ISSUE
№ 1
January, 2018

KAUST Solar Center News

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Message from the Director

It is a pleasure to introduce you to our first KAUST Solar Center (KSC) newsletter. Within these pages, we hope to convey the enthusiasm of our members and the exciting scope and impact of the technology and applications we are developing.

Our center is continually evolving to address commercially relevant opportunities in solar technology from improving the temperature coefficient in silicon photovoltaics to developing new large area processing of flexible and transparent solar cell modules, as well as discovering new materials for efficient hydrogen evolution by solar-driven water splitting. Our mission is to create modern science and technology in the field of solar energy conversion, providing an environment for interdisciplinary research, training, and innovation for the benefit of society. Clearly, with such ambitious goals, we are kept very busy!

The photovoltaic themes within our project portfolio, for example, address three key directions for future solar applications: to improve device efficiency, to add new application functionality and to lower manufacturing costs. These provide an excellent platform for our center to build on and the opportunity to flexibly address our target applications. As you can imagine, this requires a truly interdisciplinary team.

This newsletter will give a glimpse of our faculty, postdocs, students, alumni and overall center research activities.

Iain McCulloch,
Director of KAUST Solar Center,
Professor of Chemical Science

"...Our mission is to create modern science and technology in the field of solar energy conversion, providing an environment for interdisciplinary research, training, and innovation for the benefit of society."

KSC Research Highlights

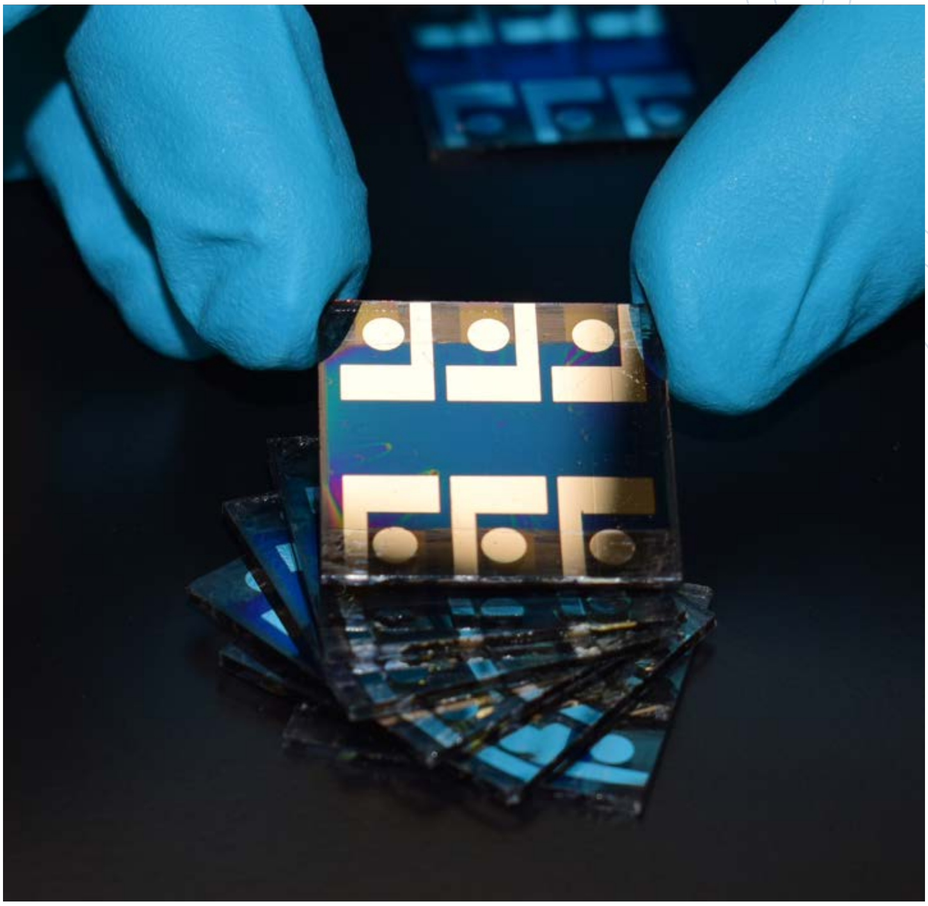
The sun shines on perovskite solar cells —By Esma Ugur

Esma Ugar (left) and Associate Professor Frédéric Laquai (right) are studying the impact of ambient conditions on the photophysical processes in $MAPbI_3$ perovskites processed with glycol ethers.

Esma Ugur got her BSc degree in Physics from Middle East Technical University, Turkey. After completing MSc in TOBB University of Economics and Technology, she joined KAUST as a Ph.D. candidate in Frédéric Laquai's group in January 2016. Her main research focus is the understanding of charge carrier generation, transport and recombination processes in perovskite solar cells.

The term 'Perovskite' describes a specific crystal structure of compounds, that have an AMX_3 composition, in which A and M are cations and X is anionic. In metal halide perovskites, cation A can be organic, inorganic or combination of organic and inorganic ions, while X is a halide such as iodide, bromide and/or chloride. In less than a decade metal halide perovskite solar cells (PSCs) have reached power conversion efficiencies of more than 22%. The high efficiency of PSCs is attributed to the unique optical and electrical properties of perovskite absorbers such as large absorption coefficients across a wide spectral range in the visible region, and high carrier mobility, allowing micrometer long electron and hole diffusion lengths. Moreover, contrary to organic materials, the electron-hole pair, created by photoexcitation, is loosely bound (Wannier-type excitons) and therefore only a small amount of energy of the order of k_BT is needed to separate the charge carriers at room temperature.

The aforementioned outstanding optoelectronic properties combined with the possibility of low-temperature solution processing make perovskites promising as active materials for next-generation photovoltaic devices. Moreover, this material is adaptable to many processing protocols such as vacuum based co-evaporation or vapor-assisted processing. New processing schemes have led to higher quality perovskite thin films and have opened pathways for applicability to larger areas. However, the bottleneck for industrial application is the instability, presence of lead, and lack of reliable stability test protocols. Mixed perovskites, containing inorganic cations such as Cs, Rb, etc. and bromide incorporation improve the stability of the perovskite. Furthermore, 2D perovskite materials have shown better stability. Recently, perovskite devices with stabilities exceeding one year were demonstrated, achieved by engineering the 2D/3D perovskite interface. Apart from stability issues, understanding the reason behind hysteresis in perovskite photovoltaic devices is still an important topic. Untill now, ion migration, capacitive



A photograph of perovskite solar device.

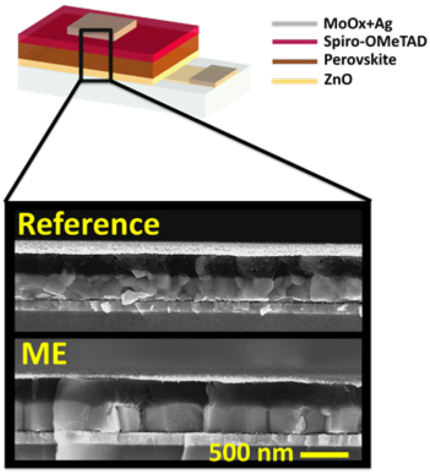


Figure: Device structure of $MAPbI_3$ perovskite solar cells and cross-sectional SEM images of Reference and ME devices. Reprinted with permission from ACS Energy Lett., 2017, 2 (9), pp 1960–1968. Copyright 2018 American Chemical Society.

dark currents, and surface polarization at the ETL/perovskite interface have been suggested as the main reasons for hysteresis. However, the origin of the hysteresis is still not entirely clear, while it needs to be understood to eliminate this issue. In the Solar Center, we have several groups working on material development, device engineering, processing, and fundamental understanding of the efficiency-limiting processes.

In the Center, first generation perovskite solar cells, based on methylammonium lead iodide ($MAPbI_3$), have been studied extensively. Different electron transport layers, organic based hole transport layers for Spiro-OMeTAD and/or PEDOT:PSS replacement and process engineering for highly crystalline perovskite solar cells have been reported. The figure shows the device architecture and cross-sectional SEM images of $MAPbI_3$ perovskite solar cells. Here, a sequential interdiffusion method was used to fabricate the perovskite layers shown in the SEM images. ME represents $MAPbI_3$ perovskite absorber layers processed with 2-methoxyethanol as additive in MAI solution. Currently, we can fabricate solution-processed small area (<1cm^2) devices with high efficiencies (>20%) in the KAUST Solar Center (KSC) by using mixed-cation lead mixed-halide perovskite absorber layers. These perovskite solar cells give better performance than $MAPbI_3$ devices with enhanced stability. Combining highly efficient perovskite solar cells with traditional Si photovoltaics (perovskite/Si tandem devices) is an additional topic of potentially high impact, which is currently pursued in the KSC.

To shed more light on device performance and the limitations in energy conversion in solar cells, it is important to identify the dominant recombination mechanisms. In our group, we focus on photophysical processes in perovskite solar cells. As a spectroscopy group, we are highly interested in developing a better understanding of the charge-carrier dynamics in perovskite thin films, such as $MAPbI_3$ perovskites processed with glycol ethers, and the impact of ambient conditions on the photophysical processes. This could help to address the stability issue since the impact of humidity on non-radiative losses is still not clear. The latest generation perovskite solar cells use perovskite absorber layers composed of mixed-cation metal mixed-halide and/or 2D/3D perovskite composites. They need to be studied in terms of charge transport and recombination processes at the charge transport layers/perovskite interfaces. We are using mainly transient absorption spectroscopy (TAS) and time-resolved photoluminescence (TRPL) spectroscopy to study photophysical processes in perovskite solar cells. We believe understanding of dominant recombination pathways and finding ways to suppress them will help us to obtain higher efficiencies towards the Shockley–Queisser limit for specific perovskite device.

Inorganic semiconductors in the age of plastic electronics

—By Yuliar Firdaus

Yuliar Firdaus is on a quest to discover semiconductors that are compatible with the field of plastic electronics and beyond.

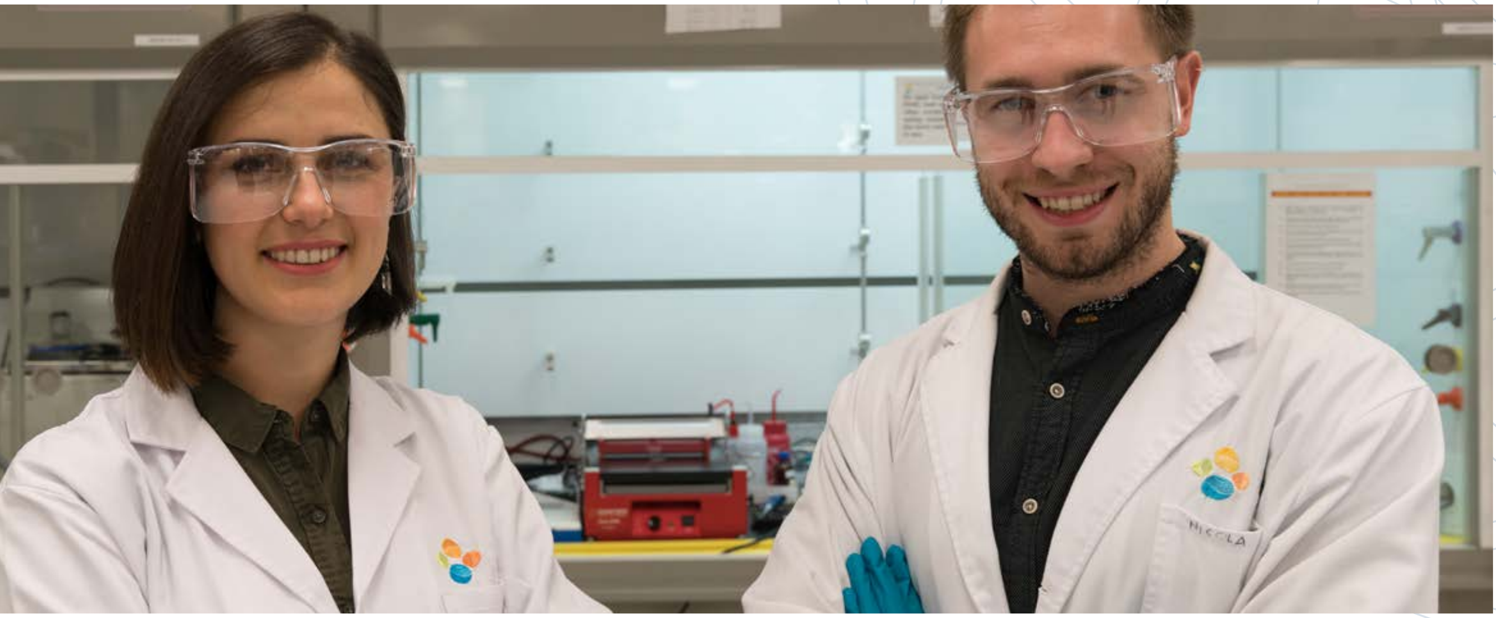
Many aspects of our modern society are built on the electronic and optical properties of semiconductors. With the push towards plastic electronics, deposition methods for semiconducting materials are being geared towards solution-based processing routes, such as printing. Amongst those solution processable semiconductors, transparent metal oxides (MOs) have emerged as a promising family of compound materials for a range of applications in the emerging area of large-area optoelectronics. MOs offer numerous advantages over incumbent technologies for use in different technology sectors as a result of the combination of tunable energy band structure, high carrier mobility, superior optical transparency, processing versatility, and mechanical flexibility. To this end, recent years have witnessed remarkable advances in the science and technology of MOs, including the discovery and characterization of new transparent conducting oxides, the realization of p-type along with traditional n-type MO materials for various exploratory applications and, most importantly, commercialization of the first amorphous MO semiconductors for flat panel displays.

The most prominent advantage of MO materials is their ease of processing from solution phase at low temperature and under ambient conditions, which could potentially provide a promising alternative to the established vacuum-based process technologies for widespread technological applications. "Unlike conventional inorganic semiconductors, the chemical nature of MOs allow them to be deposited using solution-processing techniques, such as roll-to-roll printing, spray pyrolysis, and spin-coating," said Firdaus.

Firdaus completed his Ph.D. in KU Leuven, Belgium, in 2015 where he focused his study on quantum dot solar cells. After his dissertation, he joined KSC as postdoctoral fellow in Pierre Beaujuge's group. He then moved to KAUST's Laboratory for Advanced Materials & Applications (LAMA), headed by Thomas Anthopoulos; he is currently working on the development of solution-processed inorganic materials for applications such as thin-film transistors (TFT) and solar cells.

Besides MOs, the LAMA team also focuses on numerous other inorganic materials in a quest to discover semiconductors that are compatible with the field of plastic electronics and beyond. "There is still a vast repository of inorganic materials that are still waiting to be discovered and studied."explained Firdaus. Some of the examples are: oxychalcogenides, oxypnictides, chalcogenides and molecular pseudohalides. "Pseudohalides such as CuSCN have great potential for optoelectronic applications and our group has performed pioneering work on the development and application of this material in plastic opto/electronics," said Firdaus. Furthermore, the LAMA team design, develop and study the use of novel processing techniques such as rapid photonic sintering using high-power optical flash lamps. This effort is driven primarily by the fact that the vast majority of solution-processed inorganic materials rely on thermal conversion at high temperature (typically >200 °C) for prolonged periods of time (>1 h). This makes device/system processing lengthy and also limits the choice of substrate materials to those able to cope with the high thermal budget annealing. "Our optical sintering techniques might help overcome these issues and define how the large-area electronics of the future will be manufactured".

"Certainly, solution-processable inorganic semiconductors hold the key for many emerging technologies and the LAMA team is determined to make a difference," said Firdaus.



KSC Assistant Professor Derya Baran (left) and Nicola Gasparini's (right) research focuses on ternary organic solar cells.

The new era of organic electronics —By Nicola Gasparini

The paths of KAUST Solar Center and Nicola Gasparini crossed for the first time during the solar conference organized by the center in 2016. "At that time I was amazed by the facilities of KSC and when Derya Baran offered me a position, deciding to join KAUST was a natural choice." he said. He completed his Ph.D. in Friedrich Alexander University Erlangen-Nuremberg under the supervision of Prof. Brabec were he focused on the charge carrier recombination processes of ternary organic solar cells. After his dissertation, he joined Baran's research group in September 2017 to pursue his post-doctoral studies and expand his interests to organic electronics to exceed the current limitations.

"Being part of KAUST is exhilarating and the opportunities for remarkable discoveries are limitless. Moreover, joining Baran's group is the perfect continuation of our last four years of research collaboration, and at the same time I am excited to be part of a young, talented and driven research group." said Gasparini.

Together with Baran, Gasparini's research will focus on different technical areas of organic semiconductors, spacing from solar cells, transistors, and photodetectors. In particular, they are focusing on transport studies, investigation and design of complex organic semiconductor composites. Together with KSC member faculty, they will explore novel and scalable composites for thin film photovoltaics. "My goal is to combine concepts from different fields to realize smart devices," he said.

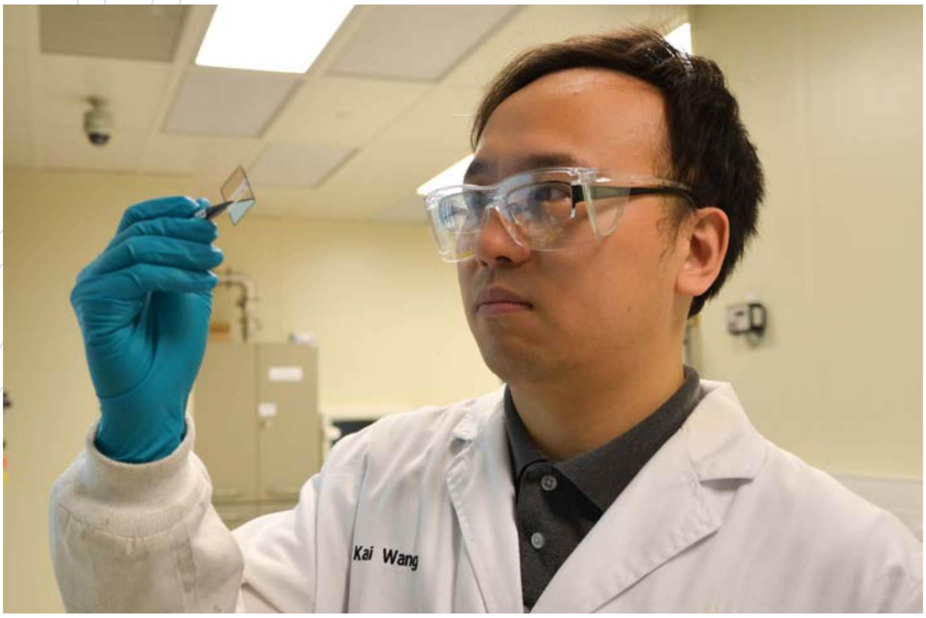
One key advantage of solution-processable organic semiconductors is the opportunity to blend different materials to attain novel material properties and applications. One of the concepts that Gasparini's research will focus on is ternary organic solar cells, which makes use of exactly that idea: three (or more) organic chromophores are combined to better match the solar irradiance spectrum and thus increase the amount of light absorbed (reflected in higher short-circuit current density), which in turn will increase the power output of the solar cell. Similar to the working principle of organic photovoltaics, controlling the structural disorder and excitonic nature of organic materials is the key driver for organic photodetector's (OPD) performance. A particularly appealing characteristic of OPD devices, which derives from the ability of processing on plastics as well as the ease with which the organic semiconductor can be chemically functionalized, is its integration into complex systems of color vision, with recent examples emerging in both biological and robotic-humanoid systems. Furthermore, the chemical design of organic chromophores with relatively narrow absorption spectra allows organic photodetectors to be explored for selective narrowband photodetection, where cost-effective material choices remain scarce.

"KSC offers a unique environment with prestigious PIs and all aspects of the organic semiconductor field, everything from the synthesis of the materials to the optoelectronic/ morphological investigations can be tackled in-house." Moreover, the OmegaLab team focuses on understanding one of the main limitations of organic solar cells for real-world application, i.e. their reliability and stability under light and thermal stress and finds solutions for that for niche-applications.

"With the development of novel materials in combination with smart design concepts, organic photovoltaic technology will move from a mere phenomenon in the lab to a niche market, and I am looking forward to the results that we as OmegaLab will obtain." said Gasparini.

Printed hybrid-tandem solar cells and modules —By Kai Wang

After finishing his Ph.D. in Organic Chemistry from Jilin University, China, Kai Wang joined KSC in 2014 in Pierre Beaujuge's group.



Kai Wang work towards ultra-high efficient perovskite/silicon tandem cells for low-cost electricity.

> KSC is one of the best equipped academic centers for solar energy research."

"I was impressed with KAUST's reputation as a world-class institution with ambitious goals for addressing global challenges," Wang says, adding, "KSC is one of the best equipped academic centers for solar energy research and my research is broadened by collaborative projects utilizing the complementary expertise of KSC faculty members."

Wang is now working as a joint postdoctoral fellow in Stefaan De Wolf's and Aram Amassian's groups on one of the center funded projects, 'Printed hybrid-tandem solar cells and modules', which aims at developing perovskite solar cells and semitransparent contacts that can be combined with silicon solar cells, with an ultimate goal of being monolithically integrated into 2-terminal perovskite-silicon tandem solar cells (PCE > 30%). As silicon cell efficiency is already very close to the limit, perovskite/silicon tandem cells with their potential for ultra-high efficiency at affordable costs represent the most straightforward way to decrease the overall cost of photovoltaic systems, and consequently also to reduce the price of electricity for end-users. "Stefaan De Wolf is an expert in fabrication of high-efficiency silicon-based solar cells and perovskite-silicon tandem solar cells. Under his guidance, I mainly focus on low-temperature processed, high-efficiency perovskite solar cell fabrication and characterization." Wang explained.

To achieve his goal, Wang has been working with his colleagues to establish a high-efficiency perovskite device baseline to further push device performance to the state-of-the-art with more stability. "Inspired by some recent leading work in this field, we have found one material/device system showing great potential to reach high efficiency. To understand more about the perovskite dynamic process which starts as a solution and turns solid during spin coating which benefits our device engineering. I performed in situ grazing incidence wide-angle X-ray scattering experiments at Cornell High Energy Synchrotron Source (CHESS) with the guidance of Aram Amassian." Wang said. The results show that the perovskite and other phase formation processes are entirely dependent on halide and cation compositions, allowing people to understand more about the role of each composition in perovskites. Consequently, this provides the anticipation and guideline of anti-solvent dripping, which is one of the critical factors to achieve high-efficiency devices.

In addition to device engineering, Wang is also working on developing alternative organic/inorganic electron transporting layer (ETL) and hole transporting layer (HTL) material with less parasitic absorption. Parasitic absorption induced by HTL or ETL is one of the most limiting factors to achieving high efficiency for tandem solar cells. Therefore, to achieve high-efficiency tandem solar cells, parasitic absorption must be eliminated. For n-i-p device structure, Sprio-OMeTAD causes serious parasitic absorption, one of the targets is to look for existing alternative HTL or develop new HTL to replace it. The alternative material was required to possess less absorption, proper energy-alignment and can reach comparable or even better device performance than Sprio-OMeTAD. Similarly, PCBM, which is the most common used ETL in p-i-n structure and also causes parasitic absorption, needed to be replaced by alternative ETL with less parasitic absorption as well.

"I will continue working on device engineering to reach high-efficiency perovskite solar cells with less hysteresis and more repeatability, additionally boost KSC perovskite solar cell baseline before we put it on top of silicon solar cell or apply it to scalable processes. Meanwhile, I will develop alternative HTL/ETL with less parasitic absorption and comparable or potentially better device performance, with an ultimate aim to achieve high-efficiency tandem solar cells." said Wang.

Faculty Focus

Interview with Professor Stefaan De Wolf

Stefaan De Wolf joined KSC in September of 2016 as an Associate Professor of Material Science and engineering in the University›s Physical Science and Engineering (PSE) Division. He obtained his Ph.D. in silicon solar cells at IMEC, a sizeable nano-electronics institute in Belgium. Stefaan then spent several years at The National Institute of Advanced Industrial Science and Technology (AIST) (Japan), followed by almost nine years as a team leader responsible for high-efficiency solar cells at Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland.

"The core of my activities is based around silicon heterojunction solar cells, a technology that uses silicon wafers to absorb the sunlight. In these devices, the electric contacts are made by scalable thin-film deposition techniques. Here at KAUST, I am particularly interested in tailoring this technology to develop high-efficiency solar cells that perform very well in hot climates." he explained.

What was your motivation to join KAUST?

The first time I came to KAUST was at the beginning of 2015 to give a seminar on silicon solar cells. After visiting the campus and getting tours of the lab facilities, I realized that KAUST is indeed an extraordinary place. I had never seen a university like this, combining extremely well-equipped labs with a very ambitious mission, addressing the 'grand' sustainability challenges, including the one for energy. One of the reasons which motivated me to consider KAUST as the next step for my career was the KAUST Solar Center, which is especially strong in chemistry and material science. My background is rather in semiconductor device physics and engineering. The different 'angle' KSC offers on solar energy research gives me an extraordinary opportunity to expose myself to a new scientific environment, which always inspires, and allows me to pursue inter-disciplinary research which is very appealing to find new solutions.

How do you like working at KAUST?

KAUST is young, highly dynamic and full of grand aspirations. This makes it a unique research environment. In addition to my work on perovskite solar cells in KSC, I am setting up silicon activities which demand a substantial financial commitment. Developing this in any part of the world would be very difficult in an academic setting. I am also excited that my research focus is directly linked to KAUST mission, where I also hope to contribute to educating the next generation of solar scientists and engineers. In simple words, KAUST is a place to execute great ideas as it provides the vital ecosystem to cultivate your research.

De Wolf noted that as soon as he heard of the university, "I knew I had to be here because of the KAUST commitment to addressing grand challenges, including the one for sustainable energy supply. At KAUST, time flies, and every day I meet inspiring people—it couldn't be better."

What is your primary research focus?

The core of my activities is based around silicon heterojunction solar cells, a technology that uses silicon wafers to absorb the sunlight. In these devices, the electric contacts are made by scalable thin-film deposition techniques, and this technology recently set the world-record conversion efficiency for silicon solar cells. Here at KAUST, I am particularly interested in tailoring this technology to develop high-efficiency solar cells that perform very well in hot climates. Long-term, I focus on tandem solar cells, still using silicon heterojunction solar. In the tandem design, we aim at using perovskites as 'top' cells, as they are susceptible to blue light. In this sense, in such tandems, the perovskite top cell harvests blue light from the solar spectrum, whereas silicon bottom cell is sensitive to red light. Thus, tandems enable further increases in photovoltaic conversion efficiency, but also will result in less heating of the devices, as we convert the blue light more efficiently into electricity, rather than heat. Consequently, such tandem solar cells are desirable for the hot-climate electricity market.

What do you like to do beyond research?

I like to swim and read in my free time. I used to go sailing and surfing, and I am planning to start it here again. I also try to explore the Kingdom as much as time allows.

What is your advice to young scientists?

I would encourage young scientists to expose themselves to influences outside their direct research projects. Great science often comes from those that can make associations others didn't see. Louis Pasteur famously said, "Chance favors the prepared mind." I believe this only can happen when one has a broad interest beyond one's specialization. At KAUST, many seminars are given, as well regular 'enrichment' programs with keynote talks and workshops, which I find very inspiring. Young scientists should eagerly take full advantage of these opportunities, attend these events and, most importantly, talk to people and interact with them.

In the Spotlight:

KSC's recent high impact paper


nature
materials

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Altmetric: 54 Citations: 104

Article

Reducing the efficiency–stability–cost gap of organic photovoltaics with highly efficient and stable small molecule acceptor ternary solar cells

Derya Baran, Raja Shahid Ashraf, David A. Hanifi, Maged Abdelsamie, Nicola Gasparini, Jason A. Röhr, Sarah Holliday, Andrew Wadsworth, Sarah Lockett, Marios Neophytou, Christopher J. M. Emmott, Jenny Nelson, Christoph J. Brabec, Aram Amassian, Alberto Salleo, Thomas Kirchartz, James R. Durrant & Iain McCulloch

Nature Materials **16**, 363–369 (2017)
doi:10.1038/nmat4797
Download Citation

Conjugated polymers Electronic materials
Photonic devices Solar cells

Received: 28 April 2016
Accepted: 13 October 2016
Published online: 21 November 2016

Derya Baran authored a Nature Materials paper that was cited over 100 times in 2017.

"Only a couple of years ago, the dream for researchers in organic solar cells was able to overcome the '10% efficiency barrier." Baran recalled, "In this work, replacing the work-horse 'fullerene acceptors' of organic photovoltaics (OPV) paved the way for highly efficient solar cells with efficiencies greater than 10%. The paper reports how to reduce the efficiency-stability-cost gap for organic photovoltaics using novel small molecule acceptors for commercial OPV applications."

"It reports the highest power conversion efficiency for poly-3-hexyl-thiophene (P3HT) solar cells (7.7%) with remarkable stability in the air which is significant for long-term use of these devices." expained Baran.

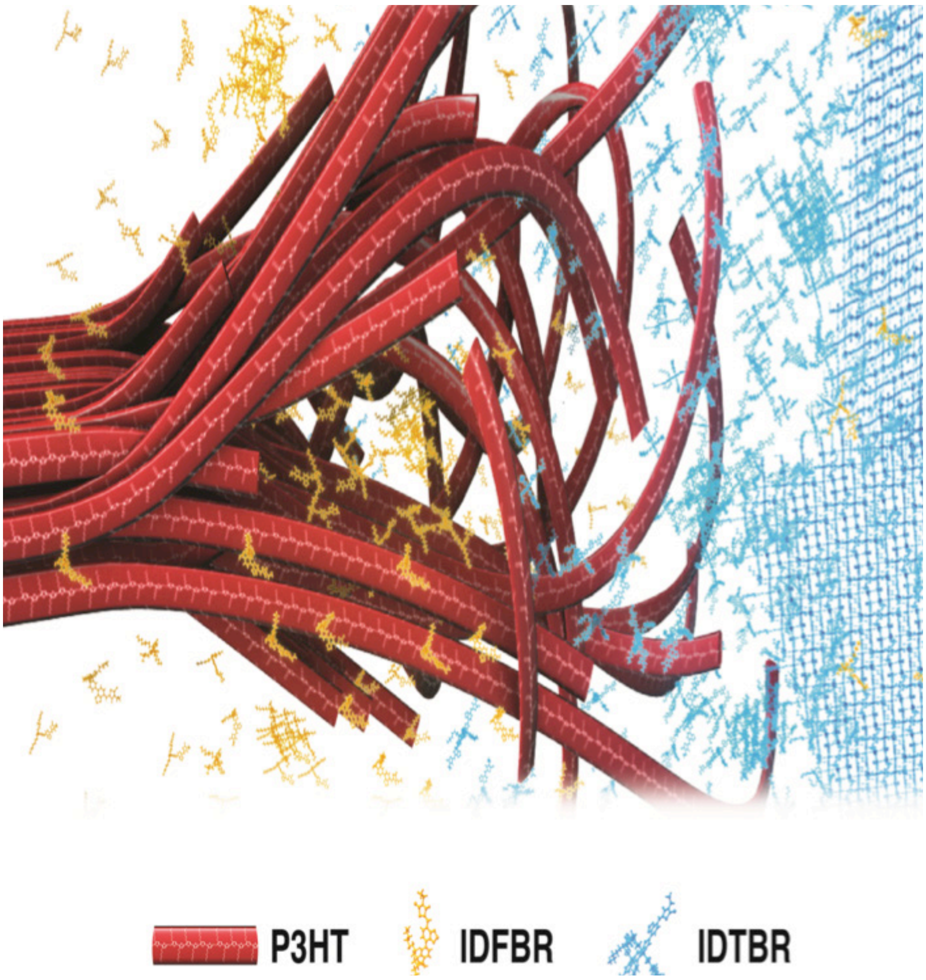


Figure: Visual illustration of the binary P3HT:IDTBR blend with IDFBR presence, wherein the crystallinity of both P3HT and IDTBR is preserved. The ternary film can be described as having three partially miscible components, comprising a crystalline P3HT phase, which also hosts a molecular dispersion of IDFBR molecules, as well as an IDTBR-rich crystalline phase that also contains IDFBR. This 3-phase morphology has been reported from other groups as a sine-non quo for an efficient solar cell nano-structure which has been achieved with P3HT:IDFBR:IDTBR combination. The manuscript also proved the universality of this two acceptor ternary combination by using another well-known polymer PBDTTT-EFT(or PCE10, where the name is given due to 10% efficiency with fullerene alternatives) and achieve 11% power conversion efficiency breaking the record with its fullerene alternative.

Reprinted with permission from Nature Materials **16**, 363–369 (2017).

International Partners

Establishing new and maintaining fruitful international collaborations is of utmost importance to KSC and at the core of our center's mission. We benefit greatly from the scientific expertise of other research groups outside KAUST (as do they from ours) and, in addition, these collaborations create valuable channels for student exchange, postdoc recruitment, and placement of our own graduates and postdoctoral associates after their auspicious time at KAUST.

One of our distinguished collaborators is Prof. Edward (Ted) Sargent, University Professor in the Edward S. Rogers Sr. Department of Electrical and Computer Engineering at the University of Toronto. He has made valuable contributions to the development of solar cells and light sensors based on solution-processed semiconductors. KSC has had ongoing collaborations on multiple projects with Ted, since July 2008, beginning with the Global Research Partnership program. We talked with Ted to gather his views about KSC and KAUST

How would you describe your experience working with KAUST and in particular KSC?

It has been a real privilege to collaborate with KAUST and KSC. Faculty members and students at KAUST and KSC are the best in the world at what they do. They are focused on developing new science and technology to harness energy from the sun for various applications. Our partnership has been productive: since 2008, my team has collaborated with over ten research teams and 20+ students. Through the collaboration, we have published nearly three dozen scholarly papers together. The interdisciplinary nature of the work and the exceptional quality of KAUST faculty and graduate students have helped us disseminate some of these findings in interdisciplinary journals such as Science, Nature Materials, Nature Nanotechnology, and Nature Communications.

What do you think would be the current/future applications from the collaborative projects?

In our current collaborative projects, we will develop solution-processed semiconductor nanomaterials for use in next-generation energy conversion devices, such as solar cells, photodetectors, and thermoelectrics. We will focus on two classes of solution-processed materials, colloidal quantum dots, and metal halide perovskites. These materials have distinctive physical and chemical features that make them very promising for next-generation, flexible, high-efficiency solar cells. These materials will enable low-cost photovoltaics that can absorb the entire solar spectrum and be easily integrated onto a multitude of surfaces, such as on vehicles or buildings.

How is KSC contributing to the realization of the above-mentioned applications?

To fulfill those goals, my team will be working with KSC research groups in five different thrusts, including the following PIs: Iain McCulloch, Frédéric Laquai, Udo Schwingenschlögl, Aram Amassian, Stefaan de Wolf, Derya Baran, and Thomas Anthopoulos. KSC researchers will be actively contributing their expertise in each step of the investigation, including theoretical modeling of the materials' properties at the molecular level, the design of new compositions of perovskites and quantum dots, experimental investigations of the materials optoelectronic properties, and the fabrication and optimization of various types of devices. The research will be accelerated by the tools available at KSC, including high-performance electron microscopies, large-scale materials printers, ultrafast laser spectroscopy, and supercomputing core lab resources.

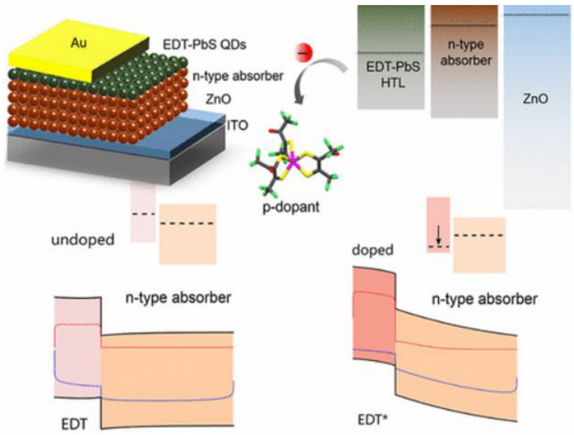


Figure : An approach to effectively balance band-edge energy levels of the main CQD absorber and charge-transport layer for these high-performance solar cells. Reprinted with permission from ACS Energy Lett., 2017, 2 (9), pp 1952–1959. Copyright 2017 American Chemical Society.

Alumni Focus

Guy Olivier Ngongang Ndjawa

"...The scope and scale of the research facilities at KAUST are practically unequalled. This affords researchers at KAUST a unique advantage..."

Guy Olivier Ngongang Ndjawa, currently a postdoctoral research associate at Princeton University, graduated with a Ph.D. in Materials Science and Engineering (June 2017) from KSC under the supervision of Aram Amassian.

While describing KAUST/KSC as the springboard for his future research, Guy said "The scope and scale of research facilities at KAUST are practically unequalled. This affords researchers at KAUST a unique advantage and makes them extremely competitive. As a KSC member, I have benefited from the integrated approach to lab facilities, with no limitations to instrumentation access and numerous opportunities for training with the support of a comprehensive staff."

His Ph.D. work focused on looking at interfaces where current is generated in organic solar cells. Such interfaces have a complex three-dimensional arrangement and by far lack long-range order as found in most inorganic solar cells. "One approach which has proven very useful is 'deconstructing' such interfaces by recreating representative, yet more straightforward, systems that emulate aspects of the real systems." he explained.

Guy describes his time at KAUST as very fulfilling. "Programs to foster learning beyond the lab, such as leadership training opportunities were valuable to me. Exposure beyond the campus was valued and encouraged at KSC, allowing me to present my work at prestigious conferences." He continued, "I enjoyed the off-campus trips and the numerous social events organized by the Student Center. Several inspiring keynotes lectures delivered during the winter enrichment program have left lifelong impressions on me. The food festival event "Flavors" was by far my favorite event.

"The intellectual vitality, steadily growing reputation and the extended research portfolio constitute a set of uniquely attractive traits and opportunities for anyone interested in joining KAUST." He said, "In addition to the research-related incentives, the diverse community combined with family-friendly environment makes KAUST a great and memorable experience."

Student Awards

Abdulkhaleq Almansaf wins 3M's 2017 Invent a New Future Challenge

Abdulkhaleq Almansaf, a Ph.D. candidate in Omar F. Mohammed's group, was a winner of 3M's 2017 Invent a New Future Challenge.

From over 900 ideas submitted in the Kingdom, Almansaf was selected to represent Saudi Arabia in the global final held on July 24th at 3M's corporate headquarters in St. Paul Minnesota, USA.

"My idea was to use new types of materials called Metal Nanoclusters in the field of solar energy which is cheaper than classical silicon materials." said Almansaf.

In both rounds of the competition, Almansaf was able to draw upon his experiences and cite KAUST as a shining example for resource utilization and diversity.

"I would like to encourage all the students here to participate in such competitions because you will learn and gain a lot of experience for your future career." he said.

Sara Abbas won RSC's Materials Horizons & Nanoscale Horizons poster award

In August, Ph.D. candidate Sara Abbas, from Aram Amassian's group, won a Materials Horizons and Nanoscale Horizons prize for her poster, entitled "Solution-Processed Smart Window Platform Based on Plasmonic Electrochromic and Photonic Coatings," at the UK's Royal Society of Chemistry's 13th International Conference on Materials in Chemistry.

The conference was held from 10-13th July in Liverpool, UK. The 'MC' conference series has provided a showcase for materials chemistry for two decades and is the flagship event of the RSC's Materials Chemistry Division.

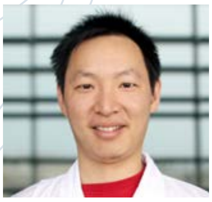
"Representing KAUST at the global level was a big achievement for me, and it was an honor to be the winner. This achievement has encouraged me to keep getting better." said Abbas.

Recent Ph.D. Graduates

Ahmad R. Kirmani, Hanlin Hu, Rahim Munir

Ahmad R. Kirmani

Dr. Ahmad R. Kirmani successfully defended his Ph.D. enthesis titled 'Surface Traps in Colloidal Quantum Dot Solar Cells, their Mitigation and Impact on Manufacturability' on July 31st, 2017, under the supervision of Aram Amassian. Ahmad has recently joined NIST starting November 2017



Hanlin Hu

Dr. Hanlin Hu defended his Ph.D. thesis entitled 'Aggregation of Conjugated Polymers in the Solution State and Its Influence on Carrier Transport and Solar Cell Performance.' His thesis was supervised by Aram Amassian. Hanlin has recently joined TCL Cooperation as a Research Engineer.

Rahim Munir

Dr. Rahim Munir defended his Ph.D. thesis entitled 'Hybrid Perovskite Thin Film Formation: From Lab Scale Spin Coating to Large Area Blade Coating.' His thesis was supervised by Aram Amassian.

Ph.D. Profile

Daniel Corzo

> "...KAUST provides great support from peers who have experience in the field.."

Daniel Corzo, a Ph.D. student in Derya Baran's group, is originally from Mexico where he studied Mechanical and Electrical Engineering. He finished his Master thesis with KSC's Aram Amassian. During his undergraduate studies, Corzo's interest in energy, particularly in reducing dependence on hydrocarbons and our ecological impact, grew and he became aware of KAUST.

"It seemed to offer an incredible opportunity to work in a multicultural environment while trying to tackle some of the world's problems through science. Working with KSC would enable me to work with like-minded people towards that goal," commented Corzo.

Corzo is working on improving the manufacturability of new materials for electronics, using novel techniques such as inkjet printing and 3D printing to reduce the fabrication costs and time while enhancing the ability of technology. His initial focus is printing solar cells, and he would like to work on transistors, diodes, and sensors in future. "Eventually, I would want to move into industry through patent publication, licensing and entrepreneurship. I believe the massive efforts towards entrepreneurship within the Kingdom of Saudi Arabia and especially at KAUST will help me transition into it." said Corzo.

"On top of the amazing facilities, KAUST provides great support from peers who have experience in the field, and I can seek counsel from anyone. Research collaboration across fields and into industry is also possible, as KAUST brings us all together." he said continuing "I make use of the sporting facilities: I like to run and play ultimate frisbee. I am involved with the art club and the astronomy club, and would like to become more involved with entrepreneurship activities."

New Faces at KSC

Alexandra Paterson

Postdoc with Thomas Anthopoulos

From - Imperial College London, United Kingdom

Emre Yarali

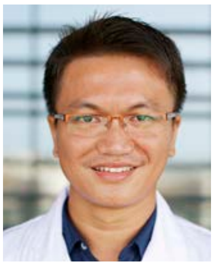
Ph.D. Student with Thomas Anthopoulos

From - TOBB Economics and Technology University, Ankara, Turkey

Kalaivanan Loganathan

Ph.D. Student with Thomas Anthopoulos

From - Pondicherry University, Puducherry, India



Mohamad Nugraha

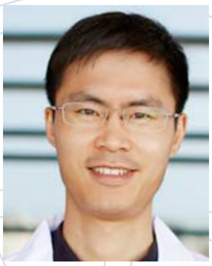
Postdoc with Derya Baran

From - University of Groningen, Netherlands

Sri Harish Kumar Paleti

Ph.D. Student with Derya Baran

From - Friedrich-Alexander-University Erlangen-Nuremberg, Germany



Wenzhu Liu

Postdoc with Stefaan De Wolf

From - University of Chinese Academy of Sciences, China

Eloise Bihar

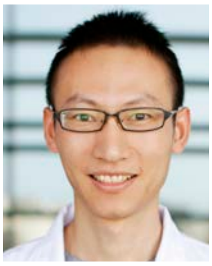
Postdoc with Derya Baran

From - Ecole des Mines de Saint Etienne, France

Joel Thoughton

Postdoc with Derya Baran

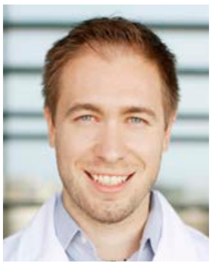
From - Swansea University, United Kingdom



Mingcong Wang

Postdoc with Frédéric Laquai

From - China Academy Of Engineering, China



Nicola Gasparini

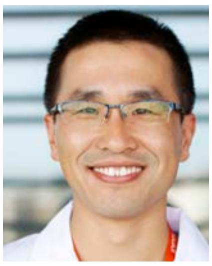
Postdoc with Derya Baran

From - Friedrich-Alexander-University Erlangen-Nuremberg, Germany

Thomas Allen

Postdoc with Stefaan De Wolf

From - Australian National University, Australia



Yajun Gao

Postdoc with Frédéric Laquai

From - University of Cologne, Germany

Upcoming Events

KAUST Research Conference: Synergistic Approaches in Solar Energy Conversion

February 2018, 25 – 28

Auditorium between Building 4 and 5

Key Dates:

February 25 Young Researcher Workshop

- Fundamentals of Solar Energy Conversion
- Early-stage career development session

February 26-27 Technical Program

- Guest speakers
- Poster session
- Junior speaker sessions

Guests will also have the opportunity to visit KAUST laboratory facilities as well as to enjoy a varied social program.

Themes:

- Performance-limiting factors and challenges in solar energy conversion technologies
- Emerging synergistic approaches
- Approaches to overcome the current performance limits

Conference Speakers:

Dr. Annamaria Petrozza	IIT, Italy
Dr. Edward Sargent	University of Toronto, Canada
Dr. Harald Ade	NC State, USA
Dr. Henry Snaith	University of Oxford, UK
Dr. Joel W. Ager	Lawrence Berkeley National Laboratory, UC Berkeley, USA
Dr. Michio Kondo	AIST, Japan
Dr. Mikio Taguchi	Panasonic, Japan
Dr. Moh. R. Amer	KACST, KSC and UCLA, USA
Dr. Monica Morales-Masis	EPFL, Switzerland
Dr. Nancy M. Haegel	NREL, USA
Dr. Nicolas Calvet	Masdar Institute, UAE
Dr. Peng Wang	KAUST, KSA
Dr. Peter Ho	NUS, Singapore
Dr. Pietro Altermatt	Trina Solar, China
Dr. Rutger Schlatmann	Helmholtz-Zentrum, Berlin, Germany
Dr. Shengzhong (Frank) Liu	Shaanxi Normal University, China
Dr. Thomas Anthopoulos	KAUST, KSA
Dr. Tom White	ANU, Australia

Workshop Speakers:

Dr. Elsa Couderc	Nature Energy, UK
Dr. Koen Vandewal	Hasselt University, Belgium
Dr. Thomas Kirchartz	University of Duisburg-Essen, Germany Research Centre Jülich
Dr. Wolfgang Tress	EPFL, Switzerland
Dr. Olindo Isabella	TU Delft, Netherlands

Organizing Committee

Chair: Dr. Stefaan De Wolf
Associate Professor of Material Science & Engineering

Co-Chair: Dr. Derya Baran
Assistant Professor of Material Science & Engineering

Conference website:

ksc.kaust.edu.sa/Conference-2018

Contact:

KSC@KAUST.edu.sa

Organized by: KAUST Solar Center (KSC) with financial support from the King Abdullah University of Science and Technology (KAUST) Office of Sponsored Research (OSR).
Additional support is provided by the KAUST Industry Collaboration Program (KICP), Industry Partnerships Office.
The poster session is kindly sponsored by the Royal Society of Chemistry's Energy & Environmental Science and Sustainable Energy & Fuels.

KSC Internship Program

KSC is committed to supporting students entering the final year of their undergraduate studies by providing the opportunity to conduct research and technology development in our center laboratories. Our internship programs allow students to experience the diversity of our solar energy related technologies and the capability of our faculty research groups through structured research and educational programs.

Our summer internship is an 8-12 week program providing students with both research project experience as well as a series of lectures in solar energy and related areas, whereas our 9-12 month student placement scheme additionally offers a more intensive research experience embedded in one of our faculty laboratories.

These programs enable the students to engage with the world-class facilities that the KSC has to offer, including more broadly, KAUST analytical facilities, equipment and services, as well as the wide range of community facilities, and recreational activities available on campus.

2017 KSC Interns (from top left) Filip Aniés, George Fish, Patrick Murton, Rebecca Rowden, Sky Macphee, Floriana Moruzzi, Catherine Webley and Colm Boyle.

KAUST Solar Center

Summer Internship Program

July - August 2018

King Abdullah University of Science & Technology (KAUST)
Kingdom of Saudi Arabia

The KSC Summer Internship is an 8-12 week program which provides final year undergraduate students with research experience in the diversity of our solar energy related technologies and the capability of our faculty research groups through structured research and educational programs.

Contact - KSC@KAUST.edu.sa

KAUST Solar Center

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