_5O_{12}$:Ce (TAG) und TAG:Ce, Eu mit $Mg^{2+}$ und $Si^{4+}$-Ersetzungen*

**Sabrina Schmitt** (Brabec)
*Untersuchung der Stabilität organischer Halbleiter für Photovoltaik Anwendungen mittels in-situ Photoleitungsmessungen*

**Max-Pascal Quast** (Brabec)
*Influence of $Y^{3+}$ and $Mg^{2+}$ substitutions in $Ca_3Sc_2Si_3O_{12}$:Ce phosphor particles on their luminescence properties*

**Christian Wißgott** (Brabec)
*Abhängigkeit des Schichtdickenverlaufs von den Parametern des beschleunigten Doctor Blading-Prozesses für die Herstellung organische Solarzellen*

**Johannes Zeltner** (Brabec)
*Synthesis and surface modification of nanosized $SrAl_2O_4$: Eu, Sm for photosimulated luminescence nanomarkers*

**Sven Strüber** (Wellmann)
*Untersuchung der Wachstumskinetik von 4H-SiC Einkristallen anhand der Morphologie der Wachstumsfacette*

**Thomas Zenk** (Wellmann)
*Untersuchung des Einflusses von Makrodefekten auf die Mikroröhrendichte in 4H-SiC Einkristallen*

**Baraa Abu-Khousa** (Wellmann)
*Untersuchung von undotierten 3C-SiC Epitaxieschichten*

**Dominic Neumeyer** (Wellmann)
*Untersuchung der Schichthomogenität von CIGSSe Dünnschichten mit Hilfe der Photolumineszenz*

**Adrian Burger** (Wellmann)
*Untersuchung der Polytypenstabilität und Versetzungsdichte in 100 mm 4H-SiC Einkristallen*

## 2019

**Sophie Mull** (Brabec)
*Investigation of a new interfacial layer for fully solution-processed OSCs*

**Adrian Valenas** (Batentschuk)
*Synthese und Untersuchung von mit Europium einfach dotierten und mit Europium und Cerium doppeldotierten $Ca_3Sc_2Si3O_{12}$ Mikrokristallen*

**Sebastian Bürzele** (Forberich)
*In-situ Plasma Vorkonditionierung vor Metallisierungsschritten bei der Herstellung von GaAs basierten VCSELn*

**Antonio Manco** (Brabec, Helmholtz Institute Erlangen-Nürnberg)
*Untersuchung von Silizium-Solarmodulen bei stabiler, mechanischer Belastung*

**Stefanie Vorstoffel** (Brabec)
*Stabilität von Zwischenschichten organischer Solarzellen im Elektrolumineszenz-Imaging*

**Lukas Peltner** (Brabec)
*Einfluss von Umweltparametern auf die Performance fehlerbehafteter Solarmodule*

**Robin Meinert** (Brabec)
*The effect of interface modification on the photoluminescence quantum yield of MAPbI3 perovskite*

**Eugenia Vlasyuk** (Batentschuk)
*Optimization of the manufacturing conditions of $Ca_2MgYScSi_3O_{12}$: $Ce^{3+}$ microcrystals as light converters for white light emitting diodes*

**Mona Telford** (Wellmann)
*Application of Birefringence Measurements for the Semiquantitative Characterization of SiC Semiconductor Wafers*

# 5. Master Theses

## 2018

**Anh-Dai Dang** (Brabec)
*Tintenstrahldrucken Tintenstrahldrucken von Nano-Mikrostrukturen für die integrierte Elektronik*

**Sarah Deumel** (Heiß)
*Methylammoniumbleiiodid für die Röntgendetektion*

**Felix Ernst** (Brabec)
*Defining optimal conditions for fast and reliable perovskite solar cell performance characterization using maximum power point tracking*

**Felix Enzenberger** (Brabec)
*Analyse des Degradationsverhaltens hinsichtlich der Entstehung und Veränderungen von Zellrissen in PV-Modulen unter zyklischer mechanischer Belastung*

**Leonard Höcht** (Brabec)
*Laser scribing of perovskite solar modules*

**Felix Kalkowski** (Brabec)
*Synthesis of Perovskite Based Quantum Dots for QD-LED Displays*

**Judith Knüttel** (Brabec)
*Development and fabrication of perovskite-based X-ray detectors*

**Moritz Scholl** (Brabec)
*Entwicklung eines neuen Verfahrens zur Erzeugung von aktiven Beschichtungen mittels der Floating Film Transfer Method (FTM) zur Herstellung von organischen Solarzellen*

**Jerrit Wagner** (Brabec)
*Development of high throughput methods for automated production and characterization of organic solar cells*

**Zhenguo Zhang** (Heiß)
*TOF-SIMS und XPS zur chemischen Charakterisierung von CdTe Solarzellen*

**Kaicheng Zhang** ((Brabec), Soochow University, China)
*Interfacial Engineering and Crystallization-controlling of Perovskite Film in Perovskite Solar Cells*

**Lukas Einsiedler** (Brabec)
*Carbon Nanotubes for photodetectors and solar cells*

**Eduardo Calderón del Rivero** (Brabec)
*Quantitative and qualitative electroluminescence analysis in Si photovoltaic panels with different cameras*

**Maximilian Lederer** (Wellmann)
*3C-SiC as a material for integrated quantum optics*

**Melisse Roder** (Wellmann)
*Defect and Strain Characterization of 4H SiC*

## 2019

**Anh-Dai Dang** (Brabec)
*Tintenstrahldrucken Tintenstrahldrucken von Nano-Mikrostrukturen für die integrierte Elektronik*

**Jiyun Zhang** (Brabec)
*The Crystal Structure Analysis and Optical Properties Tuning of GGAG Transparent Ceramics*

**Andreas Eigen** (Heiß)
*Ionenleitfähigkeiten in Perowskit Halbleitern für die Röntgendetektion*

**Johannes Gerner** (Brabec)
*Degradation of organic photovoltaic materials analysed via absorption-, photoluminescence- and Fourier-transform infrared spectroscopy*

**Tim Freund** (Heiß)
*Epitaktisches Tintenstrahldrucken von Perovskiten*

**Deep Thanki** (Brabec)
*Energy and Exergy Analysis for Optimal Performance of a Combined Photovoltaic/Thermal Collector Using FEM Simulation*

**Julian Fischer** (Brabec)
*Correlation of Photo-oxidation and UV-degradation of active layers with lifetime measurements on organic solar cells*

**Marc Steinberger,** (Brabec)
*Thermo-oxidation of Organic Solar Cells and the Effect of $Ni(dtc)_2$ as Stabilizing Additive*

**Huiying Hu** (Osvet)
*Development of Quantum Dot Enhancement Films Based on Perovskites with Stable Red and Green Color Emission*

**Yizhe Yang** (Brabec)
*Compositional perovskite powder and ink engineering for low and high energy radiation detectors*

**Leon Beickert** (Batentschuk)
*Einfluss von Ladungskompensation und Flussmittel auf die Quantenausbeute bei der Herstellung von $Ca_3Sc_2Si_3O_{12}$:Ce für weiße LEDs*

**Julien Körfer** (Heiß)
*Plasmonische Metalloxid Nanokristalle für elektrochrome Bauteile*

**Ricardo Morales Hernández** (Brabec)
*Automatisation and characterisation of OLEDs*

**Thomas Cournil** (Osvet)
*Nanosecond transient absorption spectroscopy of absorber materials for organic photovoltaics*

**Viktor Rehm** (Heiß)
*Doping of 2-dimensional $Bi_2Se_3$ for optimized charge carrier transport*

**Alexander Kollitz** (Wellmann)
*Einfluss der Oberflächen-Prozesstechnologie auf die Rauigkeit und Deformationszone von SiC Halbleiterscheiben*

**Clemens Brecht** (Wellmann)
*Influence of thermal treatments on the presence of point defects and optically active centres in 3C-SiC*

**Manuel Kollmuß** (Wellmann)
*Einfluss kristalliner Defekte in 3C-SiC Halbleitersubstraten auf homoepitaktisch gewachsene Schichten*

**Jan Tobias Oesterreich** (Wellmann)
*Untersuchung von Punktdefekten in 3C-SiC mit Hilfe der optisch detektierten magnetischen Resonanz-Photolumineszenz-Spektroskopie*

# 6. Doctoral Theses

## Doctoral Theses in Preparation

**Ali, Amjad** (Batentschuk, i-MEET)
*Developement of phosphors for light conversion in solar panels*

**Almora Rodríguez, Osbel** (Brabec, i-MEET)
*Hysteresis and Capacitive Features of Perovskite Solar Cells*

**Arzig, Matthias** (Wellman, i-MEET)
*Systematische Untersuchung der Wachstumskinetik von SiC Einkristallen und Ableitung eines Wachstumsmodells, zur Beschreibung von lateralem Überwachsen von Kristalldefekten und Aufweiten des Kristalldurchmessers*

**Bechert, Hermann** (Brabec, OSRAM OLED GmbH.)
*Flexible und hochsegmentierte organische Leuchtdioden für Fahrzeugrückleuchten-Applikationen*

**Berger, Christian** (Brabec, ZAE)
*IT systems and infrastructure for the world wide materials genome*

**Carigiet, Fabian** (Brabec, Zürcher Hochschule für Angewandte Wissenschaften)
*AC PV-Modul: Kontaktlose Stromübertragung von PV-Modulen ins Stromnetz*

**Classen, Andrej** (Brabec, i-MEET)
*Investigation of factors limiting the performance of organic solar cells*

**Deumel, Sarah** (Heiß, i-MEET)
*Hybrid inorganic-organic perovskites for X-Ray detection*

**Doll, Bernd** (Brabec, ZAE)
*High Throughput Luminescence Methods for outdoor Photovoltaic*

**Dong, Lirong** (Brabec, i-MEET)
*Engineering of advanced composition and surface ligand for perovskite-based optoelectronic devices*

**Elia, Jack** (Brabec, i-MEET)
*Liquid Phase Epitaxy of Perovskite-Halides and Garnets*

**Elsayed, Hany** (Heiß, i-MEET)
*Lasers based on Organo-Metal-Halide Perovskites*

**Feroze, Sarmad** (Brabec, ZAE)
*Building Integrated Organic Photovoltaics*

**Fischer, Rene** (Brabec, Siemens GmbH.)
*Hybrid-organische und perovskitische halbleitende metall-organische Absorbermaterialien für die Anwendung in Röntgendetektoren*

**Garcia Cerrillo, José** (Brabec, i-MEET)
*Fabrication of multication-, mixed halide-perovskite/silicon tandem solar cells by partial processing in air*

**Gu, Ening** (Brabec, i-MEET)
*Solution-processed semiconducting materials for optoelectronic application*

**Güldal, Nusret Sena** (Brabec, i-MEET)
*In-situ monitoring of active layer drying kinetics in organic solar cells*

**He, Yakun** (Li, i-MEET)
*Charge generation and recombination investigation based on solution processed organic solar cells*

**Hepp, Johannes** (Brabec, ZAE/i-MEET)
*Development of visualization and quantification techniques of local material failures in PV*

**Hornich, Julian** (Barbec, i-MEET)
*Simulations of solar cells with FDTD methods*

**Hübner, Tobias** (Brabec, OSRAM Opto Semiconductors GmbH)
*Inkjet-printing of Quantum Dots for optoelectronic devices*

**Jang, DongJu** (Egelhaaf, ZAE)
*Up scaling perovskite for R2R process*

**Kalancha, Violetta** (Forberich, i-MEET)
*Investigation of Hybrid Silver Nanowire Electrodes*

**Karl, André** (Brabec, i-MEET)
*Development of novel imaging techniques for tandem solar cells*

**Killilea, Niall** (Heiß, i-MEET)
*Inkjet printed phototransistors*

**Kollmuß, Manuel** (Wellmann, i-MEET)
*3C-SiC large area bulk growth*

**Krebs, Kerstin** (Brabec, i-MEET)
*Transparent, leitfähige Beschichtungen als Elektroden für Touch Panel Displays*

**Langner, Stefan** (Stubhan, i-MEET)
*Ink formulation and high-throughput experimentation in organic photovoltaics*

**Liu, Chao** (Li, i-MEET)
*Interfacial engineering for organic solar cells*

**Mashkov, Oleksandr** (Heiß, i-MEET)
*Organic pigment nanocrystals*

**Meng, Wei** (Li, i-MEET)
*Interface engineering for high-efficiency perovskite solar cells*

**Sauermann, Tobias** (Brabec, Belectric GmbH.)
*Degradation Mechanisms in Organic Solar Cells*

**Schöler, Michael** (Wellmann, i-MEET)
*Dotierung und Charakterisierung von 3C-SiC*

**Schwamb, Philipp** (Brabec, OSRAM OLED GmbH.)
*Flexible white OLEDs*

**Shen, Yilei** (Brabec, i-MEET)
*Lösungsprozessierung für die semitransparenten Elektroden der organischen Leuchtdioden*

**Stegner, Christoph** (Brabec, ZAE)
*Integration elektrochemischer Energiespeicher ins Verteilnetz*

**Steiner, Johannes** (Wellmann, i-MEET)
*Quantitative characterization and prediction of dislocation behavior in high-purity SiC*

**Steinberger, Marc** (Egelhaaf, ZAE)
*Printing of Optoelectronics*

**Tam, Kai Cheong** (Brabec, ZAE)
*Ink-jet printing on organic imaging device*

**These, Albert** (Matt, i-MEET)
*Lead Free perovskites for X-Ray detection*

**Wang, Rong** (Brabec, i-MEET)
*Development of novel doped interfaces for efficient and stable organic-inorganic hybrid tandem solar cells*

**Wachsmuth, Josua** (Egelhaaf, ZAE)
*Solution-Processed HTL-Layers for NFA-based Organic Solar Cell*

**Wortmann, Jonas** (Brabec, ZAE)
*Spectral Imaging in Organic and Perovskite Solar Cells*

**Xie, Chen** (Brabec, i-MEET)
*Water/alcohol-based nanoparticle inks for organic photovoltaics*

**Xu, Junyi** (Brabec, i-MEET)
*Organic nanoparticles as the transport layer for solar cells*

**YousefiAmir, AminAbbas** (Heiß, i-MEET)
*Inkjet printed Nanocrystal Detectors*

**Zhang, Heyi** (Brabec, i-MEET)
*The Growth of Crystalline Perovskite Layers*

**Zhang, Jiyun** (Brabec, i-MEET)
*Robot Based High Throughput Methods for Combinatorial Synthesis of Semiconductors*

**Zhang, Kaicheng** (Brabec, i-MEET)
*Development and Characterization of Novel Interfaces for Organic and Perovskite Solar Cells*

## 7. Doctoral Theses Completed 2018

29.01.2018
**Chen, Haiwei** (Brabec, i-MEET)
*Interface and composition engineering towards stable and efficient organic-inorganic perovskite solar cells*

14.02.2018
**Khanzada, Laraib** (Brabec, i-MEET)
*Low Cost, Abundant, Non- Toxic and Low Temperature Solution Processable lnorganic Seminconductors for Photovoltaic Applications*

15.02.2018
**Shrestha, Shreetu** (Brabec, i-MEET)
*Methylammonium Lead Iodide Perovskite for Direct X-ray Detection*

12.03.2018
**Fecher, Frank** (Brabec, ZAE)
*Simulation of thin-film photovoltaic modules: 2D and 3D spatially resolved electrical and electrothermal finite element calculations*

20.04.2018
**Kahmann, Simon** (Brabec, i-MEET)
*Photophysics of nanomaterials for opto-electronic applications*

23.07.2018
**Wilhelm, Martin** (Wellmann, i-MEET)
*Germaniumeinbau in der SiGeC Hetero-Epitaxie*

15.10.2018
**Makhdoom, Atif** (Brabec, ZAE)
*Low Temperature Processing Route of Silicon Nanparticle Layers for Solar Cell Application*

10.12.2018
**Chepyga, Liudmyla** (Batentschuk, i-MEET)
*Developement of new phosphors for high-temperature thermometry*

12.12.2018
**Ramirez Quiroz, César Omar** (Brabec, i-MEET)
*Efficient perovskite tandem solar-cells: Structure, optimization and novel concepts*

18.12.2018
**Heinrichsdobler Armin** (Brabec, OSRAM OLED GmbH.)
*Tintenstrahldruckprozesse für organische Leuchtdioden*

20.12.2018
**Schimmel, Saskia** (Wellmann, i-MEET)
*In situ Visualisierung des ammonothermalen Kristallisationsprozesses mittels Röntgenmesstechnik*

## Doctoral Theses Completed 2019

23.01.2019
**Dalsass, Manuel** (Brabec, ZAE)
*Quality Assessment of Large- scale Photovoltaic Generators Based on Inverter Data and Thermographic Inspections*

08.02.2019
**Chen, Shi** (Brabec, i-MEET)
*High Throughput Engineering of Hybrid Perovskite Semiconductors for Photovoltaic Applications*

19.02.2019
**Schuster, Matthias** (Wellmann, i-MEET)
*Synthesis of nanoparticulate precursors and analysis of layer formation mechanisms of $CuInSe_2$ solar cell absorbers*

25.02.2019
**Maisch, Philipp** (Brabec, ZAE)
*Process Development for lnkjet Printing of Organic Photovoltaics*
*Prozessentwicklung für den Tintenstrahldruck organischer Photovoltaik*

25.02.2019
**Montenegro Benavides, Cindy Alexandra** (Brabec, Siemens Healthcare GmbH.)
*Optimization of Organic Photodetectors from the Visible to the Near Infrared Spectra for Industrial Applications*

22.03.2019
**Perea Ospina, Jose Dario** (Brabec, i-MEET)
*Solubility and Miscibility of Organic Semiconductors for Efficient and Stable Organic Solar Cells Investigated via Machine Learning and Quantum Chemistry Methods*

22.03.2019
**Tang, Xiaofeng** (Brabec, i-MEET)
*Investigation on the material stability of the metal-halide perovskite semiconductors*

24.05.2019
**Pröll, Markus (**Brabec, ZAE)
*Entwicklung eines schwach konzentrierten CPC PVT- Flachkollektors*

17.06.2019
**Bogenrieder, Josef** (Brabec)
*Adapting photovoltaic systems to requirements of a future electricity supply system*

28.06.2019
**Schuh, Philipp** (Wellmann, i-MEET)
*Sublimation Epitaxy of bulk-like Cubic Silicon Carbide*

06.11.2019
**Burlafinger, Klaus** (Brabec)
*Development of a High Irradiance Setup for Precisely Controlled Accelerated Photo-Degradation of Organic Solar Cells*

26.11.2019
**Gu, Ening** (Brabec, i-MEET)
*Synthesis and characterization of solution-processed emerging hybrid perovskites and $AgBiS_2$*

12.12.2019
**Fahlbusch, Lars** (Wellmann, i-MEET)
*Hochtemperaturlösungszüchtung von Siliziumkarbid aus Si-C-Lösungen ohne Zugabe von Metallen nach der vertikalen Bridgman-Methode*

17.12.2019
**Gao, Shuai** (Brabec, i-MEET)
*A combined theoretical and experimental analysis on performance and functionality of printed dielectric mirrors*

13.12.2019
**Channa, Iftikhar** (Brabec, ZAE)
*Development of solution processed thin film barriers for packaging thin film electronics*

# 8. Awards

## Almora Rodríguez, Osbel

SAOT student Award 2019

## Bechert, Hermann

2nd place **OE-A Competition 2018** in 'Prototypes & New Products' and in 'Public Choice Award'

## Brabec, Christoph

Honored as ***Highly Cited Researcher in 2018*** (Web of Science, 6th time in a row)
Honored as ***Highly Cited Researcher in 2019*** (Web of Science, 7th time in a row)

## Killilea, Niall and YousefiAmin, AmirAbbas

2nd Prize for German falling wall lab (international innovation pitch) with the topic: Breaking the Wall of Food Fraud Detection.
Within the last 3 finalists in the "free style prototype" section of the LOPEC competition 2019
EIT Health Boot Camp 2019 (EIT Health is a network of best-in-class health innovators, supported by the EU)
"FAU sandbox" program 2019

## Li, Ning

Nachwuchswissenschaftler/in des Jahres 2018, Dr. Ning Li was nominated by the jury as one of the top 10.

## Shrestha, Shreetu

GRK starting grant and SAOT Student Award (category Optical Materials and Systems).

# 9. Publications

## (Full Papers and Conference Proceedings)
### Full Papers

#### 2018

**Philipp Maisch, Kai Cheong Tam, Pavel Schilinsky, Hans-Joachim Egelhaaf, and Christoph J. Brabec.**
Shy Organic Photovoltaics: Digitally Printed Organic Solar Modules With Hidden Interconnects
*Solar RRL **2(7)**, 9 pages, Article number 1800005, 2018*
DOI: 10.1038/s41467-018-07807-5

**Chen Xie, Thomas Heumüller, Wolfgang Gruber, Xiaofeng Tang, Andrej Classen, Isabel Schuldes, Matthew Bidwell, Andreas Späth, Rainer H. Fink, Tobias Unruh, Iain McCulloch, Ning Li & Christoph J. Brabec.**
Overcoming efficiency and stability limits in water-processing nanoparticular organic photovoltaics by minimizing microstructure defects
*Nature Communications **9**, Article number 5335, 11 pages, 2018*
DOI: 10.1038/s41467-018-07807-5

**Berlinghof, M., Bär, C. Haas, D., Bertram, F., Langner, S., Osvet, A., Chumakov, A., Will, J., Schindler, T., Zech, T., Brabec, C.J., Unruh, T.**
Flexible sample cell for real-time GISAXS, GIWAXS and XRR: design and construction
*Journal of Synchrotron Radiation **25**, pp.1664–1672, 2018*
DOI: 10.1107/S1600577518013218

**Baobing Fan, Xiaoyan Du, Feng Liu , Wenkai Zhong, Lei Ying, Ruihao Xie, Xiaofeng Tang, Kang An, Jingming Xin, Ning Li, Wei Ma, Christoph J. Brabec, Fei Huang and Yong Cao**
Fine-tuning of the chemical structure of photoactive materials for highly efficient organic photovoltaics
*Nature energy, **3**, 1051-1058, 2018*
DOI: 10.1038/s41560-018-0263-4

**Shuai Gao, Xiaofeng Tang, Stefan Langner, Andres Osvet, Christina Harreiß, Maïssa K. S. Barr, Erdmann Spiecker, Julien Bachmann, Christoph J. Brabec, and Karen Forberich**
Time-Resolved Analysis of Dielectric Mirrors for Vapor Sensing
*Acs Applied Materials & Interfaces **10**, pp. 36398−36406, 2018*
DOI: 10.1021/acsami.8b11434

**Ilka M. Hermes, Yi Hou, Victor W. Bergmann, Christoph J. Brabec, Stefan A.L. Weber**
The Interplay of Contact Layers: How the Electron Transport Layer Influences Interfacial Recombination and Hole Extraction in Perovskite Solar Cells.
*Journal of Physical Chemistry Letters **9**, pp. 6249-6256, 2018*
DOI: 10.1021/acs.jpclett.8b02824

**Andrew Wadsworth, Zeinab Hamid, Matthew Bidwell, Raja S. Ashraf, Jafar I. Khan, Dalaver H. Anjum, Camila Cendra, Jun Yan, Elham Rezasoltani, Anne A. Y. Guilbert, Mohammed Azzouzi, Nicola Gasparini, James H. Bannock, Derya Baran, Hongbin Wu, John C. de Mello, Christoph J. Brabec, Alberto Salleo, Jenny Nelson, Frédéric Laquai, and Iain McCulloch**
Progress in Poly (3-Hexylthiophene) Organic Solar Cells and the Influence of Its Molecular Weight on Device Performance
*Advanced Energy Materials* ***8(28)****, Article number 180208, 15 pages, 2018*
DOI: 10.1002/aenm.201801001

**P. Dreher, R. Schmidt, A. Vetter, J. Hepp, A. Karl, C.J. Brabec**
Non-destructive imaging of defects in Ag-sinter die attach layers – A comparative study including X-ray, Scanning Acoustic Microscopy and Thermography
*Microelectronics Reliability* ***88-90****, pp. 365-370, 2018*
DOI: 10.1016/j.microrel.2018.07.121

**Diana Galli, Nicola Gasparini, Michael Forster, Anika Eckert, Christian Widling, Manuela S. Killian, Apostolos Avgeropoulos Vasilis G. Gregoriou, Ullrich Scherf, Christos L. Chochos, Christoph J. Brabec, and Tayebeh Ameri**
Suppressing the Surface Recombination and Tuning the Open-Circuit Voltage of Polymer/Fullerene Solar Cells by Implementing an Aggregative Ternary Compound
*ACS Applied Materials and Interfaces* ***10(34)****, pp. 28803-28811, 2018*
DOI: 10.1021/acsami.8b09174

**Sara Mashhoun, Yi Hou, Haiwei Chen, Fariba Tajabadi, Nima Taghavinia, Hans-Joachim Egelhaaf, and Christoph J. Brabec**
Resolving a Critical Instability in Perovskite Solar Cells by Designing a Scalable and Printable Carbon Based
Electrode-Interface Architecture
*Advanced Energy Materials* ***8(31)****, Article number 180208, 6 pages, 2018*
DOI: 10.1002/aenm.201802085

**Daniel Niesner, Martin Hauck, Shreetu Shrestha, Ievgen Levchuk, Gebhard J. Matt, Andres Osvet, Miroslaw Batentschuk, Christoph Brabec, Heiko B. Weber, and Thomas Fauster**
Structural fluctuations cause spin-split states in tetragonal $(CH_3NH_3)PbI_3$ as evidenced by the circular photogalvanic effect
*Proceedings of the National Academy of Sciences* ***115(38)****, pp. 9509-9514, 2018*
***Vol. 10687****, 10 pages, 2018*
DOI: 10.1073/pnas.1805422115

**S. Strohm, F. Machui, S. Langner, P. Kubis, N. Gasparini, M. Salvador, I. McCulloch, H.-J. Egelhaaf and C. J. Brabec**
P3HT: Non-fullerene acceptor based large area, semi-transparent PV modules with power conversion efficiencies of 5%, processed by industrially scalable methods
*Energy and Environmental Science* ***11(8)****, pp. 2225-2234, 2018*
DOI: 10.1039/c8ee01150h

**Xi Liu, Xiaoyan Du, Junyi Wang, Chunhui Duan, Xiaofeng Tang, Thomas Heumueller, Guogang Liu, Yan Li, Zhaohui Wang, Jing Wang, Feng Liu, Ning Li, Christoph J. Brabec, Fei Huang, and Yong Cao**
Efficient Organic Solar Cells with Extremely High Open-Circuit Voltages and Low Voltage Losses by Suppressing Nonradiative Recombination Losses
*Advanced Energy Materials, Article number 1801699, 9 pages, 2018*
DOI: 10.1002/aenm.201801699

**Thomas Kirchartz, Sophie Korgitzsch, Jürgen Hüpkes, César O. R. Quiroz, and Christoph J. Brabec**
Performance Evaluation of Semitransparent Perovskite Solar Cells for Application in Four-Terminal Tandem Cells
*ACS Energy Letters **3(8)**, pp. 1861-1867, 2018*
DOI: 10.1021/acsenergylett.8b00598

**Xi Liu, Chaohong Zhang, Chunhui Duan, Mengmeng Li, Zhicheng Hu, Jing Wang, Feng Liu, Ning Li, Christoph J. Brabec, René A. J. Janssen, Guillermo C. Bazan, Fei Huang, and Yong Cao**
Morphology Optimization via Side Chain Engineering Enables All Polymer Solar Cells with Excellent Fill Factor and Stability
*Journal of the American Chemical Society **140(28)**, pp. 8934-8943, 2018*
DOI: 10.1021/jacs.8b05038

**Qifan Xue, Ruoxi Xia, Christoph J. Brabec and Hin-Lap Yip**
Recent advances in semi-transparent polymer and perovskite solar cells for power generating window applications
*Energy & Environmental Science **11**, pp. 1688-1709, 2018*
DOI: 10.1039/c8ee00154e

**Chen Xie, Xiaofeng Tang, Marvin Berlinghof, Stefan Langner, Shi Chen, Andreas Späth, Ning Li, Rainer H. Fink, Tobias Unruh, and Christoph J. Brabec**
Robot-Based High-Throughput Engineering of Alcoholic Polymer: Fullerene Nanoparticle Inks for an Eco-Friendly Processing of Organic Solar Cells
*ACS Applied Materials & Interfaces **10(27)**, pp. 23225-23234, 2018*
DOI: 10.1021/acsami.8b03621

**Ening Gu, Xianzhong Lin, Xiaofeng Tang, Gebhard J. Matt, Andres Osvet, Yi Hou, Sebastian Jäger, Chen Xie, Andre´ Karl, Rainer Hocke and Christoph J. Brabec**
Single molecular precursor ink for $AgBiS_2$ thin films: synthesis and characterization
*Journal of Materials Chemistry C **6**, pp. 7642-7651, 2018*
DOI: 10.1039/c8tc01195h

**Christoph Brabec, Hans-Joachim Egelhaaf, Michael Salvador**
The path to ubiquitous organic electronics hinges on its stability
*Journal of Materials Research **33(13)**, pp. 1839-1840, 2018*
DOI: 10.1557/jmr.2018.239

**Nicola Gasparini, Alberto Gregori, Michael Salvador, Markus Biele, Andrew Wadsworth, Sandro Tedde, Derya Baran, Iain McCulloch, and Christoph J. Brabec**
Visible and Near-Infrared Imaging with Nonfullerene-Based Photodetectors
*Advanced Materials Technologies* ***3(7)****, Article number 1800104, 7 pages, 2018*
DOI: 10.1002/admt.201800104

**Ning Li, Iain McCulloch and Christoph J. Brabec**
Analyzing the efficiency, stability and cost potential for fullerene-free organic photovoltaics in one figure of merit
*Energy & Environmental Science* ***11(6)****, pp. 1355-1361, 2018*
DOI: 10.1039/c8ee00151k

**Peng Zhu, Baobing Fan, Xiaoyan Du, Xiaofeng Tang, Ning Li, Feng Liu, Lei Ying, Zhenye Li, Wenkai Zhong, Christoph J. Brabec, Fei Huang, and Yong Cao**
Improved Efficiency of Polymer Solar Cells by Modifying the Side Chain of Wide-Band Gap Conjugated Polymers Containing Pyrrolo[3,4- f]benzotriazole-5,7(6 H)-dione Moiety
*ACS Applied Materials and Interfaces* ***10(26)****, pp. 22495-22503, 2018*
DOI: 10.1021/acsami.8b05700

**Dalsass M., Scheuerpflug H., Fecher F.W., Buerhop-Lutz C., Camus C., Brabec C.J.**
Correlation between the generated string powers of a photovoltaic: Power plant and module defects detected by aerial thermography
*2017 IEEE 44th Photovoltaic Specialist Conference, PVSC 2017, Category number CFP17PSC-ART; Code 136737, 6 pages, 2018*
DOI: 10.1109/PVSC.2017.8366737

**Simon Kahmann, Maria A. Loi and Christoph J. Brabec**
Delocalisation softens polaron electronic transitions and vibrational modes in conjugated polymers
*Journal of Materials Chemistry C* ***6(22)****, pp. 6008-6013, 2018*
DOI: 10.1039/c8tc00909k

**Liudmyla M. Chepyga, Andres Osvet, Ievgen Levchuk, Amjad Ali, Yuriy Zorenko, Vitalii Gorbenko, Tetiana Zorenko, Alexander Fedorov, Christoph J. Brabec, Miroslaw Batentschuk**
New silicate based thermographic phosphors $Ca_3Sc_2Si_3O_{12}$:Dy, $Ca_3Sc_2Si_3O_{12}$:Dy,Ce and their photoluminescence properties
*Journal of Luminescence* ***202****, pp. 13-19, 2018*
DOI: 10.1016/j.jlumin.2018.05.039

**Max Burian, Carina Karner, Maksym Yarema, Wolfgang Heiss, Heinz Amenitsch, Christoph Dellago, and Rainer T. Lechner**
A Shape-Induced Orientation Phase within 3D Nanocrystal Solids
*Advanced Materials* ***30(32)****, Article number 1802078, 7 pages, 2018*
DOI: 10.1002/adma.201802078

**Maciej Gryszel, Mykhailo Sytnyk, Marie Jakešová, Giuseppe Romanazzi, Roger Gabrielsson,**
**Wolfgang Heiss, and Eric Daniel Głowacki**
General Observation of Photocatalytic Oxygen Reduction to Hydrogen Peroxide by Organic Semiconductor Thin Films and Colloidal Crystals
*ACS Applied Materials & Interfaces* ***10(16)****, pp. 13253-13257, 2018*
DOI: 10.1021/acsami.8b01295

**Zhenye Li, Lei Ying, Ruihao Xie, Peng Zhu, Ning Li, Wenkai Zhong, Fei Huang, Yong Cao**
Designing ternary blend all-polymer solar cells with an efficiency of over 10% and a fill factor of 78%
*Nano Energy,* ***51****, p. 434-441, 2018*
DOI: 10.1016/j.nanoen.2018.06.081

**Baobing Fan, Peng Zhu, Jingming Xin, Ning Li, Lei Ying, Wenkai Zhong, Zhenye Li,**
**Wei Ma, Fei Huang, and Yong Cao**
High-Performance Thick-Film All-Polymer Solar Cells Created Via Ternary Blending of a Novel Wide-Bandgap Electron-Donating Copolymer
*Advanced Energy Materials,* ***8(14)****, Article number 1703085, 2018*
DOI: 10.1002/aenm.201703085

**Xuemei Zhou, Ning Li, Tadahiro Yokosawa, Andres Osvet, Matthias E. Miehlich, Karsten Meyer, Erdmann Spiecker, and Patrik Schmuki**
Intrinsically Activated SrTiO3: Photocatalytic H2 Evolution from Neutral Aqueous Methanol Solution in the Absence of Any Noble Metal Cocatalyst
*ACS Applied Materials & Interfaces,* ***10(35)****, pp 29532-29542, 2018*
DOI: 10.1021/acsami.8b08564

**Yannan Zhang, Mengfan Gu, Ning Li, Yalong Xu, Xufeng Ling, Yongjie Wang, Sijie Zhou, Fangchao Li, Fan Yang, Kang Ji, Jianyu Yuan and Wanli Ma**
Realizing solution-processed monolithic PbSQDs/perovskite tandem solar cells with high UV stability
*Journal of Materials Chemistry A,* ***6****, pp 24693-24701, 2018*
DOI: 10.1039/C8TA09164A

**Ruihao Xie, Zhenye Li, Wenkai Zhong, Lei Ying, Qin Hu, Feng Liu, Ning Li, Thomas P. Russell, Fei Huang and Yong Cao**
Overcoming the morphological and efficiency limit in all- polymer solar cells by designing conjugated random copolymers containing α naphtho[1,2-c:5,6-c']bis([1,2,5]thiadiazole)] moiety
*Journal of Materials Chemistry A,* ***6****, pp 23295-23300, 2018*
DOI: 10.1039/C8TA09356C

**Ellen Hertle, Liudmyla Chepyga, Miroslaw Batentschuk, Stefan Will, Lars Zigan**
Temperature-dependent luminescence characteristics of $Dy^{3+}$ doped in various crystalline hosts
*Journal of Luminescence, **204**, pp 64-74, 2018*
DOI: 10.1016/j.jlumin.2018.07.032

**Jing Wei, Fengwan Guo, Xi Wang, Kun Xu, Ming Lei, Yongqi Liang, Yicheng Zhao, and Dongsheng Xu**
$SnO_2$-in-Polymer Matrix for High-Efficiency Perovskite Solar Cells with Improved Reproducibility and Stability
*Advanced Materials, **30(52)**, Article number 1805153, 2018*
DOI: 10.1002/adma.201805153

**F. La Via, A. Severino, R. Anzalone, C. Bongiorno, G. Litrico, M. Mauceri, M. Schoeler, P. Schuh, P. Wellmann**
From thin film to bulk 3C-SiC growth: Understanding the mechanism of defects reduction
*Materials Science in Semiconductor Processing*, ***78***, *pp. 57-68, 2018*
DOI: 10.1016/j.mssp.2017.12.012

**Arzig, M., Salamon, M., Uhlmann, N., Johansen, B.A., Wellmann, P.**
Growth conditions and in situ computed tomography analysis of facetted bulk growth of SiC boules
*Materials Science Forum, **924**, pp. 245-248, 2018*
https://dx.doi.org/10.4028/www.scientific.net/MSF.924.245

**Schimmel, S., Duchstein, P., Steigerwald, T., Kimmel, A.-C., Schlücker, E., Zahn, D., Niewa R., Wellmann, P**
In situ X-ray monitoring of transport and chemistry of Ga-containing intermediates under ammonothermal growth conditions of GaN
*Journal of Crystal Growth, **498**, pp. 214-223, 2018*
DOI: 10.1016/j.jcrysgro.2018.06.024

**Arzig, M., Hsiao, T., Wellmann, P.**
Optimization of the SiC powder source size distribution for the sublimation growth of long crystal boules *Advanced Materials Proceedings, **3(9)**, pp. 540-543, 2018*
DOI: 10.5185/amp.2018/1414

**Schuster, M., Sisterhenn, P., Graf, L., Wellmann, P.**
Processing and Characterization of Vacuum-Free $CuInSe_2$ Thin Films from Nanoparticle-Precursors using Novel Temperature Treatment Techniques
*International Journal of Nanoparticle Research, **2(4)**, 2018*
DOI: 10.28933/ijnr-2017-12-1501

**Wellmann, P.**
Review of SiC crystal growth technology
*Semiconductor Science and Technology, **33(10)**, pp. 1-21, 2018*
DOI: 10.1088/1361-6641/aad831

**Fahlbusch, L., & Wellmann, P.**
Solution Growth of Silicon Carbide Using the Vertical Bridgman Method
*Crystal Research and Technology, **53(7)**, 2018*
DOI: 10.1002/crat.201800019

**Abdelhaleem, S., Hassanien, A., Ahmad, R., Schuster, M., Ashour, A., Distaso, M., Peukert W., Wellmann, P**
Tuning the Properties of CZTS Films by Controlling the Process Parameters in Cost-Effective Non-vacuum Technique
*Journal of Electronic Materials, **47 (12)**, pp. 7085-7092, 2018*
DOI: 10.1007/s11664-018-6636-4

**Osbel Almora, Clara Aranda, and Germà Garcia-Belmonte**
Do Capacitance Measurements Reveal Light-Induced Bulk Dielectric Changes in Photovoltaic Perovskites?
*The Journal of Physical Chemistry C **122 (25)**, pp. 13450-54, 2018.*
DOI: 10.1021/acs.jpcc.7b11703

**Osbel Almora, Kyung Taek Cho, Sadig Aghazada, Iwan Zimmermann, Gebhard J. Matt, Christoph J. Brabec, Mohammad Khaja Nazeeruddin, and Germà Garcia-Belmonte**
Discerning Recombination Mechanisms and Ideality Factors through Impedance Analysis of High-Efficiency Perovskite Solar Cells
*Nano Energy **48**, pp. 63-72, 2018.*
DOI: 10.1016/j.nanoen.2018.03.042

**Kyung Taek Cho, Giulia Grancini, Yonghui Lee, Emad Oveisi, Jaehoon Ryu, Osbel Almora, Manuel Tschumi, Pascal Alexander Schouwink, Gabseok Seo, Sung Heo, Jucheol Park, Jyongsik Jang, Sanghyun Paek, Germà Garcia-Belmonte, and Mohammad Khaja Nazeeruddin**
Selective Growth of Layered Perovskites for Stable and Efficient Photovoltaics
*Energy & Environmental Science 11 (4), pp. 952-959, 2018.*
DOI: 10.1039/C7EE03513F

**Pilar Lopez-Varo, Juan A. Jiménez-Tejada, Manuel García-Rosell, Sandheep Ravishankar, Germà Garcia-Belmonte, Juan Bisquert, and Osbel Almora**
Device Physics of Hybrid Perovskite Solar Cells: Theory and Experiment
*Advanced Energy Materials 8 (14), 1702772, 2018.*
DOI: 10.1002/aenm.201702772

**Antonio Guerrero, Agustín Bou, Osbel Almora, Thomas Heumuller, Germà Garcia-Belmonte, Juan Bisquert, Yi Hou, and Christoph J. Brabec**
Switching Off Hysteresis in Perovskite Solar Cells by Fine-Tuning Energy Levels of Extraction Layers
*Advanced Energy Materials **8 (21)**, 201703376, 2018.*
DOI: 10.1002/aenm.201703376

## Conference Proceedings

**Doll B, Kornhas J, Hepp J, Buerhop C, Hauch J, Camus C, Brabec C**
Towards true contactless outdoor luminescence of silicon photovoltaic modules with inhomogeneous small area excitation source
*IEEE 7th World Conference on Photovoltaic Energy Conversion, WCPEC 2018 - A Joint Conference of 45th IEEE PVSC, 28th PVSEC and 34th EU PVSEC, pp. 390–394.*

**Bernd Doll, Tobias Pickel, Oliver Schreer, Cornelia Zetzmann, Janine Teubner, Claudia Buerhop, Jens Hauch, Christian Camus, Christoph J. Brabec**
High through-put, outdoor characterization of silicon photovoltaic modules by moving electroluminescence measurements,
*SPIE Optical Engineering + Applications, San Diego, 2018,* ***Vol. 10766****, Infrared Sensors, Devices, and Applications VIII*

**Hermann Bechert, Sebastian Wittmann, Christoph J. Brabec, Thomas Wehlus**
Flexible and highly segmented OLED for automotive applications
*SPIE Proceedings: Organic Electronics and Photonics: Fundamentals and Devices 22.-26.04.2018, Strasbourg, France* ***Vol. 10687****, 10 pages, 2018*
DOI: 10.1117/12.2318442

**Bernd Doll, Tobias Pickel, Oliver Schreer, Cornelia Zetzmann, Janine Teubner, Claudia Buerhop, Jens Hauch, Christian Camus, Christoph J. Brabec**
High throughput, outdoor characterization of silicon photovoltaic modules by moving electroluminescence measurements
*SPIE Proceedings: Infrared Sensors, Devices, and Applications VIII, 19.-23.08.2018 San Diego, California, United States* ***Vol. 10766****, 11 pages, 2018*
DOI: 10.1117/12.2320518

**K. G. Bedrich, J. Chai, and M. Bliss**,
1st International Round Robin on EL Imaging : Automated Camera Calibration and Image Normalisation
*35th EUPVSEC, pp. 1049 - 1056.*

**C. Buerhop-Lutz, S. Deitsch, A. Maier, F. Gallwitz, S. Berger, B. Doll, J. Hauch, C. Camus, C.J. Brabec**
A Benchmark for Visual Identification of Defective Solar Cells in Electroluminescence Imagery
*35th EUPVSEC, pp. 1287 - 1289*.

**C. J. B. Claudia Buerhop, Tobias Pickel, Franziska Wenz, Cornelia Zetzmann, Bernd Doll, Jens Hauch, Christian Camus**,
Influence of the Irradiance on the Detection and Performance of PID-Affected PV-Modules
*35th EUPVSEC, pp. 2001 - 2004.*

**Matthias Arzig, Michael Salamon, Norman Uhlmann, Bertil A. Johansen, Peter J. Wellmann**
Growth Conditions and In Situ Computed Tomography Analysis of Facetted Bulk Growth of SiC Boules *Materials Science Forum, **Vol. 924**, pp. 245-248, 2018*

**Fabian Carigiet, Raphael Knecht,Thomas Baumann,Christoph J. Brabec, Franz P.Baumgartne.**
New PV System Concept – Inductive Power Transfer For PV Modules
*Proceedings of the 35th European Photovoltaic Solar Energy Conference and Exhibition (35th EUPVSEC), September 24-27, 2018 Brussels, Belgium*
DOI: 10.21256/zhaw-4033

**Ning Li, Chaohong Zhang, Christoph J Brabec.**
Microstructure instabilities in solution-processed organic bulk-heterojunction solar cells
*IEEE 7th World Conference on Photovoltaic Energy Conversion (WCPEC) (A Joint Conference of 45th IEEE PVSC, 28th PVSEC & 34th EU PVSEC), pp. 2683-26897, 2018*
DOI: 10.1109/PVSC.2018.8547826

**Lucera L., Machui, F., Kubis P., Egelhaaf H.-J., Brabec C.J.**
Highly efficient, large area, roll coated flexible and rigid solar modules: Design rules and realization
*44th IEEE Photovoltaic Specialist Conference, PVSC 2017, Category number CFP17PSC-ART; Code 136737, 4 pages, 2018*
DOI: 10.1109/PVSC.2017.8366564

**Iftikhar Ahmed Channa, Andreas Distler, Michael Zaiser, Christoph J. Brabec, and Hans-Joachim Egelhaaf**
Thin Film Encapsulation of Organic Solar Cells by Direct Deposition of Polysilazanes from Solution
*Advanced Energy Materials,* ***9(26)****, 10 pages, Article number 1900598, 2019*
DOI: 10.1002/aenm.201900598

**Rui Sun, Jie Guo, Qiang Wu, Zhuohan Zhang, Wenyan Yang, Jing Guo, Mumin Shi, Yaohong Zhang, Simon Kahmann, Long Ye, Xuechen Jiao, Maria A. Loi, Qing Shen, Harald Ade, Weihua Tang, Christoph J. Brabec and Jie Min**
A multi-objective optimization-based layer-by-layer blade-coating approach for organic solar cells: rational control of vertical stratification for high performance
*Energy & Enviromnental Science,* ***10(12)****, pp. 3118-3132, 2019*
DOI: 10.1039/c9ee02295c

**Jing Guo, Yao Wu, Rui Sun, Wei Wang, Jie Guo, Qiang Wu, Xiaofeng Tang, Chenkai Sun, Zhenghui Luo, Kai Chang, Zhuohan Zhang, Jun Yuan, Tengfei Li, Weihua Tang, Erjun Zhou, Zuo Xiao, Liming Ding, Yingping Zou, Xiaowei Zhan, Chuluo Yang, Zhen Li, Christoph J. Brabec, Yongfang Li and Jie Min**
Suppressing photo-oxidation of non-fullerene acceptors and their blends in organic solar cells by exploring material design and employing friendly stabilizers
*Journal of Materials Chemistry A,* ***43(7)****, pp. 25088-25101, 2019*
DOI: 10.1039/c9ta09961a

**Thaer Kassar, Marvin Berlinghof, Nusret Sena Güldal, Tilo Schmutzler, Federico Zontone, Marco Brandl, Ezzeldin Metwalli, Johannes Will, Ning Li,Tayebeh Ameri, Christoph J. Brabec, and Tobias Unruh**
Real-Time Study on Structure Formation and the Intercalation Process of Polymer: Fullerene Bulk Heterojunction Thin Films
*Solar RRL,* ***4(3)****, 10 pages, Article number 1900508, 2019*
DOI: 10.1002/solr.201900508

**Xiaofeng Tang, Gebhard J. Matt, Shuai Gao, Ening Gu, Osbel Almora, and Christoph J. Brabec**
Electrical-Field-Driven Tunable Spectral Responses in a Broadband-Absorbing Perovskite Photodiode
*ACS Applied Materials & Interfaces,* ***11(42)****, pp. 39018-39025, 2019*
DOI: 10.1021/acsami.9b14788

**Baobing Fan, Wenkai Zhong, Lei Ying, Difei Zhang, Meijing Li, Yanrui Lin, Ruoxi Xia, Feng Liu, Hin-Lap Yip, Ning Li, Yuguang Ma, Christoph J. Brabec, Fei Huang & Yong Cao**
Surpassing the 10% efficiency milestone for 1-$cm^2$ all-polymer solar cells
*Nature Communications,* ***10****, Article number 4100, 2019*
DOI: 10.1038/s41467-019-12132-6

**Bernd Doll, Tobias Pickel, Oliver Schreer, Cornelia Zetzmann, Johannes Hepp, Janine Teubner,**
**Claudia Buerhop, Jens A. Hauch, Christian Camus, Christoph J. Brabec**
High-throughput, outdoor characterization of photovoltaic modules by moving electroluminescence measurements
*Optical Engineering, **58(8)**, Article number 083105, 2019*
DOI: 10.1117/1.OE.58.8.083105

**Christina Harreiß, Stefan Langner, Marvin Berlinghof, Stefanie Rechberger, Johannes Will, Tobias Unruh, Christoph J. Brabec, Erdmann Spiecker**
In Situ and Ex Situ Energy-Filtered Transmission Electron Microscopy Studies on the Nanomorpholgy Evolution of Organic Bulk Heterojunction Solar Cells
*Microscopy and Microanalysis, **25**, pp. 2092-2093, 2019*
DOI: 10.1017/S143192761901119X

**Ruoxi Xia, Christoph J. Brabec, Hin-Lap Yip, and Yong Cao**
High-Throughput Optical Screening for Efficient Semitransparent Organic Solar Cells
*Joule, **3(9)**, pp. 2241-2254, 2019*
DOI: 10.1016/j.joule.2019.06.016

**Guitao Feng, Junyu Li, Yakun He, Wenyu Zheng, Jing Wang, Cheng Li, Zheng Tang, Andres Osvet, Ning Li, Christoph J. Brabec, Yuanping Yi, He Yan, and Weiwei Li**
Thermal-Driven Phase Separation of Double-Cable Polymers Enables Efficient Single-Component Organic Solar Cells
*Joule, **3(7)**, pp. 1765-1781, 2019*
DOI: 10.1016/j.joule.2019.05.008

**Christian Camus, Pascal Offermann, Martin Weissmann, Claudia Buerhop, Jens Hauch, Christoph J. Brabec**
Site-specific assessment of mechanical loads on photovoltaic modules from meteorological reanalysis data
*Solar Energy, **188**, pp. 1134-1145, 2019*
DOI: 10.1016/j.solener.2019.06.077

**Andrej Classen, Thomas Heumueller, Isabell Wabra, Johannes Gerner, Yakun He, Lukas Einsiedler, Ning Li, Gebhard J. Matt, Andres Osvet, Xiaoyan Du, Andreas Hirsch, and Christoph J. Brabec**
Revealing Hidden UV Instabilities in Organic Solar Cells by Correlating Device and Material Stability
*Advanced Energy Materials, **9(39)**, Article number 1902124, 2019*
DOI: 10.1002/aenm.201902124

**N. Schrenker, P. Schweizer, M. Moninger, N. Karpstein, M. Mačković, G.D. Spyropoulos, M. Göbelt, S.Christiansen, C. J. Brabec,and E. Spiecker**
Quantitative assessment of the power loss of silicon PV modules by IR thermography and its dependence on data-filtering criteria
*Progress in Photovoltaics, **27(10)**, pp.856-868, 2019*
DOI: 10.1002/pip.3175

**N. Schrenker, P. Schweizer, M. Moninger, N. Karpstein, M. Mačković, G.D. Spyropoulos, M. Göbelt, S.Christiansen, C. J. Brabec,and E. Spiecker**
Mechanical and Electrical Failure of Silver Nanowire Electrodes: A Scale Bridging In Situ Electron Microscopy Study
*Microscopy and Microanalysis, **25**, pp. 2038-2039, 2019*
DOI: 10.1017/S1431927619010924

**César Omar Ramírez Quiroz,* George D. Spyropoulos, Michael Salvador, Loïc M. Roch, Marvin Berlinghof, José Darío Perea, Karen Forberich, Laura-Isabelle Dion-Bertrand, Nadine J. Schrenker, Andrej Classen, Nicola Gasparini, Ganna Chistiakova, Mathias Mews, Lars Korte, Bernd Rech, Ning Li, Frank Hauke, Erdmann Spiecker, Tayebeh Ameri, Steve Albrecht, Gonzalo Abellán, Salvador León, Tobias Unruh, Andreas Hirsch, Alán Aspuru-Guzik, and Christoph J. Brabec**
Interface Molecular Engineering for Laminated Monolithic Perovskite/Silicon Tandem Solar Cells with 80.4% Fill Factor
*Advanced Functional Materials, **29(40)**, Article number 1901476, 2019*
DOI: 10.1002/adfm.201901476

**Jingyang Xiao, Minrun Ren, Guichuan Zhang, Jianbin Wang, Donglian Zhang,Linlin Liu, Ning Li, Christoph J. Brabec, Hin-Lap Yip, and Yong Cao**
An Operando Study on the Photostability of NonfullereneOrganic Solar Cells
*Solar RRL, **3(7)**, 9 pages, Article number 1900077, 2019*
DOI: 10.1002/solr.201900077

**Linxiang Zeng, Zongao Chen, Shudi Qiu, Jinlong Hu, Chaohui Li, Xianhu Liu, Guangxing Liang, Christoph J. Brabec, Yaohua Mai, Fei Guo**
2D-3D heterostructure enables scalable coating of efficient low-bandgap Sn–Pb mixed perovskite solar cells
*Nano Energy, **66**, 11 pages, Article number 104099, 2019*
DOI: 10.1016/j.nanoen.2019.104099

**Juliane Borchert, Ievgen Levchuk, Lavina C. Snoek, Mathias Uller Rothmann, Renée Haver,‖Henry J. Snaith, Christoph J. Brabec, Laura M. Herz, and Michael B. Johnston**
Impurity Tracking Enables Enhanced Control and Reproducibility of Hybrid Perovskite Vapor Deposition
*ACS Applied Materials & Interfaces, 11(32), pp. 28851-28857, 2019*
DOI: 10.1021/acsami.9b07619

**Daniel Cruz, José Garcia Cerrillo, Baris Kumru, Ning Li, Jose Dario Perea, Bernhard V. K. J. Schmidt, Iver Lauermann, Christoph J. Brabec and Markus Antonietti**
Influence of Thiazole-Modified Carbon Nitride Nanosheets with Feasible Electronic Properties on Inverted Perovskite Solar Cells
*Journal of the American Chemical Society, **141(31)**, pp. 12322-12328, 2019*
DOI: 10.1021/jacs.9b03639

**B. Doll, E. Calderón del Rivero, J. Hepp, T. Pickel, C. Buerhop, R. Knecht, C. Camus, J. Hauch, J. Parisi and C.J. Brabec**
Quantitative Assessment of the Influence of Camera and Parameter Choice for Outdoor Electroluminescence Investigations of Silicon Photovoltaic Panels
*Zeitschrift für Naturforschung Section A - A Journal of Physical Sciences, 9 pages, 2019*
DOI: 10.1515/zna-2019-0025

**Philipp Maisch, Lena M. Eisenhofer, Kai Cheong Tam, Andreas Distler, Monika M. Voigt, Christoph J. Brabec and Hans-Joachim Egelhaaf**
A generic surfactant-free approach to overcome wetting limitations and its application to improve inkjet-printed P3HT:non-fullerene acceptor PV
*Journal of Materials Chemistry A, 7, pp. 13215-13224, 2019*
DOI: 10.1039/C9TA02209K

**Fei Guo, Shudi Qiu, Jinlong Hu, Huahua Wang, Boyuan Cai, Jianjun Li, Xiaocong Yuan, Xianhu Liu, Karen Forberich, Christoph J. Brabec and Yaohua Mai**
A Generalized Crystallization Protocol for Scalable Deposition of High-Quality Perovskite Thin Films for Photovoltaic Applications
*Advanced Science, **6(17)**, Article number 1901067, 2019*
DOI: 10.1002/advs.201901067

**Chaohong Zhang, Thomas Heumueller, Wolfgang Gruber, Osbel Almora, Xiaoyan Du, Lei Ying, Junwu Chen, Tobias Unruh, Yong Cao, Ning Li and Christoph J. Brabec**
Comprehensive Investigation and Analysis of Bulk-Heterojunction Microstructure of High-Performance PCE11:PCBM Solar Cells
*ACS Applied Materials & Interfaces, **11(20)**, pp. 18555-18563, 2019*
DOI: 10.1021/acsami.8b22539

**Nicola Gasparini, Simon Kahmann, Michael Salvador, Jose Dario Perea, Andreas Sperlich, Andreas Baumann, Ning Li, Stefanie Rechberger, Erdmann Spiecker, Vladimir Dyakonov, Giuseppe Portale, Maria A. Loi, Christoph J. Brabec, and Tayebeh Ameri**
Favorable Mixing Thermodynamics in Ternary Polymer Blends for Realizing High Efficiency Plastic Solar Cells
*Advanced Energy Materials, **9(19)**, Article number 1803394, 2019*
DOI: 10.1002/aenm.201803394

**Yakun He, Thomas Heumüller, Wenbin Lai, Guitao Feng, Andrej Classen, Xiaoyan Du, Chao Liu, Weiwei Li, Ning Li, and Christoph J. Brabec**
Evidencing Excellent Thermal- and Photostability for Single-Component Organic Solar Cells with Inherently Built-In Microstructure
*Advanced Energy Materials, **9(21)**, Article number 1900409, 2019*
DOI: 10.1002/aenm.201900409

**Jingjing Tian, Qifan Xue, Xiaofeng Tang, Yuxuan Chen, Ning Li, Zhicheng Hu, Tingting Shi, Xin Wang, Fei Huang, Christoph J. Brabec, Hin-Lap Yip, and Yong Cao**
Dual Interfacial Design for Efficient CsPbI2Br Perovskite Solar Cells with Improved Photostability
*Advanced Materials, **31(23)**, Article number 1901152, 2019*
DOI: 10.1002/adma.201901152

**Fei Guo, Wenxin He, Shudi Qiu, Chuan Wang, Xianhu Liu, Karen Forberich, Christoph J. Brabec, and Yaohua Mai**
Sequential Deposition of High-Quality Photovoltaic Perovskite Layers via Scalable Printing Methods
*Advanced Functional Materials, **29(24)**, Article number 1900964, 2019*
DOI: 10.1002/adfm.201900964

**Osbel Almora, Pilar Lopez-Varo, Kyung Taek Cho, Sadig Aghazada, Wei Meng, Yi Hou, Carlos Echeverría-Arrondo, Iwan Zimmermann, Gebhard J. Matt, Juan A. Jiménez-Tejada, Christoph J. Brabec, Mohammad Khaja Nazeeruddin, Germà Garcia-Belmonte**
Ionic dipolar switching hinders charge collection in perovskite solar cells with normal and inverted hysteresis
*Solar Energy Materials and Solar Cells,* **195***, pp. 291-298, 2019*
DOI: 10.1016/j.solmat.2019.03.003

**Peter Kubis, Jan Winter, Anna Gavrilova, Markus Hennel, Susanne Schlosser, Isabel Richter, Andreas Distler, Madeleine Heyder, Stefan Kery, Peter Lenk, Stephan Geiger, Christoph J. Brabec, Heinz P. Huber, Hans-Joachim Egelhaaf**
All sub-nanosecond laser monolithic interconnection of OPV modules
*Progress in Photovoltaics: Research and Applications, **27(6)**, pp. 479-490, 2019*
DOI: 10.1002/pip.3115

**Chaohong Zhang,Thomas Heumueller, Salvador Leon, Wolfgang Gruber, Klaus Burlafinger, Xiaofeng Tang, Jose D. Perea, Isabell Wabra, Andreas Hirsch, Tobias Unruh, Ning Li and Christoph J. Brabec**
A top-down strategy identifying molecular phase stabilizers to overcome microstructure instabilities in organic solar cells
*Energy & Enviromnental Science* **12,** *pp. 1078-1087, 2019*
DOI: 10.1039/c8ee03780a

**Xiaoyan Du, Thomas Heumueller, Wolfgang Gruber, Andrej Classen, Tobias Unruh, Ning Li, Christoph J. Brabec**
Efficient Polymer Solar Cells Based on Non-fullerene Acceptors with Potential Device Lifetime Approaching 10 Years
*Joule* **3(1),** *pp. 215-226, 2019*
DOI: 10.1016/j.joule.2018.0

**André Karl, Andres Osvet, Andreas Vetter, Philipp Maisch, Ning Li, Hans Joachim Egelhaaf, Christoph J. Brabec**
Discriminating bulk versus interface shunts in organic solar cells by advanced imaging techniques
*Progress in Photovoltaics: Research and Applications 1-9, 2019*
DOI: 10.1002/pip.3121

**Lucija Rakocevic, Felix Ernst, Nadine T. Yimga, Saumye Vashishtha, Tom Aernouts, Thomas Heumueller, Christoph J. Brabec, Robert Gehlhaar, and Jef Poortmans**
Reliable Performance Comparison of Perovskite Solar Cells Using Optimized Maximum Power Point Tracking
*Solar RRL **3(2),** Article number 1800287, 2019*
DOI: 10.1002/solr.201800287

**Andrej Classen, Lukas Einsiedler, Thomas Heumueller, Arko Graf, Maximilian Brohmann, Felix Berger, Simon Kahmann, Moses Richter, Gebhard J. Matt, Karen Forberich, Jana Zaumseil, and Christoph J. Brabec**
Absence of Charge Transfer State Enables Very Low $V_{OC}$ Losses in SWCNT:Fullerene Solar Cells
*Advanced Energy Materials **9(1),** Article number 1801913, 2019*
DOI: 10.1002/aenm.201801913

**Johannes Hepp, Andreas Vetter, Stefan Langner, Michael Woiton, Gordana Jovicic, Klaus Burlafinger,Jens A. Hauch, Christian Camus, Hans-Joachim Egelhaaf, and Christoph J. Brabec**
Infrared absorption imaging of water ingress into the encapsulation of (opto-)electronic devices
*IEEE Journal of Photovoltaics **9(1),** pp. 252-258, 2019*
DOI: 10.1109/JPHOTOV.2018.2

**AmirAbbas YousefiAmin, Niall A. Killilea, Mykhailo Sytnyk, Philipp Maisch, Ka Cheong Tam, Hans-Joachim Egelhaaf, Stefan Langner, Tobias Stubhan, Christoph J. Brabec, Tobias Rejek, Marcus Halik, Katharina Poulsen, Jan Niehaus, Anton Köck, and Wolfgang Heiss**
Fully Printed Infrared Photodetectors from PbS Nanocrystals with Perovskite Ligands
*ACS Nano **13(2),** pp. 2389-2397, 2019*
DOI: 10.1021/acsnano.8b09223

**Hou Y., Xie C., Radmilovic V.V., Puscher B., Wu M., Heumüller T., Karl A., Li N., Tang X., Meng W., Chen S., Osvet A., Guldi D.M., Spiecker E., Radmilovic V.R., Brabec C.**
Assembling Mesoscale-Structured Organic Interfaces in Perovskite Photovoltaics
*Advanced Materials **31(8),** Article number 1806516, 2019*
DOI: 10 10.1002/adma.201806516

**Ellen Hertle, Liudmyla Chepyga, Andres Osvet, Christoph J Brabec, Miroslaw Batentschuk, Stefan Will, and Lars Zigan**
$(Gd,Lu)AlO_3:Dy^{3+}$ and $(Gd,Lu)_3Al_5O_{12}:Dy^{3+}$ as high-temperature thermographic phosphors
*Measurement Science & Technology* ***30(3),*** *9 pages, 2019*
DOI: 10.1088/1361-6501/aafcac

**Hermann Bechert, Osbel Almora, Kilian Regau, Gebhard J. Matt, Christoph J. Brabec, and Thomas Wehlus**
Thin-Film Electrostatic Discharge Protection for Highly Segmented OLEDs in Automotive Applications
*Advanced Materials Technologies,* ***4(5)****, Article number 1800696, 2019*
DOI: 10.1002/admt.201800696

**Biele M., Montenegro Benavides C., Hürdler J., Tedde S.F., Brabec C.J., Schmidt O.**
Spray-Coated Organic Photodetectors and Image Sensors with Silicon-Like Performance
*Advanced Materials Technologies* ***4(1)****, Article number 1800158, 2019*
DOI: 10.1002/admt.201800158

**Philipp Maisch, Kai Cheong Tam, Pavel Schilinsky, Hans-Joachim Egelhaaf, and Christoph J. Brabec.**
Shy Organic Photovoltaics: Digitally Printed Organic Solar Modules With Hidden Interconnects
*Solar RRL* **2(7),** *9 pages, Article number 1800005, 2018*
DOI: 10.1038/s41467-018-07807-5

**Chen Xie, Thomas Heumüller, Wolfgang Gruber, Xiaofeng Tang, Andrej Classen, Isabel Schuldes, Matthew Bidwell, Andreas Späth, Rainer H. Fink, Tobias Unruh, Iain McCulloch, Ning Li & Christoph J. Brabec.**
Overcoming efficiency and stability limits in water-processing nanoparticular organic photovoltaics by minimizing microstructure defects
*Nature Communications* **9***, Article number 5335, 11 pages, 2018*
DOI: 10.1038/s41467-018-07807-5

**Osbel Almora, Marisé García-Batlle and Germà Garcia-Belmonte**
Utilization of Temperature-Sweeping Capacitive Techniques to Evaluate Band Gap Defect Densities in Photovoltaic Perovskites
*J. Phys. Chem. Lett.* **10(13),** *pp. 3661-3669, 2019*
DOI: 10.1021/acs.jpclett.9b00601

**Osbel Almora and Germà Garcia-Belmonte.**
Light capacitances in silicon and perovskite solar cells
*Solar Energy* **189***, pp. 103-110, 2019.*
DOI: 10.1016/j.solener.2019.07.048

**Arzig, M.; Salamon, M.; Uhlmann, N.; Wellmann, P. J.**
Investigation of the Growth Kinetics of SiC Crystals during Physical Vapor Transport Growth by the Application of In Situ 3D Computed Tomography Visualization
*Adv. Eng. Mater., Article number 190077, 2019*
DOI: 10.1002/adem.201900778

**Steiner, J.; Arzig, M.; Wellmann, P. J.**
Impact of varying parameters on the temperature gradients in 100 mm silicon carbide bulk growth in a computer simulation validated by experimental results.
*Cryst. Res. Technol.,* **55(2),** *Article number 1900121, 9 pages, 2020.*
DOI: 10.1002/crat.201900121

**Schöler, M., Brecht, C., Wellmann, P.J.**
Annealing-induced changes in the nature of point defects in sublimation-grown cubic silicon carbide
*Materials,* **12(15),** *2487, 2019*
DOI: 10.3390/ma12152487

**Schöler, M., Lederer, M.W., Wellmann, P.J.**
Deep electronic levels in n-type and p-type 3C-SiC
*Materials Science Forum, 963, pp. 297-300, 2019*
DOI: 10.4028/www.scientific.net/MSF.963.297

**Schöler, M., Lederer, M.W., Schuh, P., Wellmann, P.J.**
Intentional Incorporation and Tailoring of Point Defects during Sublimation Growth of Cubic Silicon Carbide by Variation of Process Parameters
*Physica Status Solidi (B),* **257(1)***, 1900286, 2020*
DOI: 10.1002/pssb.201900286

**Schöler, M., Schuh, P., Steiner, J., Wellmann, P.J.**
Modeling of the PVT growth process of bulk 3C-SiC-growth process development and challenge of the right materials data base
*Materials Science Forum,* **963***, pp. 157-160, 2019*
DOI: 10.4028/www.scientific.net/MSF.963.157

**Michael Schöler, Maximilian W. Lederer, Philipp Schuh, Peter J. Wellmann;**
Incorporation and control of defects with quantum functionality during sublimation growth of cubic silicon carbide
*arXiv:1906.07433 [cond-mat.mtrl-sci] 2019*

**Matthias Schuster , Dominik Stapf, Tobias Osterrieder, Vincent Barthel and Peter J. Wellmann**
Vacuum-Free and Highly Dense Nanoparticle Based Low-Band-Gap $CuInSe_2$ Thin-Films Manufactured by Face-to-Face Annealing with Application of Uniaxial Mechanical Pressure
*Coatings* 2019, **9(8)**, 484
DOI: 10.3390/coatings9080484

**Johannes Steiner, Melissa Roder, Binh Duong Nguyen, Stefan Sandfeld, Andreas Danilewsky and Peter J. Wellmann**
Analysis of the Basal Plane Dislocation Density and Thermomechanical Stress during 100 mm PVT Growth of 4H-SiC
*Materials* **2019**, **12(13),** 2207
DOI: 10.3390/ma12132207

**Ellefsen, O.M.; Arzig, M.; Steiner, J.; Wellmann, P.; Runde, P.**
Optimization of the SiC Powder Source Material for Improved Process Conditions During PVT Growth of SiC Boules
*Materials* **2019**, **12(19)**, 3272.
DOI: 10.3390/ma12193272

**Arzig, M.; Steiner, J.; Salamon, M.; Uhlmann, N.; Wellmann, P.J**.
Influence of Morphological Changes in a Source Material on the Growth Interface of 4H-SiC Single Crystals
*Materials* **2019**, **12(16)**, 2591.
DOI: 10.3390/ma12162591

**Schuh, P.; Steiner, J.; La Via, F.; Mauceri, M.; Zielinski, M.; Wellmann, P.J.**
Limitations during Vapor Phase Growth of Bulk (100) 3C-SiC Using 3C-SiC-on-SiC Seeding Stacks
*Materials* **2019**, **12(15),** 2353.
DOI: 10.3390/ma12152353

**Schöler, Michael, Philipp Schuh, Johannes Steiner, and Peter J. Wellmann.**
Modeling of the PVT Growth Process of Bulk 3C-SiC - Growth Process Development and Challenge of the Right Materials Data Base.
*Materials Science Forum,* **963***, pp. 157–160, 2019*
DOI: 10.4028/www.scientific.net/MSF.963.157

**B. Fan, Z. Zeng, W. Zhong, L. Ying, D. Zhang, M. Li, F. Peng, N. Li, F. Huang, Y. Cao**
Optimizing microstructure morphology and reducing electronic losses in 1cm$^2$ polymer solar cells to achieve efficiency over 15%
*ACS Energy Letters 2019,* **4***, 2466.*
DOI: 10.1021/acsenergylett.9b01447

**E. M. Speller, A. J. Clarke, J. Luke, H. K. H. Lee, J. R. Durrant, N. Li, T. Wang, H. C. Wong, J.-S. Kim, W. C. Tsoi, Z. Li**
From fullerene acceptors to non-fullerene acceptors: prospects and challenges in the stability of organic solar cells
*Journal of Materials Chemistry A, 2019,* **7***, 23361.*
DOI: 10.1039/C9TA05235F

**Z. Li, W. Zhong, L. Ying, F. Liu, N. Li, F. Huang, Y. Cao**
Morphology optimization via molecular weight tuning of donor polymer enables all-polymer solar cells with simultaneously improved performance and stability
*Nano Energy 2019,* **64***, 103931.*
DOI: 10.1016/j.nanoen.2019.103931

**X. Wang, Y. Pan, X. Liu, H. Liu, N. Li, C. Liu, D. W. Schubert, C. Shen**
Facile and green fabrication of super hydrophobic biodegradable and eco-friendly polylactic acid foam for oil-water separation via skin-peeling
*ACS Applied Materials & Interfaces 2019,* **11***, 15, pp.14362-14367*
DOI: 10.1021/acsami.9b02285

**Z. Li, L. Ying, P. Zhu, W. Zhong, N. Li, F. Liu, F. Huang, Y. Cao**
A generic green solvent concept boosting the performance of all-polymer solar cells to 11%
*Energy & Environmental Science 2019,* **12***, pp. 157-163.*
DOI: 10.1039/C8EE02863J

**Jing Wei, Fengwan Guo, Bing Liu, Xiangyu Sun, Xi Wang, Zijiang Yang, Kun Xu, Ming Lei, Yicheng Zhao, and Dongsheng Xu**
UV-Inert $ZnTiO_3$ Electron Selective Layer for Photostable Perovskite Solar Cells
*Advanced Energy Materials* **9(40)***, Article number 1901620, 2019*
DOI: 10.1002/aenm.201901620

**Adam K. Budniak, Niall A. Killilea, Szymon J. Zelewski, Mykhailo Sytnyk, Yaron Kauffmann, Yaron Amouyal, Robert Kudrawiec, Wolfgang Heiss, and Efrat Lifshitz**
Exfoliated $CrPS_4$ with Promising Photoconductivity
*Small* **16(1),** *Article number 1905924, 2019*
DOI: 10.1002/smll.201905924

**Mustapha Abdu-Aguye, Dmytro Bederak, Simon Kahmann, Niall Killilea, Mykhailo Sytnyk, Wolfgang Heiss, and Maria Antonietta Loi**
Photophysical and Electronic Properties of Bismuth-Perovskite Shelled Lead Sulfide Quantum Dots.
*J. Chem. Phys.,* **151***, 214702, 2019.*
DOI: 10.1063/1.5128885

**Mykhailo Sytnyk, Sarah Deumel, Sandro Francesco Tedde, Gebhard J. Matt, and Wolfgang Heiss**
A Perspective on the Bright Future of Metal Halide Perovskites for X-Ray Detection.
*Appl. Phys. Lett.* **115***, Article Number 190501, 2019.*
DOI: 10.1063/1.5125999

**Niall Killilea, Mingjian Wu, Mykhailo Sytnyk, Amir Abbas Yousefi Amin, Oleksandr Mashkov, Erdmann Spiecker, and Wolfgang Heiss**
Pushing PbS/Metal-Halide-Perovskite Core/Epitaxial-Ligand-Shell Nanocrystal Photodetectors beyond 3 μm Wavelength
*Advanced Functional Materials,* **29(14)***, Article number 1807964, 2019*
DOI: 10.1002/adfm.201807964

**Loreleyn F. Flores, Karem Y. Tucto, Jorge A. Guerra, Jan A. Töfflinger, Erick S. Serquen, Andres Osvet, Miroslaw Batentschuk, Albrecht Winnacker, Rolf Grieseler, Roland Weingärtner**
Luminescence properties of $Yb^{3+}$-$Tb^{3+}$ co-doped amorphous silicon oxycarbide thin films
*Opt Mater (Amst);* **92***, pp. 16–21, 2019*
DOI:10.1016/j.optmat.2019.04.003

**Zorenko, T., Paprocki, K., Levchuk, I., Batentschuk, M., Epelbaum, B., Fedorov, A., Zorenko, Y.**
Luminescent properties of $Ce^{3+}$ doped $LiLuP_4O_{12}$ tetraphosphate under synchrotron radiation excitation
*Journal of Luminescence,* **210***, pp. 47-51.*
DOI: 10.1016/j.jlumin.2019.02.016

**Lin L, Ou Y, Jokubavicius V, Syväjärvi M, Liang M, Liu Z, Yi X, Schuh P, Wellmann P, Herstrøm B, Jensen F, Ou H**
An adhesive bonding approach by hydrogen silsesquioxane for silicon carbide-based LED applications
*Materials Science in Semiconductor Processing*, **91**, *pp. 9-12*.
DOI: 10.1016/j.mssp.2018.10.028

**Hassanien, A.E.; Abdelhaleem, Soraya; Ahmad, Rameez; Schuster, Matthias; Moustafa, S. H.; Distaso, Monica; Peukert, Wolfgang; Wellmann, P. J.**
Effect of Fast Annealing on Structural Characteristics and Optical Properties of $Cu_2ZnSnS_4$ Absorber Films Deposited by Doctor-Blade Technique
*Nanoelectronics and Optoelectronics,* **14(10)***, 1394-1400*
DOI: 10.1166/jno.2019.2633

**Philipp Schuh, Francesco La Via, Marco Mauceri, Marcin Zielinski, and Peter J. Wellmann**
Growth of Large-Area, Stress-Free, and Bulk-Like 3C-SiC (100) Using 3C-SiC-on-Si in Vapor Phase Growth
*Materials* **2019**, **12(13),** 2179
DOI: 10.3390/ma12132179

**Abebe T. Tarekegne, K. Norrman, V. Jokubavicius, M. Syväjärvi, P. Schuh, P. Wellmann & H. Ou**
Impacts of carrier capture processes in the thermal quenching of photoluminescence in Al–N co-doped SiC
*Appl. Phys. B* **125,** *172, 2019*
DOI: 10.1007/s00340-019-7279-8

**Philipp Schuh, Ulrike Künecke, Grazia Litrico, Marco Mauceri, Francesco La Via, Sylvain Monnoye, Marcin Zielinski, Peter J. Wellmann**
Vapor Growth of 3C-SiC Using the Transition Layer of 3C-SiC on Si CVD Templates
*Mater. Sci. Forum* ***2019****, 963, pp. 149-152*
DOI: 10.4028/www.scientific.net/MSF.963.149

## Conference Proceedings

**Zekun Ren, Felipe Oviedo, Hansong Xue, Muang Thway, Kaicheng Zhang, Ning Li, Jose Dario Perea, Mariya Layurova, Yue Wang, Siyu Tian, Thomas Heumueller, Erik Birgersson, Fen Lin, Armin Aberle, Shijing Sun, Ian Marius Peters, Rolf Stangl, Christoph J. Brabec, Tonio Buonassisi**
Physics-guided characterization and optimization of solar cells using surrogate machine learning model
*Proceedings of 2019 IEEE 46th Photovoltaic Specialists Conference (PVSC), 16-21 June, 2019, Chicago, IL, USA*
DOI: 10.1109/PVSC40753.2019.8980715

**Lucija Rakocevic, Felix Ernst, Robert Gehlhaar, Tom Aernouts, Christoph Brabec, Jef Poortmans**
Reliable comparison of perovskite solar cell performance using maximum power point tracking
*Proceedings of International Conference on Hybrid and Organic Photovoltaics (HOPV19), 12-15 May, 2019, Rome, Italy*
DOI: 10.29363/nanoge.hopv.2019.031

**V. A. Camargo Franco, Nicola Gasparini, Tetsuhiko Nagahara, Larry Lüer, Giulio Cerullo and Christoph Brabec**
Instantaneous charge separation in non-fullerene acceptor bulk-heterojunction of highly efficient solar cells
*EPJ Web of Conferences* **205***, 05010, 2019*
DOI: 10.1051/epjconf/201920505010

**Juliane Bochert, Ievgen Levchuk, Lavina C. Snoek, Mathias Uller Rothmann, Henry J. Snaith, Christoph J. Brabec, Laura M. Herz, Michael B. Johnston**
Impurities and their influence on the co-evaporation of methylammonium perovskite thin-film solar cells
*Proceedings of the International Conference on Hybrid and Organic Photovoltaics (HOPV19), 12-15 May, 2019, Rome, Italy*
DOI: 10.29363/nanoge.hopv.2019.140

**Ievgen Levchuk, Judith Knüttel, Shreetu Shrestha, Johannes Dallmann, Rainer Hock, Wolfgang Heiss, Christoph J.Brabec**
High Performance X-ray to Current Converters Fabricated via Sintering or Melting of a Metal-Halide Perovskite
*Proceedings of the nanoGe Fall Meeting 2019, 4-8 November, 2019, Berlin, Germany*
DOI: 10.29363/nanoge.ngfm.2019.142

**Claudia Buerhop, Tobias Pickel, Janine Teubner, Bernd Doll, Jens Hauch, Christoph J. Brabec**
Analysis of digitized PV-module/system data for failure diagnosis
*Proceedings of the 36th EU PVSEC 2019 Conference, 9-13 September, 2019, Marseille, France*
DOI: 10.4229/EUPVSEC20192019-5BO.7.6

**Mathis Hoffmann, Bernd Doll, Florian Talkenberg, Christoph J. Brabec, Andreas K. Maier, and Vincent Christlein**
Fast and Robust Detection of Solar Modules in Electroluminescence Images
*Proceedings of the 18th International Conference, Computer Analysis of Images and Pattern 2019 (CAIP 2019), Salerno, Italy, September 3–5, 2019*
DOI: 10.1007/978-3-030-29891-3-46

**Arzig, M.; Steiner, J.; Salamon, M.; Uhlmann, N.; Wellmann, P. J.**
Influence of Morphological Changes in a Source Material on the Growth Interface of 4H-SiC Single Crystals *Materials (Basel)* ***2019****, 12, (16)*
DOI: 10.3390/ma12162591

**Salamon, M.; Arzig, M.; Wellmann, P. J.; Uhlmann, N**.
Comparison of Achievable Contrast Features in Computed Tomography Observing the Growth of a 4H-SiC Bulk Crystal
*Materials (Basel)* **2019,** *12, (22)*
DOI: 10.3390/ma12223652

**Salamon, M.; Arzig, M.; Uhlmann, N.; Wellmann, P. J.**
Advances in *In Situ* SiC Growth Analysis Using Cone Beam Computed Tomography
*Mater. Sci. Forum* ***2019****, 963, 5-9*
DOI: 10.4028/www.scientific.net/MSF.963.5

**M. Salamon, M. Arzig, P. J. Wellmann,N. Uhlmann**
Three-dimensional in-situ growth surveillance of bulky SiC crystals
*Proceedings of the International Symposium on Digital Industrial Radiology and Computed Tomography – DIR2019, (****2019****)*

**Ellefsen, O. M.; Arzig, M.; Steiner, J.; Wellmann, P.; Runde, P.**
Optimization of the SiC Powder Source Material for Improved Process Conditions During PVT Growth of SiC Boules
*Materials (Basel)* ***2019****, 12, (19)*
DOI: 10.3390/ma12193272

**Steiner, J.; Arzig, M.; Hsiao, T. C.; Wellmann, P. J.**
Optimization of the SiC Powder Source Size Distribution for the Sublimation Growth of Long Crystals Boules *Mater. Sci. Forum* ***2019****, 963, 42-45*
DOI: 10.4028/www.scientific.net/MSF.963.42

**Schöler, M., Brecht, C., Wellmann, P.J.**
Investigation of near infrared photoluminescence in cubic silicon carbide
*E-MRS 2019, Nice –(X X-VIb.3)*

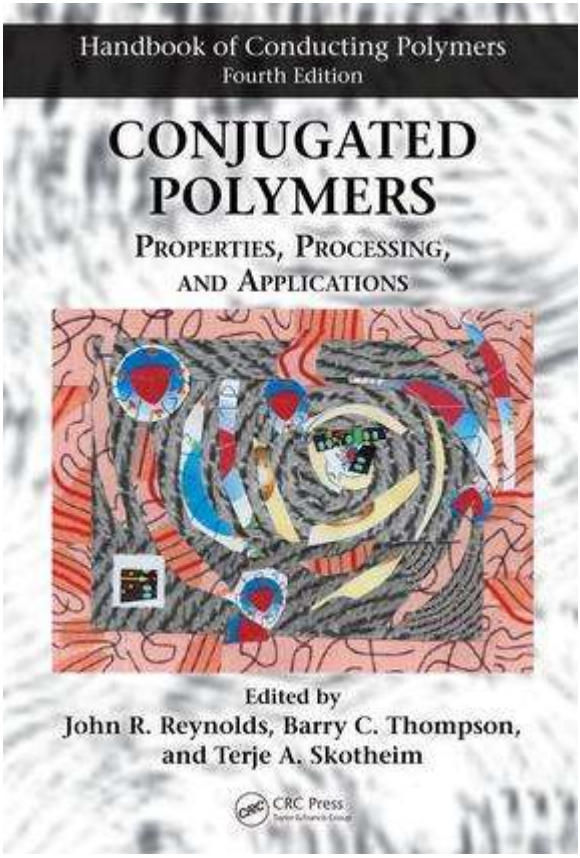
# 10. Books & Book Chapters

**Stefan Langner, Jose Dario Perea Ospina, Chaohong Zhang, Ning Li, Christoph J. Brabec.**

The Relevance of Solubility and Miscibility for the Performance of Organic Solar Cells
*Book Chapter in Conjugated Polymers. Properties, Processing, and Applications. Edited By John R. Reynolds, Barry C. Thompson, Terje A. Skotheim, Boca Raton: CRC Press, Chapter 15, 2019*

eBook ISBN: 9780429190520

DOI: 10.1201/9780429190520-15



# 11. Presentations at Conferences, Workshops, Events

## 2018

### Almora Osbel

**28 – 31.05.2018**
10th International Conference on Hybrid and Organic Photovoltaics (HOPV-18), Benidorm, Spain
Poster: *Discerning Recombination Mechanisms in Perovskite Solar Cells including 2D/3D Interfaces and Mixed Anions/Cations Absorbers*

**26 – 31.08.**
8th International Conference on Optical, Optoelectronic and Photonic Materials and Applications (ICOOPMA-2018), Maresias-SP, Brazil
Talk: *Anomalous Capacitive Features in Perovskite Solar Cells*

**30.09.2018 – 02.10.2018**
4th International Conference on Perovskite Solar Cells and Optoelectronics (PSCO-2018), Lausanne, Switzerland
Poster: *Capacitive Features of Perovskite Solar Cells: Connecting Theory and Experiment*

### Arzig, Matthias

**03 – 06.09.2018**
European Conference on Silicon Carbide and Related Materials (ECSCRM 2018), Birmingham, United Kingdom
Talk: *Growth Conditions and In Situ Computed Tomography Analysis of Facetted Bulk Growth of SiC Boules*

**10.10.2018**
DGKK Arbeitskreis treffen “Massive Halbleiterkristalle”
Talk: *In-Situ Charakterisierung der Wachstumsfläche von SiC-Einkristallen mittels Röntgen-Computertomographie*

### Batentschuk, Miroslaw

**08. – 13.07.2018**
2018 Europhysical Conference on Defects in Insulating Materials (EURODIM 2018), Bydgoszcz, Poland
Invited talk: *Defects in light conversion phosphors with a high fluorescent quantum yield for white light emitting diodes and solar cells*

### Bechert, Hermann

**26.04.2018**
SPIE Photonics Europe, Strasbourg, France
Talk: *Flexible and highly segmented OLED for automotive applications*

## Brabec, Christoph J.

**25.01.2018**
Imperial Plastic Electronics Graduate School, London, United Kingdom
Invited talk: *Understanding Non Fullerene Acceptors in Organic Solar Cells*

**26.01.2018**
Imperial Plastic Electronics Graduate School, London, United Kingdom
Invited talk: *Advanced Interface Concepts in Perovskite Solar Cells*

**23.02.2018**
SEPV COST Conference, Barcelona, Spain
Invited talk: *The role of miscibility on burn-in degradation – addressing microstructure instabilities*

**23.03.2018**
South China University of Technology, Guangzhou, China
Invited talk: *The Materials Genome for the PV Terrawatt Era*

**04.04.2018**
MRS Spring Meeting, Phoenix, Arizona, USA
Invited talk: *Non Fullerene Acceptors for OPV: enhancing stability and reducing VOC losses*

**05.04.2018**
MRS Spring Meeting, Phoenix, Arizona, USA
Invited talk: *Perovskite Solar Cells: from 4T to 2T concepts with solution processing*

**12.04.2018**
University Jena, CEEC, Jena, Germany
Invited talk: *The Materials Genome for Photovoltaic Materials*

**08.05.2018**
PHONSI – a European ITR Workshop, Nürnberg, Germany
Invited talk: *From Lab to Fab: Printed Photovoltaics*

**04.06.2018**
FU Berlin (GDCH Talk), Berlin, Germany
Invited talk: *The Material´s Genome Quest*

**07.06.2018**
Belgrad Academy of Science, Belgrad, Serbia
Invited talk: *The Material´s Genome Quest*

**08.06.2018**
Belgrad Academy of Science, Belgrad, Serbia
Invited talk: *Advanced Interface Engineering for Perovskites Devices*

**18.06.2018**
International Conference on Organic Electronics (ICOE), Bordeaux, France
Invited talk: *A Robot Based High Throughput Approach to address microstructure instabilities in bulk heterojunction composites*

**04.07.2018**
ICSM, Busan, Korea
Invited talk: *Non Fullerene Acceptor BHJ Composites: Insights into Mechanisms Suppressing Non-Radiative Recombination & Governing $V_{OC}$ Losses*

**01.10.2018**
4th International Conference on Perovskite Solar Cells and Optoelectronics (PSCO18), Lausanne, Switzerland
Invited talk: *Accelerating the Perovksite Technology with Smart Automation*

**02.10.2018**
4th International Conference on Perovskite Solar Cells and Optoelectronics (PSCO18), Lausanne, Switzerland
Invited talk: *Perovksite Solar Cells: from 4T to 2T tandem concepts with solution processing*

**03.10.2018**
SOLTECH, Würzburg, Germany
Invited talk: *Interface Engineering for High Performance Perovskite Solar Cells*

**22.10.2018**
11th International Summit on Organic and Hybrid Photovoltaics Stability, Suzhou, China
Plenary talk: *How to stabilize organic solar cells beyond 100.000 hrs of operational stability*

**20.11.2018**
ZSW Conference on Perovksites, Stuttgart, Germany
Invited talk: *Perovksite Solar Cells – Towards Printed Tandem Architectures*

## Chepyga, Liudmyla

**08. – 13.07.2018**
2018 Europhysical Conference on Defects in Insulating Materials (EURODIM 2018), Bydgoszcz, Poland
Talk: *Influence of $Mg^{2+}$ and $Si^{4+}$ substitution on the emission properties of $Y_3Al_5O_{12}$: $Ce^{3+}$ as luminescence converter for white light emitting diodes*

## Doll, Bernd

**23.08.2018**
SPIE Optical Engineering + Applications, San Diego, USA
Talk: *High through-put, outdoor characterization of silicon photovoltaic modules by moving electroluminescence measurements*

## Carigiet, Fabian

**17 – 18.07.2018**
Integration of Sustainable Energy Expo & Conference, Nürnberg
Talk: *New PV System Concept - Inductive Power Transfer for Photovoltaic Modules*

## Channa, Iftikhar Ahmed

**12.12.2018**
Internal EnCN annual conference, Erlangen , Germany
Talk: *Printed barriers for organic electronics*

## Classen, Andrej

**11 – 16.03.2018**
DPG spring meeting – condensed matter physics – Berlin 2018, Berlin, Germany
Talk: *The impact of morphology and polymer-fullerene miscibility on device stability of organic solar cells*

## Flores Escalante, Loreleyn

**08. – 13.07.2018**
2018 Europhysical Conference on Defects in Insulating Materials (EURODIM 2018), Bydgoszcz, Poland
Talk: *Study of near infrared photoluminescence in $Yb^{3+}$, $Er^{3+}$ and $Yb^{3+}$,$Tb^{3+}$ co-doped silicon oxycarbide thin films*

## Garcia Cerrillo, José

**03 – 05.10.2018**
7th conference "Solar Technologies Go Hybrid", Würzburg, Germany
Poster: *Modification of halide ratio in complex, large band gap (FA,MA,Cs,Rb)PbI_(3-x)Br_(x) perovskites: defect engineering and non-radiative recombination losses*

## Gu, Ening

**29.09 – 02.10.2018**
4th International Conference on Perovskite Solar Cells and Optoelectronics, Lausanne, Switzerland
Poster: *Exploring novel stable perovskite by a robot based high throughput composition engineering*

## Heiß, Wolfgang

**11 – 13.03.2018**
The international Conference on Materials Science and Engineering - 2018, New Borg El-Arab, Alexandria, Egypt
Keynote talk: *Hydrogen Bonded Organic Pigment Colloidal Nanocrystals*

**20.04.2018**
Symposium Photophysics, nanomaterials and more, Groningen, The Netherlands
Talk: *Cellular interfaces with hydrogen-bonded organic pigment hierarchical nanocrystals*
**22 – 26.10.2018**
nanoGe 2018, Málaga, Spain
Talk: *Heteroepitaxial growth of perovskite nanocrystals by inkjet-printing*

## Hepp, Johannes

**10 – 15.06.2018**
World Conference on Photovoltaic Energy Conversion (WCPEC-7), Waikoloa, Hawaii, USA
Talk: *Quantitative assessment of humidity in encapsulation materials for moisture-sensitive devices*

**18 – 19.10.2018**
Sensor CDT PhD showcase / Sensors Day 2018, University of Cambridge, Cambridge, UK
Talk: *Quantitative assessment of humidity in encapsulation materials for moisture-sensitive devices*

## Killilea, Niall

**20 – 21.09.2018**
Particle Based Materials Symposium 2018, Erlangen
Poster: *Bulk-like PbS Nanocrystals with Epitaxial Ligands Providing Photodetection Beyond 3000nm*

**22 – 26.10.2018**
NanoGe Fall Meeting 2018, Torremolinos, Malaga, Spain
Poster: *Bulk-like PbS Nanocrystals with Epitaxial Ligands Providing Photodetection Beyond 3000nm*

## Li, Ning

**02.01.2018**
Ding Xiang Capital, Chengdu, China
Invited talk: *Introduction to solution-processed organic photovoltaics*

**05.01.2018**
Soochow University, Suzhou, China
Invited talk: *Understanding the importance of bulk-heterojunction microstructure stability in solution-processed organic solar cells*

**23.03.2018**
South China Institute of Collaborative Innovation, Dongguan, China
Invited talk: *Printed organic solar cells towards commercialization*

**13.04.2018**
The 4th Silk Road International Spring Symposium for Distinguished Young Scholars, Xi'an Jiaotong University, Xi'an, China
Invited talk: *Analyzing the stability and industrial viability of organic photovoltaics*

**29.05.2018**
The 1st International Young Scholars Forum on Energy Science and Engineering, China University of Petroleum, Qingdao, China
Invited talk: *The prospect of commercialization of organic photovoltaic technology*

**10 – 15.06.2018**
World Conference on Photovoltaic Energy Conversion (WCPEC-7), Waikoloa, Hawaii, USA
Talk: *Microstructure instabilities in solution-processed organic bulk-heterojunction solar cells*

**01 – 06.07.2018**
The International Conference on Science and Technology of Synthetic Metals 2018 (ICSM 2018), Busan, Korea
Talk: *An analysis of efficiency, stability and commercial potential for organic photovoltaics based on non-fullerene acceptors*

**22 – 25.10.2018**
The International Summit on Organic and Hybrid Photovoltaics Stability (ISOS-11), Suzhou, China
Invited talk: *Development of solution-processed organic solar cells with excellent performance and stability*

**23.11.2018**
The 6th UESTC International Forum for Young Scholars, University of Electronic Science and Technology of China, Chengdu, China
Invited talk: *Efficient and stable organic photovoltaic solar cells*

## Mashkov, Oleksandr

**20 – 21.09.2018**
Particle Based Materials Symposium 2018, Erlangen
Poster: *Organic pigment nanoarchitectures for heavy metal removal from water*

## Meng, Wei

**03 – 05.10.2018**
7th conference "Solar Technologies Go Hybrid", Würzburg, Germany
Poster: *Effectively suppressing the non-radiative losses in efficient $CsPbI_3$ perovskite solar cells*

## Osvet, Andres

**21 – 26.01.2018**
Seminar of the Physics Department of Pontificia Universidad Católica del Perú, Lima, Peru
Talk: *Light conversion layers for photovoltaics*

**23 – 25.10.2018**
iPEN Meeting (23.10) and the 1st Intensive Course in Modern Teaching Methods and Soft Skills Development in Science, Rechovot, Israel
Poster: *Photonic Research and Nanotechnology at the Institute of Materials for Electronics and Energy Technology*

## Schöler, Michael

**02 – 07.09.2018**
European Conference on Silicon Carbide and Related Materials (ECSCRM 2018), Birmingham, UK
Poster: *Deep electronic levels in n-type and p-type 3C-SiC*

## Schuh, Philipp

**02 – 07.09.2018**
European Conference on Silicon Carbide and Related Materials (ECSCRM 2018), Birmingham, UK
Poster: *Vapor Growth of 3C-SiC Using the Transition Layer of 3C-SiC on Si CVD Templates*

## Schuster, Matthias

**18 – 22.06.2018**
EMRS Spring Meeting, Strasbourg, France
Poster: *Manufacturing and Characterization of Vacuum-Free Nanoparticle Based CuInSe2 Thin-Films Using Face-to-Face Annealing with Application of Uniaxial Mechanical Pressure*

## Shrestha, Shreetu

**30.09.2018 – 02.10.2018**
4th International Conference on Perovskite Solar Cells and Optoelectronics (PSCO-2018), Lausanne, Switzerland
Poster: *Temperature Dependence of Drift Mobility in Methylammonium Lead Iodide Perovskite Single Crystals*

**21 – 25.10.2018**
The International Summit on Organic and Hybrid Photovoltaics Stability (ISOS-11), Suzhou, China
Talk: *Temperature dependence of charge carrier drift mobility in lead halide perovskites*

## Stegner, Christoph

**18.07.2018**
Integration of Sustainable Energy EXPO & CONFERENCE, Nuremberg, Germany
Talk: *Comparing residential power demand with standard load profiles*

## Steiner, Johannes

**02 – 06.09.2018**
European Conference on Silicon Carbide and Related Materials (ECSCRM), Birmingham, United Kingdom
Poster: *Optimization of the SiC powder source size distribution for the sublimation growth of long crystal boules*

## Tam, Kai Cheong

**02.04.2018 – 06.04.2018**
MRS Spring Meeting, Phoenix, Arizona, USA
Talk: *Shy Organic Photovoltaics: Visually Attractive Digitally Printed Solar Modules with Hidden Interconnects*

**21 – 25.10.2018**
The International Summit on Organic and Hybrid Photovoltaics Stability (ISOS-11), Suzhou, China
Talk: *Shy Organic Photovoltaics: Visually Attractive Digitally Printed Solar Modules with Hidden Interconnects*

## Wellmann, Peter

**30.01.2018**
NITECH, Nagoya, Japan
Invited Lecture: *Basics and Applications of Semiconductors in Power Electronics*

**01 – 02.02.2018**
2nd FRIMS International Symposium on Frontier Materials, Nagoya, Japan
Invited talk: *Power Electronic Semiconductor Materials for Automotive Applications*
*SiC, GaN, $Ga_20_3$ and Diamond*

**15 – 19.10.2018**
5th Bilateral Symposium of E-MRS – MRS-J on Advanced Oxides, Chania, Greece
Keynote Talk: *Power Electronic Semiconductor Materials for Energy Saving Applications: SiC, GaN, $Ga_20_3$ and Diamond*

## Xu, Junyi

**02 – 06.09.2018**
European Conference on Silicon Carbide and Related Materials (ECSCRM), Birmingham, United Kingdom
Poster: *Optimization of the SiC powder source size distribution for the sublimation growth of long crystal boules*

**2019**

## Almora Rodríguez, Osbel

**11.01.2019**
Photovoltaic Research Lab IMRE-FFUH, University of Havana, Havana, Cuba
Invited talk: *Anomalous Capacitive Features in Perovskite Solar Cells*

**13-15.03.2019**
International Conference on Advanced Optical Technologies (ICAOT), Erlangen, Germany
Talk: *Light Induced Capacitance in Silicon and Perovskite Solar Cells: Dielectric, Chemical and Ionic Natures*

**20-25.10.2019**
10th International Conference on Polymers & Advanced Materials (POLYMAT-2019), Huatulco, Mexico.
Talk: *Light Intensity Modulated Impedance Spectroscopy in Perovskite Solar Cells*

**08-10.12.2019**
4th International Conference on Next Generation Solar Energy (NGSE4), Nuremberg, Germany
Poster: *Light Intensity Modulated Impedance Spectroscopy (LIMIS) in All-Solid-State Solar Cells at Open Circuit*

## Arzig, Matthias Martin

**27.05.2019**
Spring Meeting of the European Materials Research Society (E-MRS) 2019, Nice, France
Talk: *Influence of Morphological Changes in a Source Material on the Growth Interface of 4H-SiC Single Crystals*

**30.07.2019**
19th International Conference on Crystal Growth and Epitaxy (ICCGE-19), Keystone, Colorado, USA
Talk: *Influence of the growth interface shape on the defect characteristics in the facet region of 4H-SiC single crystals*

## Batentschuk, Miroslaw

**13. – 16.05.2019**
2nd Intensive Course in Laser Physics, Safety & Applications , in the frame of the Program " ERASMUS EU-Israel", Milan, Italy
Invited talk: *Photonic Sintering in semiconductors & additive manufacturing technology*

## Brabec, Christoph J.

**08.03.2019**
University of Groningen, Groningen, Netherlands
Invited talk: *Accelerating Material Innovation*

**11.03.2019**
International Winterschool Kirchberg, Austria
Invited talk: *Large Scale Facilities - a driving force for material innovation*

**28.03.2019**
Opening ceremony SAXS, Erlangen
Talk: *NFAs - a panacea for OPV?*

**29.04.2019**
University of Guangzhou, China
Plenary Talk

**29.04.2019**
Osram OS, Regensburg
Invited Talk

**10.06.2019**
Next Generation Solar Energy, Netherlands
Talk: *AMANDA - a platform for automated and autonomous solar material & device innovation*

**12.06.2019**
Next Generation Photovoltaics, Groningen, Netherlands
Invited talk: *Non Fullerene Acceptors for OPV*

**20.09.2019**
University of Toronto, Canada
Invited Talk

**22.09.2019**
MIT, USA
Invited Talk

**02.10.2019**
5th Erlangen Symposium on Synthetic Carbon Allotropes, Erlangen
Invited talk: *Non Fullerene Acceptors - surpassing limitations from CT states*

**02.12.2019**
JKU University of Linz, Austria
Invited Talk

## Classen, Andrej

**04.04.2019**
DPG-Frühjahrstagung 2019 – Sektion Kondensierte Materie, Regensburg, Germany
Talk: *Absence of charge transfer state enables very low VOC losses in SWCNT:fullerene solar cells*

## Deumel, Sarah

**30.09 - 02.10.2019**
5th International Conference on Perovskite Solar Cells and Optoelectronics (PSCO 2019), Lausanne, Switzerland,
Talk: *Hybrid inorganic-organic perovskite as Direct X converter for medical X-Ray imaging*

## Du, Xiaoyan

**23.04.2019**
MRS Spring Meeting, Phoenix, Arizona, USA
Talk: *Intrinsic and Extrinsic Factors Influencing Non-radiative VOC Losses in Solution-Processed Organic Solar Cells*

**09-12.06.2019**
NEXT-GEN IV: PV Materials, Groningen, Netherlands
Talk: *Reducing Non-radiative $V_{OC}$ Losses in Solution-Processed Organic Solar Cells*

## Elia, Jack

**30.09 - 02.10.2019**
5th International Conference on Perovskite Solar Cells and Optoelectronics (PSCO 2019), Lausanne, Switzerland,
Poster: *Epitaxial Growth of $CsPbBr_3$ on Different Substrates with Hexane/Octane Pre-Wetting*

## García Cerrillo, José

**09-12.06.2019**
NEXT-GEN IV: PV Materials, Groningen, Netherlands
Poster: *Out of the glovebox: microsecond-lived charge carriers in wide-band gap perovskite thin films through crystallization in air*

**30.09 - 02.10.2019**
5th International Conference on Perovskite Solar Cells and Optoelectronics (PSCO 2019), Lausanne, Switzerland,
Poster: *Properties of a multi-cation, mixed halide wide-band gap perovskite partially processed in air and their effect on p-i-n solar cells*

## Gu, Ening

**30.09 - 02.10.2019**
5th International Conference on Perovskite Solar Cells and Optoelectronics (PSCO 2019), Lausanne, Switzerland,
Talk: *Robot-based high throughput screening of antisolvents applied in precipitation of lead halide perovskites*

## He, Yakun

**09-12.06.2019**
NEXT-GEN IV: PV Materials, Groningen, Netherlands
Talk: *Ultra-Stable Single-Component Organic Solar Cells: the Next Frontier for OPV?*

**24 - 28.06.2019**
15th International Conference on Organic Electronics Hasselt University, Hasselt, Belgium
Poster: *Evidencing excellent thermal- and photo-stability for single-component organic solar cells with inherently built-in microstructure*

## Heiß, Wolfgang

**11 – 14.08.2019**
27th Assembly of Advanced Materials Congress, Stockholm, Sweden
Talk: *Solution processed semiconductors for medical applications (IAAM Award Lecture)*

**08 – 10.12.2019**
NGSE4-Next Generation Solar Energy conference, Nuremberg, Germany
Invited Talk: *Epitaxial metal halide perovskites by inkjet printing*

## Hepp, Johannes

**16-21.06.2019**
46th IEEE Photovoltaic Specialists Conference (PVSC), Chicago, IL, USA
Talk: *Quantitative analysis of the separate influences of material composition & local defects on the $V_{OC}$ of PV devices*

## Kalancha, Violetta

**31.03.-05.04.2019**
DPG conference, Regensburg, Germany
Poster: *Improving the stability of Silver Nanowires for electrodes via surface modification*

## Karl, André

**13-16.05.2019**
iPEN 2nd Intensive Course in Laser Physics, Safety & Applications, Milan, Italy
Poster: *Non-destructive imaging of artificial defects in organic solar cells*
**04 -08.11.2019**
NanoGE Fall Meeting 2019, Berlin, Germany
Poster: *Development of novel imaging techniques for quality control in organic solar cell manufacturing using artificially introduced defects*

## Li, Ning

**25.03.2019**
South China University of Technology, the State Key Laboratory of Luminescent Materials and Devices, Guangzhou, China
Invited Talk: *Development of Organic Solar Cells with Excellent Performance and Stability*

**23.05.2019**
Nano-C Project Meeting, Erlangen, Germany
Talk: *Current Research at i-MEET - Solution Processed OPV Devices*

**30.05.2019**
E-MRS Spring Meeting, Nice, France
Talk: *Development of highly efficient and stable organic solar cells by overcoming microstructure instabilities*

**28.06.2019**
The 15th International Conference on Organic Electronics 2019 (ICOE2019), Hasselt, Belgium
Talk: *Development of non-fullerene acceptor-based organic solar cells with excellent performance and stability*

**17.08.2019**
National Center for Nanoscience and Technology, Beijing, China
Invited Talk: *Development of highly efficient organic solar cells towards excellent stability*

**18.08.2019**
The 8th international conference on Nanoscience & Technology (ChinaNANO 2019), Beijing, China
Invited Talk: *Understanding and Overcoming Microstructure Instabilities for Highly Efficient and Stable Organic Solar Cells*

**20.08.2019**
Zhengzhou University, Zhengzhou, China
Invited Talk: *A perspective on commercialization of printed organic photovoltaics*

**18.09.2019**
Nankai University, Tianjin, China
Invited Talk: *Stability of Organic Solar Cells: From Fullerene to Non-fullerene Acceptors*

**13.11.2019**
The 12th International Photonics and OptoElectronics Meetings (POEM2019), Wuhan, China
Invited Talk: *Stability of Organic Solar Cells: From Fullerene to Non-fullerene Acceptors*

**17.12.2019**
DFG-NFA Research Unit Project Meeting, Chemnitz, Germany
Invited Talk: *OPV research activities at FAU & ZAE Bayern / HI ERN*

## Liu, Chao

**09-12.06.2019**
NEXT-GEN IV: PV Materials, Groningen, Netherlands
Poster: *Novel interfacial layers based on antimony-doped tin oxide nanoparticles for stable and efficient organic solar cells*

**24 - 28.06.2019**
15th International Conference on Organic Electronics Hasselt University, Hasselt, Belgium
Poster: *Designing a fully functional interconnection layer for reliable and reproducible fabrication of solution-processed organic tandem solar cells*
Poster: *Extraordinary switching the type of interfacial layers by introducing antimony into tin oxide nanoparticles for organic photovoltaics applications*

## Lüer, Larry

**07.11.2019**
Ultrafast Science and Technology Spain (USTS 2019), IMDEA Nanoscience, Madrid, Spain
Invited talk: *Ultrafast Spectroscopy of Organic Materials for Energy Applications*

## Matt, Gebhard J.

**04 -08.11.2019**
NanoGE Fall Meeting 2019, Berlin, Germany
Invited talk: *High performance X-ray to current converter fabricated directly on substrate via melting of an inorganic metal-halide perovskite*
**30.09 - 02.10.2019**
5th International Conference on Perovskite Solar Cells and Optoelectronics (PSCO 2019), Lausanne, Switzerland,
Talk: *High performance X-ray to current converter fabricated directly on substrate via melting of an inorganic metal-halide perovskite*

## Meng, Wei

**09-12.06.2019**
NEXT-GEN IV: PV Materials, Groningen, Netherlands
Poster: *Effectively suppressing the non-radiative losses in efficient $CsPbI_3$ perovskite solar cells*

## Osvet, Andres

**13-16.05.2019**
iPEN 2nd Intensive Course in Laser Physics, Safety & Applications, Milan, Italy
Poster: *Laser processing in solar cell technology*

**30.09 - 02.10.2019**
5th International Conference on Perovskite Solar Cells and Optoelectronics (PSCO 2019), Lausanne, Switzerland,
Poster: *Robot-based high-throughput solvent and composition engineering of lead halide perovskites*

## Schöler, Michael

**28.05.2019**
Spring Meeting of the European Materials Research Society (E-MRS) 2019, Nice, France
Talk: *Investigation of near infrared photoluminescence in cubic silicon carbide*

## Steiner, Johannes

**27.05.2019**
Spring Meeting of the European Materials Research Society (E-MRS) 2019, Nice, France
Talk: *Analysis of the basal plane dislocation density and thermomechanical stress during 100 mm PVT growth of 4H-SiC*

**01.10.2019**
International Conference on Silicon Carbide and Related Materials (ICSCRM) 2019, Kyoto, Japan
Talk: *Prospects of bulk growth of 3C-SiC using sublimation growth*

## Sytnyk, Mykhailo

**04 -08.11.2019**
NanoGE Fall Meeting 2019, Berlin, Germany
Poster: *Epitaxial Metal Halide Perovskites by InkJet Printing*

## Wellmann, Peter

**11.11.2019**
SiC Workshop of the Sino-German-Center (SGC) in Beijing, China
Invited Talk: *Recent developments in sublimation growth of SiC*

**29.09. – 04.10.2019**
ICSCRM 2019, Kyoto, Japan
Talk: *Prospects of bulk growth of 3C-SiC using sublimation growth (presented by J. Steiner)*

## Yang, Fu

**04.11.2019**
iPEN Workshop, Erlangen, Germany
Poster: *Fully printed perovskite solar cells via blade-coating techniques*

**05.12.2019**
EnCN Annual Conference, Nuremberg, Germany
Talk: *Upscaling of Perovskite Photovoltaics*

# 12. Seminar Presentations

## Chair Seminar 2018

09.01.2018
**Bernd Doll** (Doctoral thesis report)
*Outdoor Luminescence*
**Jerrit Wagner** (Master thesis report)
*Development of high throughput methods for automated production and characterization of organic solar cells*

16.01.2018
**Johannes Zeltner** (Bachelor thesis report)
*Synthesis and surface modification of nanosized $SrAl_2O_4$: Eu, Sm for photosimulated luminescence nanomarkers*
**Dr. Loïc M. Roch** (Guest talk, Department of Chemistry and Chemical Biology Harvard University)
*Challenges and procedure towards autonomous material discovery*

13.02.2018
**Fabian Carigiet** (Doctoral thesis report extern, ZHAW School of Engineering, Schweiz)
*New PV System Concept - Inductive Power Transfer for Photovoltaic Modules*
**Yakun He** (Doctoral thesis report)
*Morphology adjustment based on small molecule solar cells*

20.02.2018
**Iftikhar Channa** (Doctoral thesis report)
*Coated barriers for organic electronics*

06.03.2018
**Florian Hopp** (Applicant for doctoral position)
*UV-härtbareVorläuferverbindungen für gedruckte Silberstrukturen*

20.03.2018
**Shuai Gao** (Doctoral thesis report)
*Dielectric reflectors for vapor sensing*
**Maximilian Dierner** (Bachelor thesis report)
*Investigation of the influences of $Mg^{2+}$ and $Si^{4+}$ substitutions on the emission properties of $Y_3Al_5O_{12}$: $Ce^{3+}$ as luminescence converter for white light emitting diodes and solar cells*
**Philipp Odenwald** (Project thesis report)
*State of the Art Phosphor and Photoconductor Flat-Panel X-ray Materials in Relation to $MAPbI_3$ Wafer and Single Crystal Based Devices*

27.03.2018
**Johannes Küffner** (Project thesis report)
*Optimization of SAM ETL for doctor bladed perovskite solar cells*
**Felix Kalkowski** (Master thesis report)
*Synthesis of Perovskite Based Quantum Dots for QD-LED Displays*
**Leonard Höcht** (Literature recherche)
*Infrared absorber with the emission function*

15.05.2018
**Prof. Robert Alicki** (Guest talk, University of Gdansk, Poland)
*Self-oscillation mechanism of work generation in photovoltatic cells*

22.05.2018
**Jose Dario Perea Ospina** (Doctoral thesis report)
*Towards Solubility and Miscibility of Organic Conjugated Semiconductors for the Performance of Organic Solar Cells via Quantum Chemistry Methods*

29.05.2018
**Johannes Hepp** (Doctoral thesis report)
*Infrared Imaging of water ingress into the encapsulation of electronic devices*
**Dr. Katharina Witte** (Guest talk, Paul Scherer Institut, Villingen, Schweiz)
*Molecular Orientation in Conjugated Polymer Thin Films*

19.06.2018
**Max-Pascal Quast** (Bachelor thesis report)
*Influence of $Y^{3+}$ and $Mg^{2+}$ substitutions in $Ca_3Sc_2Si_3O_{12}$:Ce phosphor particles on their luminescence properties*
**Jerrit Wagner, Christian Berger** (Doctoral thesis report)
*Summary of the current state of the High Throughput Experimentation project*

26.06.2018
**Dr. Roland Weingärtner** (Research report)
*Wide Bandgap Semiconductors and their Optoelectronic Functionalization for Electronical Device Applications*
**Lorelyn Flores** (Doctoral thesis report)
*Production of thin amorphous films of a-SiCO doped with rare earths, for light conversion application in solar cells*

11.07.2018
**Prof. Tonio Buonassisi and Dr. Shijng Sun** (Guest talk, Massachusetts Institute of Technology MIT (USA))
*Next Generation PV Material: Towards Rapid Screening and Development*

24.07.2018
**Miroslaw Batentschuk, Andres Osvet** (Safety instructions)
*X-ray safety instruction* (Miroslaw Batentschuk)
*Laser safety instruction* (Andres Osvet)

21.08.2018
**Leonard Höcht** (Master thesis report)
*Laser scribing of perovskite solar modules*

04.09.2018
**Felix Ernst** (Master thesis report)
*Defining optimal conditions for fast and reliable perovskite solar cell performance characterization using maximum power point tracking*
**Jack Elia** (Doctoral thesis report)
*Advanced SEM of Perovskites & possible extensions of Jeol-7610F*

18.09.2018
**Felix Enzenberger** (Master thesis report)
*Analyse des Degradationsverhaltens hinsichtlich der Entstehung und Veränderungen von Zellrissen in PV-Modulen unter zyklischer mechanischer Belastung*

17.09.2018
**Christof Dobler** (Bachelor thesis report)
*Synthese und Untersuchung der Lumineszenz von mikro- und nano-kristallen $Tb_3Al_5O_{12}$:Ce (TAG) und TAG:Ce, Eu mit $Mg^{2+}$ und $Si^{4+}$-Ersetzungen*

25.09.2018
**Dr. Oleksandr Stroyuk** (Guest talk, TU Chemnitz)
*On the road to "green" toxic-metal-free semiconductor nanocrystals*
**Zhenguo Zhang** (Master thesis report)
*TOF-SIMS und XPS zur chemischen Charakterisierung von CdTe Solarzellen*

10.10.2018
**Prof. Dr. Jana Zaumseil** (Guest talk, Angewandte Physikalische Chemie, Universität Heidelberg)
*Dense Layers of (6,5) Carbon Nanotubes for (Opto-)electronic Devices*

16.10.2018
**Dr. Xiaoyan Du** (Research report)
*Suppressing non-radiative recombination losses in organic solar cells*
**Kaicheng Zhang** (Master thesis report, Soochow University, China)
*Interfacial Engineering and Crystallization-controlling of Perovskite Film in Perovskite Solar Cells*

23.10.2018
**Judith Knüttel** (Master thesis report)
*Development and fabrication of perovskite-based X-ray detectors*
**Sabrina Schmitt** (Bachelor thesis report)
*Untersuchung der Stabilität organischer Halbleiter für Photovoltaik Anwendungen mittels in-situ Photoleitungsmessungen*

30.10.2018
**Antonio Gaetano Ricciardulli** (Guest talk, Max-Planck-Institut für Polymerforschung, Mainz)
*Solution-processed Two-dimensional Materials for Organic Optoelectronics*

06.11.2018
**Sarah Deumel** (Master thesis report)
*Methylammoniumbleiiodid für die Röntgendetektion*

13.11.2018
**Stefan Langner** (Doctoral thesis report)
*High throughput solubility investigations of organic semiconductors*
**José Garcia** (Doctoral thesis report)
*Non-radiative recombination in wide band gap perovskites solar cells*
**Anh-Dai Dang** (Master thesis report)
*Tintenstrahldrucken Tintenstrahldrucken von Nano-Mikrostrukturen für die integrierte Elektronik*

20.11.2018
**Chen Xie** (Doctoral thesis report)
*Water-processed nanoparticle-based organic photovoltaics*
**Christian Wißgott** (Bachelor thesis report)
*Abhängigkeit des Schichtdickenverlaufs von den Parametern des beschleunigten Doctor Blading-Prozesses für die Herstellung organische Solarzellen*

27.11.2018
**André Karl** (Doctoral thesis report)
*Vertically resolved imaging of artificial defects in Single Junction and Tandem OPV*
**Hermann Bechert** (Doctoral thesis report, extern OSRAM Opto Semiconductors GmbH)
*Intrinsic electro-static discharge protection for highly segmented OLEDs in automotive applications*

04.12.2018
**Sri-Vishnu Subramaniam** (Guest talk)
*Volume production of customized organic photovoltaics*

11.12.2018
**Osbel Almora Rodríguez** (Doctoral thesis report)
*Understanding recombination and charge accumulation in Perovskite Solar Cells*
**Philipp Maisch** (Doctoral thesis report)
*Process Development for Inkjet Printing of Organic Photovoltaics*

18.12.2018

**Florian Hase** (Guest talk)
*ChemOS: enabling autonomous experimentation with self-driving laboratories*
**Violetta Kalancha** (Doctoral thesis report)
*Improving the stability of Silver Nanowires for electrodes via surface modification*
**Moritz Scholl** (Master thesis report)
*Entwicklung eines neuen Verfahrens zur Erzeugung von aktiven Beschichtungen mittels der Floating Film Transfer Method (FTM) zur Herstellung von organischen Solarzellen*

## Chair Seminar 2019

15.01.2019
**Jonas Wortmann** (Doctoral thesis report)
*Precise temperature control for accelerated degradation measurements*
**Junyi Xu** (Doctoral thesis report)
*Organic Nanoparticles as Transport Layer in Organic Solar Cells*
**Wei Meng** (Doctoral thesis report)
*Effectively suppressing the non-radiative losses in efficient $CsPbI_3$ perovskite solar cells*

22.01.2019
**Ening Gu** (Doctoral thesis report)
*High through-put engineering of 2D-3D mixed perovskite semiconductor*

29.01.2019
**Chao Liu** (Doctoral thesis report)
*Reproducible high-efficiency tandem Solar Cells achieved by crosslinkable intermediate layer*
**Jiyun Zhang** (Master thesis report)
*The Crystal Structure Analysis and Optical Properties Tuning of GGAG Transparent Ceramics*
**Andreas Eigen** (Master thesis report)
*Ionenleitfähigkeiten in Perowskit Halbleitern für die Röntgendetektion*

05.02.2019
**Andrej Classen** (Doctoral thesis report)
*Transport and lifetime investigations of all-carbon solar cells*
**Frank Fecher** (Postdoc report)
*Contactless thermometry in thermochemical storage reactor with $CaCO_3$-/$CO_2$ granulate at temperatures > 800 °C*

12.02.2019
**Albert These** (Doctoral candidate, Master thesis report)
*Developing a surface enhanced Raman scattering substrate for Nanothermometry*

19.03.2019
**Sophie Mull** (Bachelor thesis report)
*Investigation of a new interfacial layer for fully solution-processed OSCs*

22.03.2019
**Jose Dario Perea Ospina** (Doctoral examination)
*Solubility and Miscibility of Organic Semiconductors for Efficient and Stable Organic Solar Cells Investigated via Machine Learning and Quantum Chemistry Methods*

26.03.2019
**Johannes Gerner** (Master thesis report)
*Degradation of organic photovoltaic materials analysed via absorption-, photoluminescence- and Fourier-transform infrared spectroscopy*

02.04.2019
**Tim Freund** (Master thesis report)
*Epitaktisches Tintenstrahldrucken von Perovskiten*

08.05.2019
**Umair Sultan** (Master thesis report)
*Spherical Colloidal Photonic Crystals (Photonic Balls)*

22.05.2019
**Julian Fischer** (Master thesis report)
*Correlation of Photo-oxidation and UV-degradation of active layers with lifetime measurements on organic solar cells*
**Christian Kupfer**
*Untersuchung von Schwingungen der H.E.S.S. Teleskope*

24.05.2019
**Markus Pröll** (Doctoral examination, ZAE)
*Entwicklung eines schwach konzentrierten CPC PVT- Flachkollektors*

12.06.2019
**Adrian Valenas,** (Bachelor Thesis)
*Synthese und Untersuchung von mit Europium einfach dotierten und mit Europium und Cerium doppeldotierten $Ca_3Sc_2Si_3O_{12}$ Mikrokristallen*

17.06.2019
**Bogenrieder Josef** (Doctoral examination)
*Adapting photovoltaic systems to requirements of a future electricity supply system*

28.06.2019
**Schuh Philipp** (Doctoral examination)
*Sublimation Epitaxy of bulk-like Cubic Silicon Carbide*

26.06.2019
**Sebastian Bürzele,** (Bachelor Thesis) *In-situ Plasma Vorkonditionierung vor Metallisierungsschritten bei der Herstellung von GaAs basierten VCSELn*

17.07.2019
**Patrick Dreher,** (Vortrag zum Literaturseminar)
*Non-pressure Silver Sintering as packaging technology in modern power electronics using infrared radiation*

24.07.2019
**Marc Steinberger**, (Master Thesis)
Thermo-oxidation of Organic Solar Cells and the Effect of Ni(dtc)2 as Stabilizing Additive

**Huiying Hu,** (Master Thesis)
Development of Quantum Dot Enhancement Films Based onPerovskites with Stable Red and Green Color Emission

07.08.2019
**Antonio Manco,** (Bachelor Thesis, Helmholtz Institute Erlangen-Nürnberg)
*Untersuchung von Silizium-Solarmodulen bei stabiler, mechanischer Belastung*
**Junyi Xu,** (annual PhD report)
*Molecular doping of organic semiconductors - its basic understanding and application*

14.08.2019
**Stefanie Vorstoffel,** (Bachelor Thesis)
*Stabilität von Zwischenschichten organischer Solarzellen im Elektrolumineszenz-Imaging*

04.09.2019
**Yizhe Yang,** (Master Thesis)
*Compositional perovskite powder and ink engineering for low and high energy radiation detectors*

18.09.2019
**Lukas Peltner,** (Bachelor Thesis)
*Einfluss von Umweltparametern auf die Performance fehlerbehafteter Solarmodule*

25.09.2019
**Leon Beickert,** (Master Thesis)
*Einfluss von Ladungskompensation und Flussmittel auf die Quantenausbeute bei der Herstellung von $Ca_3Sc_2Si_3O_{12}$:Ce für weiße LEDs*

09.10.2019
**Robin Meinert,** (Bachelor Thesis)
*The effect of interface modification on the photoluminescence quantum yield of $MAPbI_3$ perovskite*
**Julien Körfer,** (Master Thesis)
*Plasmonische Metalloxid Nanokristalle für elektrochrome Bauteile*

23.10.2019
**Ricardo Morales Hernández,** (Master Thesis)
*Automatisation and characterisation of OLEDs*
**Hermann Bechert,** (annual PhD report)
*Flexible and highly segmented OLEDs for automotive applications*

30.10.2019
**Safety instructions**

06.11.2019
**Klaus Burlafinger** (Doctoral examination)
*Development of a High Irradiance Setup for Precisely Controlled Accelerated Photo-Degradation of Organic Solar Cells*

26.11.2019
**Ening Gu** (Doctoral examination)
*Synthesis and characterization of solution-processed emerging hybrid perovskites and $AgBiS_2$*

27.11.2019
**Thomas Cournil,** (Master Thesis, supervisor Dr. Osvet)
*Nanosecond transient absorption spectroscopy of absorber materials for organic photovoltaics*
**Andrej Classen,** (annual PhD report)
*What limits efficiency in organic solar cells at negligible energy level offsets?*

04.12.2019
**Osbel Almora Rodríguez,** (annual PhD report)
*Light Intensity Modulated Impedance Spectroscopy (LIMIS) in All-Solid-State Solar Cells at Open Circuit*

11.12.2019
**Viktor Rehm,** (Master Thesis, supervisor Prof. Heiß)
*Doping of 2-dimensional $Bi_2Se_3$ for optimized charge carrier transport*

## Guest Talks 2018

16.01.2018
**Dr. Loïc M. Roch** (Department of Chemistry and Chemical Biology Harvard University)
*Challenges and procedure towards autonomous material discovery*

15.03.2018
**M.Sc. Chem. Violetta Kalancha** (National University of Chernivtsi, Ukraine)
*Effect of temperature on the photostimulated synthesis of silver nanocrystals*

15.05.2018
**Prof. Robert Alicki** (University of Gdansk, Poland)
*Self-oscillation mechanism of work generation in photovoltaic cells*

16.05.2018
**Prof. Stelios Choulis** (Molecular Electronics and Photonics Research Unit (MEP) as the Cyprus University of Technology)
*Properties of Interface Materials in Perovskite and Organic PV*

29.05.2018
**Dr. Katharina Witte** (Paul Scherrer Institut, Villingen, Schweiz)
*Molecular Orientation in Conjugated Polymer Thin Films*

11.07.2018
**Prof. Tonio Buonassisi and Dr. Shijng Sun** (Massachusetts Institute of Technology MIT (USA))
*Next Generation PV Material: Towards Rapid Screening and Development*

25.09.2018
**Dr. Oleksandr Stroyuk** (TU Chemnitz)
*On the road to "green" toxic-metal-free semiconductor nanocrystals*

10.10.2018
**Prof. Dr. Jana Zaumseil** (Angewandte Physikalische Chemie, Universität Heidelberg)
*Dense Layers of (6,5) Carbon Nanotubes for (Opto-)electronic Devices*

30.10.2018
**Antonio Gaetano Ricciardulli** (Max-Planck-Institut für Polymerforschung, Mainz)
*Solution-processed Two-dimensional Materials for Organic Optoelectronics*

04.12.2018
**Sri-Vishnu Subramaniam**
*Volume production of customized organic photovoltaics*

18.12.2018
**Florian Hase**
*ChemOS: enabling autonomous experimentation with self-driving laboratories*

## Guest Talks 2019

22.01.2019
**Dr. David A. Egger** (Sofja-Kovalevskaja Group Leader, Institute of Theoretical Physics, University of Regensburg)
*Theory of Structural Dynamics and Optoelectronic Properties of Halide Perovskites*

12.02.2019
**Tack-Ho Lee** (Doctoral guest report)
*Efficient Exciton Diffusion in Bilayer Organic Heterojunctions*

09.04.2019
**Professor Andreas Maier** (Lehrstuhl für Informatik 5, Vortrag im Rahmen des HI-ERN Seminar)
*A Gentle Introduction to Deep Learning*

4.06.2019
**Prof. Dr. Larry Lüer,** (IMDEA Nanoscience, Madrid)
*Quantifying Loss Processes in Donor - Acceptor Blends with Non-Fullerene Acceptors*

18.06.2019
**Prof. Germà Garcia-Belmonte,** (Universitat Jaume I Castelló, Spain)
*Intensity Modulated Photo Spectroscopy in Perovskite Solar Cells*

26.06.2019
**Prof. Fei Guo,**
*Printing perovskites for high efficiency photovoltaic solar cells*

28.06.2019
**Prof. Yuriy Zorenko,** (University of Bydgoszcz, Poland) *Development of composite luminescent materials based on the single crystals and single crystalline films of garnet compounds using LPE growth method*

07.08.2019
**Sebastian Lucas,** (Ulm University)
*Donor-Acceptor-Dyads for Single Material Organic Solar Cells*

11.09.2019
**Prof. Dr.-Ing. Alfred Ludwig,** (Chair for Materials Discovery and Interfaces, Institute for Materials, Ruhr University Bochum (RUB))
*Thin-film materials libraries for the data-driven discovery and investigation of new materials*

07.10.2019
**Dr. Wenxin Mao,** (Monash University)
*Towards Single-Crystalline Perovskite Devices*

16.10.2019
**Vincent Le Corre,** (Zernike Institute for Advanced Materials University of Groningen)
*Lessons learned from device modeling of perovskite solar cells*

30.10.2019
**Dr. Fabian Panzer,** (University of Bayreuth)
*Understanding and controlling perovskite film formation – optical in situ characterizations during solution processing and a solvent free route for film processing based on pressure treatment of perovskite powders*

20.11.2019
**Dr**. **Sudhanshu Shukla,** (Laboratory for Photovoltaics, University of Luxembourg)
*Defects, disorder and phase instabilities in next generation energy materials*

25.11.2019
**Dr. Christos Chochos** (Institute of Biology, Medicinal Chemistry and Biotechnology at the National Hellenic Research Foundation (IBMCB/NHRF))
*Chemical Structure Optimization of High Performance Conjugated Polymers Towards Controlled Scalability*

# 13. Conferences organized by Members of the Institute

**Batentschuk, Miroslaw**
4-6.11 2019
Conference (Full name): 3rd Intensive Course in Laser Patterning, Characterization and Soft Skills Development, in the frame of the Program " ERASMUS EU-Israel"
Location: Erlangen, Germany

**Li, Ning**
8-10.12.2019
Conference (Full name): The next generation solar energy conference (NGSE4)
Location: Nürnberg, Germany

11-14.11.2019
Conference (Full name): The 12th International Photonics and OptoElectronics Meetings (POEM2019)
Location: Wuhan, China

**Wellmann, Peter**
17-21.03.2020
Conference (Full name): German Polish Conference on Crystal Growth (GPCCG) (as session chair Semiconductors)
Location: Poznan, Poland

27-31.05.2019
Conference (Full name): EMRS Spring Meeting (member of executive committee and vice president or president)
Location: Nice, France

27-31.05.2019
Conference (Full name): EMRS Spring Meeting, Symposium X, Silicon Carbide and Related materials for Energy Saving Applications
Location: Nice, France

14-17.09.2019
Conference (Full name): EMRS Fall Meeting 2019 (member of executive committee and president)
Location: Nice, France

## The 4th International Conference on Next Generation Solar Energy (NGSE4)

The 4th International Conference on Next Generation Solar Energy (NGSE4) was held in Nürnberg, Germany, December 8-10, 2019, at the Energy Campus Nürnberg (EnCN). The NGSE4 was organized to celebrate the 10th anniversary of the establishment of institute of Materials for Electronics and Energy Technology (i-MEET), which has been headed by Prof. Christoph J. Brabec since 2009. The conference offered an excellent opportunity to learn about latest developments and current projects in the field of organic and perovskite photovoltaic technology and to exchange ideas and experiences with experts from around the world, particularly those are in close collaboration with i-MEET, ZAE Bayern and the Helmholtz Institute Erlangen-Nuremberg for Renewable Energies.

## 5th iPEN Progress Meeting

The University of Erlangen-Nürnberg with the Chair Materials for Electronics and Energy Technology (i-MEET) hosted the 5th EU- Israel project iPEN Innovative Photonics Education in Nanotechnology Progress Meeting in November 2019 and the 3rd Intensive Course in Laser Based Patterning & Sintering Processes, Characterization and Soft Skills Development. The workshop gathered 26 Teachers and 76 Students as well as PhD students from Netherland, Greece, Italy, Israel, Poland and Germany. During the intence three days of the Workshop participants were able to discuss 17 lectures, 35 posters, 12 Journal Club (Reviews made by PhD students) presetations and join excursions to the Solar Fabrik in Nürnberg and Reserach Laboratories of i-MEET.

For information: The EU- Israel project iPEN (Innovative Photonics Education in Nanotechnology) has as a primary objective to provide an education training program to young researchers (postgraduate, Research students) in the most common used photonic tools & techniques in a Nanotechnology Laboratory. iPEN project during its development will include the development of online & offline modules, the organization of intensive courses, that will foster the photonic learning skills and build the confidence of young researchers in the field of Nanotechnologies.

# 14. Cooperation in Committees

## Batentschuk, Miroslaw

Practica Commission of the Department of Material Science, Friedrich-Alexander University Erlangen-Nürnberg

Study Commission of the Department of Material Science, Friedrich-Alexander University Erlangen-Nürnberg

## Brabec, Christoph J.

*Activities for the Friedrich-Alexander University Erlangen - Nürnberg (FAU):*

Member of the Material Science Department´s Steering Committee

Spokesman of the Material Science Courses, Friedrich-Alexander University Erlangen-Nürnberg

Representative of the Material Science Department in the Faculty´s Commission of Studying

*National Activities:*

Scientific Director Department Renewable Energies, ZAE Bayern, Erlangen

Member of the EnCN Science Board (Energy Campus Nürnberg)

*International Activities:*

Honorary Professor at the University of Groningen

Director at the Forschungszentrum Jülich (FZJ) for Highthroughput Methods in Photovoltaics – Helmholtz Institute Erlangen-Nürnberg (HI-ErN)

Member of Scientific Board of the PE graduate school, Imperial College, London

Member of the Scientific Advising Board, CRANN AMBER, Trinity College Dublin, Ireland

Member of the Scientific Board of the International Conference on Organic Electronics (ICOE)

Head of the Organization Board of the Next Generation Solar Energy Conference (NGSE)

*Services to the Community:*

Serving as expert referee for European Community - European Research Council (ERC Awards)

Chairman of the Editorial Board “Advanced Energy Materials”, Wiley VCH

Member of the Editorial Board of “Progress in Photovoltaics”, Wiley VCH

Member of the Editorial Board of “Emerging Materials Research”, ice publishing

Serving as referee for several funding organizations, among them the Austrian Science Fund (FWF), for the German Research Foundation (DFG), the Baden-Württemberg Stiftung, and for more than 15 top ranked journals in the field of materials, semiconductors and energy (Nature Family, EES, Advanced Family)

**Kahmann, Simon**

Member of the Graduiertenkolleg GRK 1896

**Kalancha, Violetta**

Center for Nanoanalysis and Electron Microscopy, GRK1896

**Li, Ning**

Organizing committee for the 4th NGSE conference, Nürnberg, Germany.
Co-chair of Photonics for Energy at the POEM 2019 Conference, Wuhan, China

**Wellmann, Peter**

President EMRS
Organizer: Europa-Afrika Zusammenarbeit Materialwissenschaft
Nanosmat Satellite Symposium: Big leaps with nano steps | The European-African Materials Research Exchange (EAMARE) 2019
International Union of Materials Research Societies: Member of the Meetings Commission
Treasurer of Deutsche Gesellschaft für Kristallzüchtung und Kristallwachstum (DGKK e.V.)
Reviewer for Journal of Crystal Growth, Journal of Crystal Growth & Design, Journal of Crystal Research and Technology und Journal of Thin Solid Films.
Member Editorial board Nature Applied Sciences by Springer

# 15. Research Projects

**Deutsche Forschungsgemeinschaft DFG: MA 6617/1-1**
18.06.2018 – 30.06.2021
*Bleifreie Perovskite für die Röntendetektion*

**PV-ZUM – DynaSol, Zentrales Innovationsprogramm Mittelstand**
bis 31.07.2020
*Transientes Photoelektronisches Messverfahren*

**Cluster of Excellence Engineering of Advanced Materials (Forschungscluster „Engineering of Functional Material Interfaces“) EAM: FUMIN B**
01.11.2017 – 31.12.2018
*Energy harvefhing*

**COLCIENCIAS** (Columbia)
01.11.2014 – 30.09.2018
(Perea Ospina, Jose Dario)

**CONACYT (The Mexican National Council for Science and Technology)**
(Mexico)
01.08.2013 – 31.08.2018
**(**Ramirez Quiroz, César Omar)

**China Scholarship Council** (China)

CSC grant No. 201206130055
*Design and Fabrication of organic solar cells based on solution-processed small molecules* (Ke, Lili)

CSC grant:
Tang, Xiaofeng
Chen, Haiwei
Chen, Shi
Gu, Ening
He, Yakun
Liu, Chao
Xie, Chen
Zhang, Chaohong

**Deutscher Akademischer Austauschdienst**
**Forschungsmobilität - Programme des Projektbezogenen Personenaustauschs DAAD PPP Peru 2017** (Germany)
01.01.2017 – 31.12.2018
*Herstellung und Charakterisierung von Up-/und Downkonvertern*

**Deutsche Forschungsgemeinschaft DFG: BR 4031/6-1** (Germany)
01.01.2016 – 31.12.2018
*Entwicklung von neuen bildgebenden Verfahren zur Defekterkennung in Tandem Solarzellen*

**Deutsche Forschungsgemeinschaft DFG: BR 4031/9-1** (Germany)
01.01.2017 – 31.12.2018
*Entwicklung einer innovativen Methode zur beschleunigten Bestimmung der Photo-Stabilität neuartiger Dünnfilm-Halbleitern zur Anwendung für Solarzellen*

**Deutsche Forschungsgemeinschaft DFG-NSFC: BR 4031/13-1** (Germany)
01.01.2017 – 31.12.2019
*Development of novel organic semiconductors and advanced combinatorial characterization methods for high performance, printable polymer solar cells*

**Deutsche Forschungsgemeinschaft DFG WE 2107/12-1** (Germany)
01.04.2016 – 31.03.2020
*Analyse der Wachstumskinetik während der Hochtemperatur-Kristallzüchtung von SiC unter Anwendung der Computertomographie zur in-situ 3D Visualisierung der Wachstumsphasengrenze*

**Deutsches Zentrum für Luft- und Raumfahrt DLR: 01DJ16002** (Germany)
01.01.2016 – 30.06.2018
*Einfach und doppelt dotierte mit $Ce^{3+}$ und $Eu^{2+}$ nanokeramische Leuchtstoffe auf Silikat-Granat-Basis für weiße Hochleistungsleuchtdioden*

**EnCN2** (Germany)
01.01.2017 – 31.12.2021
*Erneuerbare EnergieträgerTechnologien im urbanen Umfeld (EET)*
*Speicher A*

**EU CHALLENGE 720827**
01.01.2017 – 31.12.2020
*3C-SiC Hetero-epitaxiALLy grown on silicon compliancE substrates and 3C-SiC substrates for sustaiNable wide-band-Gap powEr devices*

**FUMIN bridge fund DFG** (Germany)
01.11.2017 – 31.12.2018
*Energy Materials*

**GRK1896** (Germany)
01.01.2014 – 31.03.2018
*In-Situ Microscopy with Electrons, X-ray and Scanning Probes*

**HI-ERN Joint Projects Helmholtz-Institut Erlangen-Nürnberg** (Germany)
01.01.2017 – 31.12.2018
*Perovskite-based tandem solar cells*

**PHONSI** (Germany)
2015 – 2018
*Marie Skłodowska-Curie-Maßnahme Innovative Training Networks - ITN (Variante: European Training Network - ETN) im EU-Rahmenprogramm für Forschung und Innovation Horizont 2020*

**Projektträger Jülich 0324154D** (Germany)
01.11.2017 – 30.09.2020
*Verbundvorhaben: MYCIGS - Energieertragsoptimierte Cu (In,Ga)(S,Se)2-Dünnschichtsolarmodule durch gezielte Steuerung der Ertragsparameter; Teilvorhaben: Materialwissenschaftliche Charakterisierung*

**PV-ZUM DynoSol (BMWi)** (Germany)
01.05.2017 – 30.04.2020

**SFB 953 B01** (Germany)
01.01.2012 – 31.12.2019
*Synthetic Carbon Allotropes*

# 16. Teaching

## Winter Term 2017/18

**Lectures** (VORL)

Grundlagen der Halbleiterphysik [GHl], *W. Heiß*

Grundlagen des Kristallwachstums und der Halbleitertechnologie, *P. Wellmann*

Materialien der Elektronik und der Energietechnik [MEET-V], *P. Wellmann*

Materialien und Bauelemente für die Optoelektronik und Energietechnologie: Grundlagen [OpEt-G], *Ch. J. Brabec*

Nano-Bauelemente-Sensoren, MEMS, Micromachining [(NanoDev)], *Lehrbeauftragte*

Nanospektroskopie [NanoSpek], *W. Heiß, M. Batentschuk*

Photo Physics and Electronic Transport [PhPhys], *H.-J. Egelhaaf, Ch. J. Brabec*

Technische Grundlagen medizinischer Diagnostikverfahren [TGmD], *M. Thoms*

Werkstoffe und Verfahren der medizinischen Diagnostik I [WVmDI], *M. Thoms*

Werkstoffkunde für Studierende der Elektrotechnik (EEI) [Werkstoffk.(ET)], *P. Wellmann*

**Exercises and laboratory courses** (PR, PJS, SL, UE)

Lab Work Organic Electronics [OE-Pra-MWT], *T. Ameri*

Lab Work Organic Electronics NT [OE-Pra-NT], *T. Ameri*

Praktikum Materialien der Elektronik und der Energietechnologie (5. Sem.) [PR2-ET], *P. Wellmann*

Praktikum Funktionswerkstoffe in der Energietechnologie [FEt-Pra], *P. Wellmann*

Praktikum Nanotechnologie 2 (Master) [NT2-Pra], *W. Heiß, E. Spiecker*

Praktikum Thermoelektrische Eigenschaften in HL [ThEEHL-Pra], *M. Batentschuk*

Praktikum Transporteigenschaften in HL [TrEHl-Pra], *A. Osvet*

Praktikum Wahlfach Crystal Growth [WCrGr-Pra], *P. Wellmann*

Praktikum Werkstoffe 2 [PW 2], *M. Batentschuk*

Projektarbeit - Arbeitsgemeinschaft Kristallisation von SiC und CIS [AGK-Sem1], *P. Wellmann*

Projektarbeit -Arbeitsgemeinschaft Organische Photovoltaik [OPV-AG-Sem], *Ch. J. Brabec*

Übung Nano Devices [(ÜbNanoDev)], *Lehrbeauftragte*

Vorbesprechung VL, Termine u. LS-Praktika im WS, *M. Batentschuk, Ch. J. Brabec*

**Seminars** (AWA, SEM, TUT)

Anleitung zur wissenschaftlichen Arbeit [AnwA], *T. Ameri*

eTutorial - Materialien der Elektronik und Energietechnik [eTUT-WET], *P. Wellmann*

eTutorial Werkstoffkunde für EEI [eTUT-WW-EEI], *P. Wellmann*

Kern-/ Nebenfachseminar i-MEET (für Studierende im 3. MA-Semester) [KF/NF-iMEET-Sem], *Ch. J. Brabec*

Neuere Fragen zu Werkstoffen der Elektronik und Energietechnologie (Lehrstuhl-Seminar) [iMEET-Sem], *Ch. J. Brabec, M. Batentschuk, K. Forberich*

Seminar "Organic Electronics" [OE-Sem2], *T. Ameri*

Seminar on Solar Energy [SolSem], *Ch. Pflaum, Ch. J. Brabec, J. Hornich*

Seminar über Bachelor- und Masterarbeiten [BMBr-Sem], *Ch. J. Brabec*

Seminar über Bachelor-, Master und Doktorarbeiten – Crystal Growth [BMD-CG-Sem], *P. Wellmann*

Seminar über "Solution Processed Semiconductors" [SoPS-Sem], *W. Heiß*

## Summer Term 2018

**Lectures** (VORL)

Devices, *Ch.J. Brabec, K. Forberich, Th. Heumüller*

Elektrische, magnetische und optische Eigenschaften - Energietechnik, *W. Heiß*
Elektrische, magnetische, optische Eigenschaften [EMO], *Ch.J. Brabec, M. Batentschuk , W. Heiß*

Elektronische Bauelemente und Materialfragen (Technologie II), *P. Wellmann*

Halbleiter großer Bandlücke, *P. Wellmann*

Halbleitercharakterisierung, *W. Heiß*

Kolloidale Nanokristalle [KNKr], *W. Heiß*

Leuchtstoffe [LS], *M. Batentschuk, A. Winnacker*

Materialien und Bauelemente für die Optoelektronik und Energietechnologie: Anwendung [WET II], *Ch. J. Brabec , G. Matt, H.-J. Egelhaaf*

Technologie der Züchtung von Halbleiterkristallen und Photovoltaik [ZHLPV], *N.N.*

Thin films: processing, characterization and functionalities, *Ch. J. Brabec, M. Halik, H.-J. Egelhaaf*

Werkstoffe der Elektronik in der Medizin [WEM-V/Ü], *M. Batentschuk, A. Winnacker*

Werkstoffe und Verfahren der medizinischen Diagnostik II [WVmD II], *M. Thoms*

**Exercises and laboratory courses** (EX, PJS, PR, UE)

Exkursionen, *P. Wellmann*

Kernfachpraktikum I, Werkstoffe der Elektronik und Energietechnologie, *M. Batentschuk*

Kernfachpraktikum II, Wahlfach Organic Electronics, *T. Ameri*

Lab Work Organic Electronics, *T. Ameri*

Numerische Modellierung des Kristallwachstums mithilfe des Programmpakets COMSOL Multi-Physics [CGL-Comsol], *P. Wellmann*

Praktikum Eigenschaften von Leuchtstoffen [PREgsLs], *M. Batentschuk*

Praktikum Wahlfach Crystal Growth [CGr-Pra], *P. Wellmann*

Projektarbeit - Arbeitsgemeinschaft Kristallisation von SiC, CIS und CZTS [AG-Kristallisation], *P. Wellmann*

Projektarbeit - Arbeitsgemeinschaft Lösungsprozessierte Halbleiter [AG HL], *Ch. J. Brabec*

**Seminars** (SEM, SL)

Anleitung zur wissenschaftlichen Arbeit [AnwA-F], *K. Forberich*

Anleitung zur wissenschaftlichen Arbeit-E [AnwA], *H.-J. Egelhaaf*

Anleitung zur wissenschaftlichen Arbeit-H [AnwA-H], *W. Heiß*

Anleitung zur wissenschaftlichen Arbeit-GM [AnwA], *G. Matt*

How to start a company and basics of IP management, *Ch. J. Brabec, R. Kiebooms, M. Halik, H.-J. Egelhaaf*

Kernfachseminar, *Ch. J. Brabec, Assistenten*

Neuere Fragen zu Werkstoffen der Elektronik und Energietechnologie (Lehrstuhl-Seminar) [iMEET-Sem], *Ch. J. Brabec*, *P. Wellmann, M. Batentschuk*

Seminar on Solar Energy [SolSem], *Ch. J. Brabec, Ch. Camus*

Seminar über Bachelor- und Masterarbeiten, *Ch. J. Brabec*

Seminar über Bachelor- und Masterarbeiten, *W. Heiß*

Seminar über Bachelor- und Masterarbeiten, *P. Wellmann*

Vorbesprechung zum Masterstudium am i-MEET [iMEET-Vb-Ma], *M. Batentschuk, Ch. J. Brabec*

## Winter Term 2018/19

**Lectures** (VORL)

Grundlagen der Halbleiterphysik [GHl], *W. Heiß*

Grundlagen des Kristallwachstums und der Halbleitertechnologie, *P. Wellmann*

Materialien der Elektronik und der Energietechnik [MEET-V], *P. Wellmann*

Materialien und Bauelemente für die Optoelektronik und Energietechnologie: Grundlagen [OpEt-G], *Ch. J. Brabec, G. Matt*

Nanospektroskopie [NanoSpek], *W. Heiß, M. Batentschuk*

Photo Physics and Electronic Transport [PhPhys], *H.-J. Egelhaaf*

Technische Grundlagen medizinischer Diagnostikverfahren [TGmD], *M. Thoms*

Werkstoffe und Verfahren der medizinischen Diagnostik I [WVmDI], *M. Thoms*

Werkstoffkunde für Studierende der Elektrotechnik (EEI) [Werkstoffk.(ET)], *P. Wellmann*

**Exercises and laboratory courses** (PR, PJS, SL, UE)

Lab Work Organic Electronics [OE-Pra-MWT], *K. Forberich, Th. Heumüller*

Lab Work Organic Electronics NT [OE-Pra-NT], *N.N.*

Praktikum Materialien der Elektronik und der Energietechnologie (5. Sem.) [PR2-ET], *P. Wellmann*
Nano-Bauelemente-Sensoren, MEMS, Micromachining [(NanoDev)], *N.N.*

Praktikum Funktionswerkstoffe in der Energietechnologie [FEt-Pra], *P. Wellmann*

Praktikum Nanotechnologie 2 (Master) [NT2-Pra], *W. Heiß, E. Spiecker*

Praktikum Transporteigenschaften in HL [TrEHl-Pra], *A. Osvet*

Praktikum Wahlfach Crystal Growth [WCrGr-Pra], *P. Wellmann*

Praktikum Werkstoffe 2 [PW 2], *M. Batentschuk*

Projektarbeit - Arbeitsgemeinschaft Kristallisation von SiC und CIS [AGK-Sem1], *P. Wellmann*

Projektarbeit -Arbeitsgemeinschaft Organische Photovoltaik [OPV-AG-Sem], *Ch. J. Brabec*

Projektarbeit –Arbeitsgemeinschaft Solution Processed Semiconductors [SPS_AG-Sem],
*W. Heiß*

Übung Nano Devices [(ÜbNanoDev)], *N.N.*

Vorbesprechung Masterstudium i-MEET WS 18/19, *M. Batentschuk, Ch. J. Brabec*

**Seminars** (AWA, SEM, TUT)

Anleitung zur wissenschaftlichen Arbeit [AnwA-F], *K. Forberich*

Anleitung zur wissenschaftlichen Arbeit-E [AnwA], *H.-J. Egelhaaf*

Anleitung zur wissenschaftlichen Arbeit-GM [AnwA], *G. Matt*

eTutorial - Materialien der Elektronik und Energietechnik [eTUT-WET], *P. Wellmann*

eTutorial Werkstoffkunde für EEI [eTUT-WW-EEI], *P. Wellmann*

Kern-/ Nebenfachseminar i-MEET [KF/NF-iMEET-Sem], *Ch. J. Brabec*

Neuere Fragen zu Werkstoffen der Elektronik und Energietechnologie (Lehrstuhl-Seminar) [iMEET-Sem], *Ch. J. Brabec, M. Batentschuk, K. Forberich*

Projektarbeit - Arbeitsgemeinschaft Solution Processed Semiconductors [SPS_AG-Sem], *W. Heiß*

Seminar "Organic Electronics" [OE-Sem2], *N.N.*

Seminar on Solar Energy [SolSem], *Ch. Camus, Ch. J. Brabec*

Seminar über "Solution Processed Semiconductors" [SoPS-Sem], *W. Heiß*

Seminar über Bachelor- und Masterarbeiten [BMBr-Sem], *Ch. J. Brabec*

Seminar über Bachelor-, Master und Doktorarbeiten – Crystal Growth [BMD-CG-Sem], *P. Wellmann*

## Summer Term 2019

**Lectures** (VORL)

Devices, *Ch.J. Brabec, K. Forberich, Th. Heumüller*

Elektrische, magnetische und optische Eigenschaften - Energietechnik, *W. Heiß*

Elektrische, magnetische, optische Eigenschaften [EMO], *Ch.J. Brabec, M. Batentschuk , W. Heiß*

Elektronische Bauelemente und Materialfragen (Technologie II), *P. Wellmann*

Halbleiter großer Bandlücke, *P. Wellmann*

Halbleitercharakterisierung, *W. Heiß*

Kolloidale Nanokristalle [KNKr], *W. Heiß*

Leuchtstoffe [LS], *M. Batentschuk, A. Winnacker*

Materialien und Bauelemente für die Optoelektronik und Energietechnologie: Anwendung [WET II], *Ch. J. Brabec , G. Matt*

Numerische Modellierung des Kristallwachstums mithilfe des Programmpakets COMSOL Multi-Physics [CGL-Comsol], *P. Wellmann*

Technologie der Züchtung von Halbleiterkristallen und Photovoltaik [ZHLPV], *N.N.*

Thin films: processing, characterization and functionalities, *H.-J. Egelhaaf*

Thin films: processing, characterization and functionalities (Extension), *H.-J. Egelhaaf*

Werkstoffe der Elektronik in der Medizin [WEM-V/Ü], *M. Batentschuk, A. Winnacker*

Werkstoffe und Verfahren der medizinischen Diagnostik II [WVmD II], *M. Thoms*

**Exercises and laboratory courses** (EX, PJS, PR, UE)

Exkursionen, *P. Wellmann*

Kernfachpraktikum I, Werkstoffe der Elektronik und Energietechnologie, *M. Batentschuk*

Kernfachpraktikum II, Wahlfach Organic Electronics, *N.N.*

Lab Work Organic Electronics, *N.N.*

Lab Work Organic Electronics, [OE-Pra-MWT], *K. Forberich, Th. Heumüller*

Materialien und Bauelemente für die Optoelektronik und Energietechnologie: Anwendung [WET II], *Ch. J. Brabec* , *G. Matt*

Numerische Modellierung des Kristallwachstums mithilfe des Programmpakets COMSOL Multi-Physics [CGL-Comsol], *P. Wellmann*

Praktikum Eigenschaften von Leuchtstoffen [PREgsLs], *M. Batentschuk*

Praktikum Wahlfach Crystal Growth [CGr-Pra], *P. Wellmann*

Projektarbeit - Arbeitsgemeinschaft Kristallisation von SiC, CIS und CZTS [AG-Kristallisation], *P. Wellmann*

Projektarbeit - Arbeitsgemeinschaft Lösungsprozessierte Halbleiter [AG HL], *Ch. J. Brabec*

**Seminars** (SEM, SL)

Anleitung zur wissenschaftlichen Arbeit-E [AnwA], *H.-J. Egelhaaf*

Anleitung zur wissenschaftlichen Arbeit-H [AnwA-H], *W. Heiß*

How to start a company and basics of IP management, *Ch. J. Brabec, J. Hauch, H.-J. Egelhaaf*

Kernfachseminar, *W. Heiß, Assistenten*

Neuere Fragen zu Werkstoffen der Elektronik und Energietechnologie (Lehrstuhl-Seminar) [iMEET-Sem], *Ch. J. Brabec*, *M. Batentschuk*

Seminar on Solar Energy [SolSem], *Ch. J. Brabec, Ch. Pflaum, J. Hauch*

Seminar über Bachelor- und Masterarbeiten, *Ch. J. Brabec*

Seminar über Bachelor- und Masterarbeiten, *W. Heiß*

Seminar über Bachelor- und Masterarbeiten, *P. Wellmann*

Vorbesprechung zum Masterstudium am i-MEET [iMEET-Vb-Ma], *M. Batentschuk, Ch. J. Brabec*

## Winter Term 2019/2020

**Lectures** (VORL)

Grundlagen der Halbleiterphysik [GHl], *W. Heiß*

Grundlagen des Kristallwachstums und der Halbleitertechnologie, *P. Wellmann*

Materialien der Elektronik und der Energietechnik [MEET-V], *P. Wellmann*

Materialien und Bauelemente für die Optoelektronik und Energietechnologie: Grundlagen [OpEt-G], *Ch. J. Brabec, G. Matt*
Nano-Bauelemente-Sensoren, MEMS, Micromachining [(NanoDev)], *G. Matt*

Nanospektroskopie [NanoSpek], *W. Heiß, M. Batentschuk*

Photo Physics and Electronic Transport [PhPhys], *H.-J. Egelhaaf*

Photo Physics and Electronic Transport (Extention) [PhPhys_ext], *H.-J. Egelhaaf*

Technische Grundlagen medizinischer Diagnostikverfahren [TGmD], *M. Thoms*

Werkstoffe und Verfahren der medizinischen Diagnostik I [WVmDI], *M. Thoms*

Werkstoffkunde für Studierende der Elektrotechnik (EEI) [Werkstoffk.(ET)], *P. Wellmann*

**Exercises and laboratory courses** (PR, PJS, SL, UE)

Kernfachpraktikum i-MEET Grundlagen [KFP_G], *M. Batentschuk, A. Osvet*

Lab Work Organic Electronics [OE-Pra-MWT], *Th. Heumüller*

Lab Work Organic Electronics NT [OE-Pra-NT], *N.N.*

Praktikum Materialien der Elektronik und der Energietechnologie (5. Sem.) [PR2-ET], *P. Wellmann*

Nano-Bauelemente-Sensoren, MEMS, Micromachining [(NanoDev)], *G. Matt*

Praktikum Funktionswerkstoffe in der Energietechnologie [FEt-Pra], *P. Wellmann*

Praktikum Nanotechnologie 2 (Master) [NT2-Pra], *W. Heiß, E. Spiecker*

Praktikum Transporteigenschaften in HL [TrEHl-Pra], *A. Osvet*

Praktikum Wahlfach Crystal Growth [WCrGr-Pra], *P. Wellmann*

Praktikum Werkstoffe 2 [PW 2], *M. Batentschuk*

Projektarbeit - Arbeitsgemeinschaft Kristallisation von SiC und CIS [AGK-Sem1], *P. Wellmann*

Projektarbeit -Arbeitsgemeinschaft Organische Photovoltaik [OPV-AG-Sem], *Ch. J. Brabec*

Projektarbeit –Arbeitsgemeinschaft Solution Processed Semiconductors [SPS_AG-Sem], *W. Heiß*

Übung Nano Devices [(ÜbNanoDev)], *N.N.*

Vorbesprechung Masterstudium i-MEET WS 18/19, *M. Batentschuk, Ch. J. Brabec*

**Seminars** (AWA, SEM, TUT)

Anleitung zur wissenschaftlichen Arbeit [AnwA-F], *K. Forberich*

Anleitung zur wissenschaftlichen Arbeit-E [AnwA], *H.-J. Egelhaaf*

Anleitung zur wissenschaftlichen Arbeit-GM [AnwA], *G. Matt*

eTutorial - Materialien der Elektronik und Energietechnik [eTUT-WET], *P. Wellmann*

eTutorial Werkstoffkunde für EEI [eTUT-WW-EEI], *P. Wellmann*

Kern-/ Nebenfachseminar i-MEET [KF/NF-iMEET-Sem], *Ch. J. Brabec*

Neuere Fragen zu Werkstoffen der Elektronik und Energietechnologie (Lehrstuhl-Seminar) [iMEET-Sem], *Ch. J. Brabec, M. Batentschuk, K. Forberich*

Seminar "Organic Electronics" [OE-Sem2], *A. Osvet*

Seminar on Solar Energy [SolSem], *Ch. J. Brabec, J. Hauch, Ch. Pflaum*

Seminar über "Solution Processed Semiconductors" [SoPS-Sem], *W. Heiß*

Seminar über Bachelor- und Masterarbeiten [BMBr-Sem], *Ch. J. Brabec*

Seminar über Bachelor-, Master und Doktorarbeiten – Crystal Growth [BMD-CG-Sem], *P. Wellmann*

# 17. Addresses and Maps

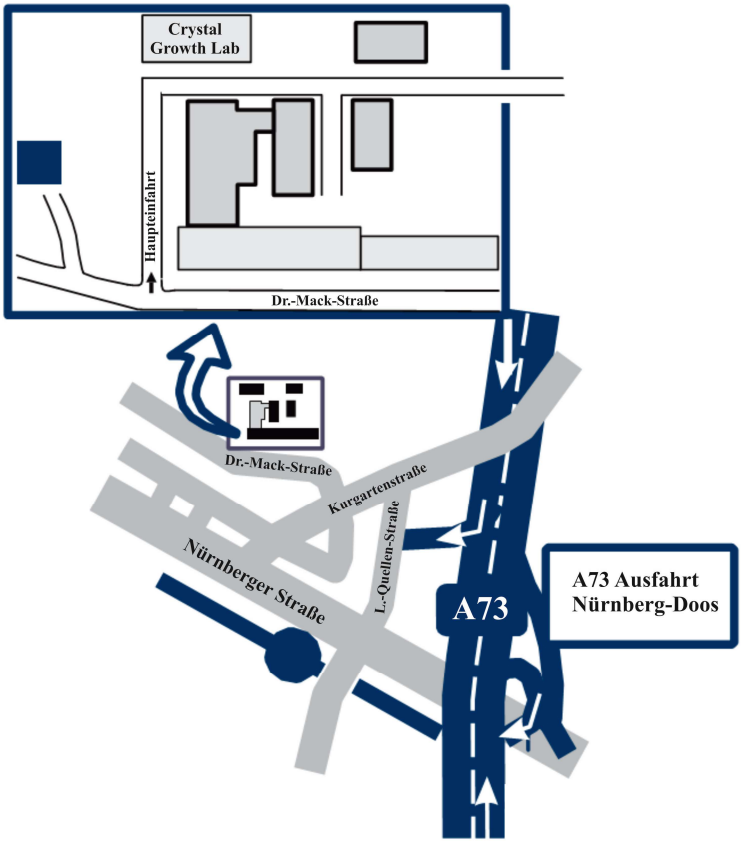
**Department of Materials Science & Engineering**
**Materials for Electronics and Energy Technology**
Friedrich-Alexander University of Erlangen-Nürnberg
Martensstr. 7
D-91058 Erlangen, Germany
Phone: +49 (0) 9131 85-27633 (Secretary)
Fax: +49 (0) 9131 85-28495
Internet: https://www.i-meet.ww.uni-erlangen.de/


**By car**:
Highway A3 exit **Tennenlohe**; direction to Erlangen (B4). Follow the signs "**Universität Südgelände".** After junction **"Technische Fakultät"** please follow the map.

**By train:**
Railway station **Erlangen.**
Bus line No. 287 direction **"Sebaldussiedlung"**. Bus stop **"Technische Fakultät".** 50 meters to a layout plan; search for **"Insitut für Werkstoffwissenschaften"**.

**ZAE Bayern Erlangen**
Erneuerbare Energien
Immerwahrstraße 2
D-91058 Erlangen, Germany
Phone: +49 (0) 9131 / 9398-100
Fax: +49 (0) 9131 / 9398-199
E-Mail**:** re@zae-bayern.de
Internet: https://www.zae-bayern.de

**Technikum 2**
Crystal Growth Lab
Dr.-Mack-Strasse 77
D-90762 Fürth
Phone: +49 (0) 911 / 65078-65081
FAX: +49 (0) 911 / 65078-65083
Email: crystals@fau.de
Internet: http://crystals.tf.fau.de



**Geschäftsstelle Energie Campus Nürnberg e.V.**
Fürther Str. 250
"Auf AEG", Gebäude 16
D-90429 Nürnberg
Phone: +49 (0) 911 / 56 854 9120
Fax: +49 (0) 911 / 56 854 9121
E-Mail: info@encn.de
Internet: http://www.encn.de