Third International Workshop on Materials for Energy and Environment

1. OVERVIEW

The workshop will discuss new advances in the development of new materials that have immediate applications in the energy and environment sectors. An overview of recently developed multi-purpose energy generating systems and their performance assessments through energy and exergy efficiencies, will be also discussed.

2. WORKSHOP SCHEDULE

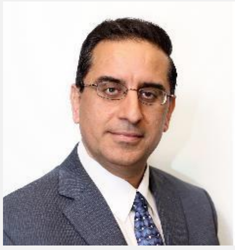
Day 1: Sunday, March 10, 2019	
Time	**Activity**
8:30 am – 9:00 am	Arrival
9:00 am – 9:30 am	Welcoming Remarks
9:30 am – 10:30 am	Prof. Detlef Bahnemann- Research Institute Nanocomposite Materials for Photonic Applications, Saint Petersburg State University/ Institute of Technical Chemistry of the Leibniz University Hannover
10:30 am – 11:00 am	Coffee break
11:00 am – 12:00 pm	Prof. Nouar Tabet- University of Sharjah
12:00 pm – 1:00 pm	Prof. Samson A. Jenekhe- University of Washington
1:00 pm – 2:00 pm	Lunch break
2:00 pm – 4:00 pm	Poster session/Round Table Discussions

Day 2: Monday, March 11, 2019	
Time	**Activity**
8:30 am – 9:00 am	Arrival
9:00 am – 10:00 am	Prof. Hussam N. Alshareef-King Abdullah University of Science and Technology (KAUST)
10:00 am – 11:00 am	Prof. Abdul Hai Alami- University of Sharjah
11:00 am – 11:30 am	Coffee break
11:30 am – 12:30 pm	Prof. Ibrahim Dincer- University of Ontario
12:30 pm – 1:30 pm	Lunch break
1:30 pm – 3:30 pm	Poster session/Round Table Discussions

3. VENUE

- Faculty Development Center, Library Building – Workshop
- Main Building Dining Room – Lunch

4. SPEAKERS



Dr. Hussam N. Alshareef
Professor of Materials Science and Enginnering
King Abdullah University of Science and Technology (KAUST)

Professor Husam Alshareef is a Processor of Materials Science and Engineering at King Abdullah University of Science and Technology (KAUST). He obtained his PhD at NC State University in 1996 followed by a post-doctoral Fellowship at Sandia National Laboratory, USA. He then embarked on a 10-year career in the semiconductor industry, holding positions at Micron Technology and Texas Instruments. There he worked on developing new materials and processes for the microelectronics industry. In 2009 he joined KAUST, where he initiated an active research group focusing on energy storage and electronics. The author of nearly 370 articles, he has nearly 70 issued patents. He has won the UNDP Undergraduate Fellowship, Seth Sprague Physics Award, NC State Dean's Fellowship, U.S. Department of Education Electronic Materials Fellowship, the SEMATECH Corporate Excellence Award (2006), two Dow Sustainability Awards (2011) and (2014), AH Shoman Award for Excellence in Energy Research (2016), and KAUST Distinguished Teaching Award (2018), and the Kuwait Prize for Sustainable and Clean Technologies (2018). He is a fellow of the Royal Society of Chemistry and IEEE Distinguished Speaker in Nanotechnology. He was co-chair for the 2014 Materials Research Society (MRS) Fall Meeting in Boston. He sits on the Editorial Board of several international journals including Wiley's Small Methods and Springers EnergyChem.

Title: Rational Electrode Material Design Strategies for Capacitive Energy Storage
By: Professor Hussam N. Alshareef

Abstract:
Electrochemical supercapacitors are important energy storage devices that bridge the gap between electrostatic capacitors and batteries. A critical component of supercapacitor design is the electrode material. In this talk I will discuss strategies that we have been developing to improve electrode material performance in conventional electrochemical supercapacitors and on-chip microsupercapacitor devices. Such strategies include direct electrode growth on current collectors for efficient electron transfer, enhanced surface areas and multimodal pore size distribution, electroactive materials with nearly metallic conductivity, two dimensional materials, and plasma and laser modification of materials. In the case of microsupercapacitors, the elimination of separator and proximity of the electrodes leads to faster ion kinetics, leading to significantly higher power devices. I will discuss approaches we have been developing to fabricate microsupercapacitors, particularly ones that combine chemistry and microfabrication. Our strategies have been applied to various types of

electrode materials, including oxides, chalcogenides, and electroactive polymers. Integration of supercapacitors in energy harvesting and sensing devices will also discussed.

Prof. Dr. rer. nat. habil. Detlef Bahnemann
Head of the Research Unit "Photocatalysis and Nanotechnology,
Institute of Technical Chemistry of the Leibniz University Hannover

Director of the Research Institute Nanocomposite Materials for
Photonic Applications, Saint Petersburg State University

Prof. Dr. rer. nat. habil. Detlef Bahnemann (PhD in Chemistry TU Berlin 1981, Habilitation in Technical Chemistry Leibniz University Hannover 2012) is currently Head of the Research Unit "Photocatalysis and Nanotechnology" at the Institute of Technical Chemistry of the Leibniz University Hannover in Germany and also Director of the Research Institute Nanocomposite Materials for Photonic Applications at Saint Petersburg State University. His main research topics include photocatalysis, photoelectrochemistry, solar chemistry and photochemistry focussed on synthesis and physical-chemical properties of semiconductor and metal nanoparticles. His more than 500 publications have been cited around 50,000 times (h-index: 86 according to Google Scholar Citations). He is Visiting Research Professor in the School of Chemistry and Chemical Engineering at Queens University Belfast (United Kingdom), DeTao Master of Photocatalysis, Nanomaterials and Energy Applications, and holds a Guest Professorship at the Tianjin University in Tianjin (China), an Honorary Professorship at Xinjiang Technical Institute of Physics & Chemistry, Chinese Academy of Science (China), a Visiting Professor under Academic Icon Programme to the Department of Civil Engineering, Faculty of Engineering, University Malaya in Kuala Lumpur (Malaysia), an Erudite Professorship, Mahatma Gandhi University, Kottayam (India), and a Visiting Professor in the Chemistry Department, College of Science, University of Dammam (Saudi Arabia). In 2017 he was awarded with the Medal "To the Memory of Academician N. M. Emanuel" presented by the Russian Academy of Sciences and M. V. Lomonosov Moscow State University (Russian Federation). Prof. Bahnemann is Chairman of the German DIN-Standardisation-Committee „Photocatalysis" (NMP 293), Member of the European CEN-Standardisation-Committee „Photocatalysis" (CEN/TC 389), Member of the International ISO-Standardisation-Committee „Photocatalysis" (ISO/TC 206), Associate Editor of the Journal Catalysis Letters, Member of the Editorial Board of the Journal of Advanced Oxidation Technologies, Member of the Editorial Board of the Journal of Photochemistry & Photobiology, A: Chemistry, and Member of the Editorial Board of the International Journal of Photoenergy.

Title: Mechanism(s) of Photocatalytic Processes: Revisitied!
By: Professor Detleff Bahnemann

Abstract:
Charge carriertransfer processes are veryimportantand play avitalroleinphotocatalytic reactions. The fundamental study of the dynamics of these charge transfer processes is thus crucial from the viewpoint of developing efficient photocatalytic systems for largescale industrialization. The current presentation mainly reviews recent efforts on understanding the charge transfer kinetics in photocatalytic processes. Some fundamental aspects involved in charge transfer processes, such as, charge carrier generation, charge carrier trapping, charge carrier recombination, and electron and

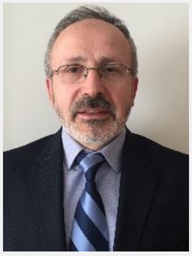
hole transfer are discussed based on the results published in the past decades. Moreover, recent studies focusing on the enhancement of the photocatalytic efficiency by improving the charge carrier transfer and separation will also be discussed here. Noble metal loading, plasmonic structure, and graphene loading have been found to be efficient methods to improve charge carrier separation and to suppress charge carrier recombination. Although there have been significant advances in the research of charge transfer dynamics, there are still many processes not fully understood, especially on the molecular-level. There are, for example, hardly any studies associated with electron and hole transfer kinetics in photocatalytic reactions on single crystal TiO_2 surfaces. Most researchers have studied the charge transfer kinetics on a very short timescale, while the charge transfer on a more extended timescale is still unclear. This review highlights the importance of charge transfer processes in photocatalytic reactions the understanding of which can provide possibilities to significantly improve photocatalytic efficiencies.

References:

L. Zhang, H. H. Mohamed, R. Dillert, D. Bahnemann, “Kinetics and Mechanisms of Charge Transfer Processes in Photocatalytic Systems: A Review”, J. Photochem. Photobiol., C: Photochemistry Reviews 13 (2012) 263-276.

J. Schneider, M. Matsuoka, M. Takeuchi, J. Zhang, Y. Horiuchi, M. Anpo, D. W. Bahnemann, “Understanding TiO_2 Photocatalysis: Mechanisms and Materials”, Chem. Rev. 114 (2014) 9919-9986.

M. Curti, J. Schneider, D. W. Bahnemann, C. B. Mendive, “Inverse Opal Photonic Crystals as a Strategy to Improve Photocatalysis: Underexplored Questions ”, J. Phys. Chem. Letters 6 (2015) 3903-3910.

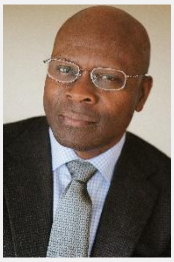


Professor Ibrahim Dincer
Professor of Mechanical Engineering, University of Ontario
Vice President for Strategy, International Association for Hydrogen Energy
Vice President, World Society of Sustainable Energy Technologies

Professor Ibrahim Dincer is a full professor of Mechanical Engineering at University of Ontario and adjunct professor at Faculty of Mechanical Engineering of Yildiz Technical University. Renowned for his pioneering works in the area of sustainable energy technologies he has authored/co-authored numerous books and book chapters, and many refereed journal and conference papers. He has chaired many national and international conferences, symposia, workshops and technical meetings. He has delivered many keynote and invited lectures. He is an active member of various international scientific organizations and societies, and serves as editor-in-chief, associate editor, regional editor, and editorial board member on various prestigious international journals. He is a recipient of several research, teaching and service awards, including the Premier's research excellence award in Ontario, Canada. During the past five years he has been recognized by Thomson Reuters as one of The Most Influential Scientific Minds in Engineering and one of the most highly cited researchers.

Title: Research-Innovation-Commercialization (RIC) Dimensions in Sustainable Energy Technologies
By: Professor Ibrahim Dincer

Abstract:
Research and development was a key target in many nations for better advancement and economic prosperity. We have now reached an era where innovation matters only, so-called: innovation era. It is now necessary for countries to formulate the research into research-innovation-commercialization to become technologically advanced, economically prospered and socially enriched. In this presentation, the dimensions of research-innovation-commercialization are introduced and discussed for sustainable energy technologies under a diversified energy portfolio, covering renewable energy technologies, cleaner technologies for fossil fuels, clean fuels, efficient energy use, system integration and multigeneration, waste to energy, etc. This presentation will also make a prime focus on newly-developed multi-purpose energy generating systems and their performance assessments through energy and exergy efficiencies as well as other newly developed sustainability parameters. Furthermore, novel system design, analysis, assessment and improvement options will be discussed. Moreover, there will be various cases studies, projects and examples presented to illustrate the sustainable energy options and green technologies for practical applications.



Professor Samson A. Jenekhe
Boeing-Martin Endowed Professor of Chemical Engineering
Professor of Chemistry
University of Washington

Professor Samson A. Jenekhe holds the Boeing-Martin Endowed Professor of Chemical Engineering and Professor of Chemistry at the University of Washington, Seattle. He graduated from Michigan Technological University with a BS degree in 1977. His graduate studies were at the University of Minnesota where he received the MS (Chemical Engineering, 1980), MA (Philosophy, 1981) and PhD (Chemical Engineering, 1985). Following appointments at Honeywell, Inc., Physical Sciences Center, Minneapolis, MN he started his academic faculty career at the University of Rochester, where he held the positions of Assistant, Associate, and Full Professor of Chemical Engineering, Professor of Materials Science, and Professor of Chemistry during 1988-2000. He assumed his current positions at the University of Washington in September 2000. His broad research interests are in the chemistry, physics, and engineering applications of conjugated polymers, organic semiconductors, electronic and optoelectronic devices, materials and devices for solar energy technologies, self-assembly and soft nanotechnology, and polymer science. He has served on the Editorial Advisory Boards of many journals, including *Macromolecules*, *Chemistry of Materials*, *Materials Chemistry Frontiers, Chemical Engineering Journal*, and *Micro- and Nano-systems*. He is an Editorial Board member of *Molecular Systems Design and Engineering*, a journal from the Royal Society of Chemistry and Institution of Chemical Engineers (IChemE). He also serves on the Editorial Board, *Research* (a new journal published by Science Partner Journals (SPJ), the American Association for the Advancement of Science (AAAS) and the China Association for Science and Technology (CAST)), 2018-present.

His research accomplishments are summarized in over 300 journal articles, which have received over 34,800 citations with h-index of 105, based on Google Scholar. He has also edited three books and was awarded over 30 US patents. Thomson Reuters (*Science Watch*, March 2011) named him among the top 40 on their worldwide list of “Top 100 Materials Scientists of the Past Decade, 2000-2010.” Thomson Reuters, and subsequently, Clarivate Analytics have also named Jenekhe a Highly Cited Researcher in materials science.

He is a Fellow of the American Association for the Advancement of Science (2003), the American Physical Society (2003) and the Royal Society of Chemistry (2015). He was elected member of the

Washington State Academy of Sciences in 2013. He is the recipient of the 2014 Charles M. A. Stine Award for Excellence in Materials Science and Engineering from the American Institute of Chemical Engineers (AIChE).

Title: Organic Electronics and Optoelectronics: Enabling new Energy and Information Technologies
By: Professor Samson A. Jenekhe

Abstract:
Organic and polymer semiconductors have emerged as the foundation for a range of new electronic, optoelectronic, and energy technologies including organic light-emitting diodes (OLEDs) for displays and solid-state lighting, thin film transistors for printed and flexible electronics, various biosensors, thermoelectric devices, high density energy storage, and low cost solar cells. The broad research interests of my *Organic Electronics and Polymer Research Laboratory* at the University of Washington is focused on fundamental and applied research addressing scientific challenges in these topics, including the chemistry, physics, and engineering applications of conjugated polymers, organic semiconductors, electronic and optoelectronic devices, materials and devices for solar energy technologies, block copolymers self-assembly and soft nanotechnology, and polymer science. Our strategy of molecular engineering of materials and devices, encompassing synthesis, processing, characterization of solid-state structure, properties, structure-property relationships, and device applications of both *p*-type and *n*-type semiconducting organic and polymeric materials has advanced recognized progress in these fields. In this lecture I will highlight several examples of our recent advances in these areas, including: solution-processed highly efficient blue, green, red and white OLEDs for displays and lighting; n-type small-molecule semiconductors for efficient non-fullerene polymer solar cells; n-type polymer semiconductors for developing efficient all-polymer solar cells; n-type polymer semiconductors for high-mobility transistors, complementary circuits, and electronic memories; and solution-phased derived graphene nanoribbons for future carbon-based ultrafast electronics and information technologies.

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(2) Li, H.; Kim, F. S.; Ren, G.; Jenekhe, S. A. “High Mobility n-Type Conjugated Polymers for Organic Electronics,” *J. Am. Chem. Soc.* **2013**, *135*, 14920-14923.

(3) Li, H.; Earmme, T.; Ren, G.; Saeki, A.; Yoshikawa, Y.; Murari, N. M.; Subramaniyan, S.; Crane, M. C.; Seki, S.; Jenekhe, S. A. “Beyond Fullerenes: Design of Nonfullerene Acceptors for Efficient Organic Photovoltaics,” *J. Am. Chem. Soc.* **2014**, *136*, 14589-14597.

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Professor Abdul Hai Alami
Associate Professor
Sustainable and Renewable Energy Engineering Program,
University of Sharjah

Professor Abdul Hai Alami is currently an Associate Professor at the Sustainable and Renewable Energy Engineering Program at University of Sharjah (2012-present), Dr Alami has received his PhD from Queen’s University in Kingston, Ontario, Canada in 2006. Since then, he has held the positions of Assistant Professor of Mechanical Engineering at the Hashemite University in Jordan (2006-2010) and Mechanical Engineering Faculty at the Higher Colleges of Technology, Al Ain (2010-2012).

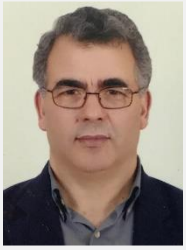
The current area of interest of Dr Alami is the synthesis and analysis of materials for counter electrodes in third generation photovoltaic solar cells, solar thermal energy utilization and augmentation (selective solar absorbers, evaporative cooling of PV modules) and novel ways of mechanical energy storage (CAES, CGES and buoyancy force).

Title: State-of-the Art Mechanical Exfoliation Techniques of Graphene for Energy Applications
By: Professor Abdul Hai Alami

Abstract:
The current research focus of Dr Alami is generally the single step synthesis and deposition of graphene for various application pertinent to solar energy conversion. The two main processes used to this end apply large mechanical (impact/centrifugal) forces to exfoliate graphite into graphene on the desired substrate. These methods are:

(1) Applying centrifugal forces on graphite powder: the process takes place in a planetary ball milling machine, where large centrifugal accelerations cause the powder to exfoliate into graphene nanoplatelets (turbostrateic graphene) against the target substrate. The parameters to be tuned are the milling speed, time, crucible material, fineness of the powder, etc.
(2) Graphite blasting: in a process analogous to sand blasting, graphite powder is directed through a nozzle by a pressurized (8 bar) air stream, exfoliating graphene on the surface of the desired substrate due to the high impact forces. The significance of this process is the ability to produce a graphene layer over a large surface area with homogeneous (and superior) properties for many applications.

The presentation will first showcase the synthesis, characterization and deposition quality of the abovementioned methods. Then four energy-related applications will be presented, for which the graphene deposition and incorporation has been instrumental in their energy enhancement. These include counter electrodes for dye-sensitized solar cells, graphene as a nanospacer in SERS sensors, enhancement of optical and thermal properties of absorber sections of solar thermal collectors, and the production of electrodes for deionization processes in desalination.



Professor Nouar Tabet
Professor
Physics Department
University of Sharjah

Professor Nouar Tabet received his PhD in Materials Sciences from University of Orsay Paris XI, France. He is Professor at Physics Department of University of Sharjah. He served in many academic positions including Rector of the university of Constantine, Algeria,

He is recipient of Al-Marai Prize for Innovation in Physics, 2004, the "Research Excellence Award" of King Fahd University of Petroleum and Minerals. He published more than 110 journals papers, 2 US patents issued and 5 filed and authored a book on "Nanotechnology and its applications"

He co-chaired the "11th Beam Injection Assessment of Microstructure in Semiconductors (BIAMS) International Workshop 2012 and the "First Sharjah International Conference on Nanotechnology and its Applications", Sharjah, 2007.

He was visiting scientist at various research institutions including Advanced Light Source (ALS), Berkeley National Laboratory, USA, Massachusetts Institute of Technology, Boston, USA and Institut de Science et Genie des Materiaux, Odeillo, CNRS / IMP Font Romeu, France.

Title: Investigation of the Charge Dynamics in Perovskite Solar Cells by Time Resolved Photoluminescence
By: Professor Nouar Tabet

Abstract:
Time Resolved Photoluminescence (TRPL) is a powerful technique to investigate the charge dynamics in perovskite solar cells. The time decay of the signal depends on the properties of the absorbing material as well as the charge transport, recombination and extraction at the interfaces of perovskite with the hole transport Layer (HTL) or electron transport layer (ETL). However, there is no physical model that enables the extraction of material and device parameters from the analysis of the PL signal decay. Instead, the experimental data are commonly analysed using a single or double exponential leading to the determination of two lifetimes of no clear relation with the actual carrier lifetime and charge dynamics at the interfaces.

In this work, we describe a model that allows the extraction of the physical parameters affecting the PL signal. The model is based on solving the continuity equation taking into account the photocarrier diffusion and recombination in the perovskite absorbing layer as well as their extraction and/or recombination at the interfaces and surfaces.

The dependence of the PL signal upon various parameters including the perovskite thickness, bulk carrier lifetime, carrier mobility and recombination velocity at interfaces is illustrated. The model is further validated through the analysis of a set of experimental data.