Keynote Speech:

Emerging semiconductor materials for high efficiency solar cells

by, Nazmul Ahsan

Short Biography:

Nazmul Ahsan is Associate Professor at the Research Center for Advanced Science and Technology (RCAST), The University of Tokyo. For his bachelor in electrical engineering (BE), after a short enrollment in Bangladesh University of Engineering and Technology (BUET) in 1991, he pursued and completed BE from Toyohashi University of Technology, Japan in 1997. He received the M.S. and Ph.D. degrees in electronic engineering from The University of Tokyo (UT), Japan, in 1999 and 2002, respectively. He then held Japan Science and Technology Agency (JST) research fellowship at UT, and worked on photonic and electronic control of ferromagnetism using III-V semiconductor heterostructures.

In 2007, he became Assistant Professor with the Department of Electronic Engineering, UT. In 2009, he joined RCAST, UT, where he is currently Associate Professor in the Department of New Energy. His research interests include ultra high-efficiency photovoltaic devices based on emerging materials such as dilute nitride/antimonide semiconductors, dilute magnetic semiconductors, etc.

Dr. Ahsan is a member of the Japan Society of Applied Physics (JSAP) and the American Physical Society (APS). He received the Bangladesh Prime Minister Gold Medal Award for securing the top position in Higher Secondary Certificate Examination in 1990 (Comilla Board). He has been a scholar with the Japanese Ministry of Education, Culture, Sports, Science & Technology (MEXT) during 1991-1997, the Rotary Yoneyama Memorial Foundation during 1997-1999, and the Honjo International Scholarship Foundation during 1999-2002. He also received the 2002 Marubun Research Award from the Marubun Research Promotion Foundation and the 2003 Best Research Paper Award from the JSAP.

Abstract:

The increasing demand for energy as well as environmental protection has raised widespread interest in photovoltaic (PV) technology since the past decades. Since the first demonstration of practical Si-based p-n junction solar cell in 1954 with a conversion efficiency of 4.5%, the development of PV technology can be divided into three generations. The first-generation solar cells consisted of highpurity single crystal silicon wafer. So far, its conversion efficiency is up to 24.7%. Despite its rich earth abundance, the energy consumption of high-purity single crystal silicon wafer growth is tremendous, and costly. The need for the reduction of material consumption and cost becomes the starting points for the development of the second-generation solar cells. Thin films such as, polycrystalline silicon, amorphous silicon, CdTe, Cu(In,Ga)Se2 alloy can significantly reduce the material consumption and the cost of solar cells. But the conversion efficiency of thin-film solar cells is still lower than that of single crystal silicon. The need for the increase of the conversion efficiency becomes the starting point of third-generation solar cells, based on an investigation of the theoretical limitation and the mechanism of energy loss of solar cells, such as, multijunction solar cells, impact ionization (quantum dot) solar cells, multiband solar cells, hot carrier solar cells, multiple electron-hole pairs solar cells, and thermophotovoltaic solar cells.

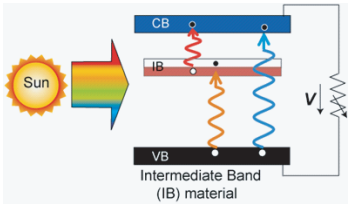


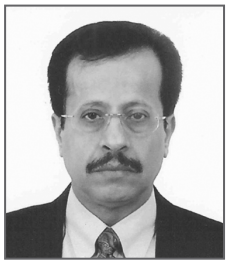
Fig. 1. Schematic diagram of an intermediate band solar cell (IBSC). The infrared photons of the solar radiation, which are otherwise transparent to the solar cell and lost, are captured by

Recently, multijunction tandem solar cells have demonstrated record conversion efficiency of 46%. Among others, multiband (namely intermediate band, IB) solar cells have attracted the most attention. IB solar cells (IBSCs) incorporate impurities that can provide a single or multiple bands of states inside the fundamental bandgap, thereby absorbing different wavelength photons, specially the infrared photons of the solar radiation which are otherwise transparent to the solar cell and lost. The limiting efficiency of IBSC solar cells with a single IB is the same as three stacked tandem solar cells, up to 63% under condensing conditions. At the same time, it not only avoids the complex process of tandem solar cells and thus reduces the cost, but also provides adjustable impurity energy levels and thus wider device design potentials. Although IBSCs will have a better and wider application potential, the relevant research is still at the beginning.

In this presentation, our recent achievements in multijunction tandem solar cells and intermediate band solar cells will be discussed. The single crystalline thin films and solar cells were fabricated using molecular beam epitaxy technique. Special focus will be placed on IBSCs emphasizing emerging semiconductor materials such as III-V dilute nitrides, III-V magnetic semiconductors, chalcogenides and quantum dot superlattice.

Ref: N. Ahsan et al. "Two-photon excitation in an intermediate band solar cell structure," Appl. Phys. Lett. 100, 172111 (2012).

Keynote Speech:



Solar Photovoltaic in Saudi Arabia: Present Status and Future Outlook

by, Abdulrahman Alamoud

Short Biography:

Abdulrahman (A.R.) M. Alamoud was born in Onaizah, Saudi Arabia. He earned his B.Sc. degree in Electrical Engineering, College of Engineering (COE) from the University of Riyadh (renamed later as KSU). He earned his M.Sc., in Microelectronics, and Ph.D. in 1984, in photovoltaic solar cells, from West Virginia University, Morgantown, W.V., USA. In June 1984, he joined the Department of Electrical Engineering as an Assistant professor and was promoted to the rank of Associate professor and Professor in 1989 and 1999 respectively.

In 1991 he took a one year leave of absence from KSU and joined the Advanced Electronics Company AEC), Riyadh, Saudi Arabia as the Special Projects Director. In 1992, he was appointed as Director, Research Center, COE, KSU for a two term period. In the academic year July 15- Dec. 15, 1996, he was a Visiting Research Associate Professor, National Renewable Energy Laboratory, Golden, Colorado, USA.He worked on the development of thin films CdTe Solar Cells and characterization of materials (such as semiconductors thin films and Saudi white sand rocks).He was alsoa Visiting Research Associate Professor (Mar. 9- Aug. 22, 1997), VLSI Research Group, Department of Electrical and Computer Engineering, University of Waterloo, Waterloo, ON, Canada, where he worked on the design of VLSI circuits using Cadence. He was chosen to be the Vice Dean for Administrative Affairs, COE, KSU during the period of June 1999- June 2005. He joined NREL during the summer of 2011 and 2012 where he worked on PV module degradation and hot spots, new thin film materials such as CZTS, and ink-injection solar cell fabrication. His research interests are in Nanoelectronics, Solar Cells and materials, PV module degradation and standards, PV system, and Photovoltaic Systems where he published more than eighty papers

Abstract:

Saudi Arabia's large area and high concentration of solar energy makes it ideal for a vast number of applications such as generating electricity for home use, mobile phone towers, road signs, roads emergency phones, mobile military forces (army, national guard, and border guard), medical ambulances, and oil pipe lines cathodic protection to name but a few. As such, there is a need for a grid-connected photovoltaic (PV) system for rooftop electricity generation and stand-alone PV electric generators for use in remote locations where the grid system is not available.

A case in point is Saudi Arabia's long borders with different countries pose a threat of multiple dimensions: infiltration of illegal individuals seeking work, smuggling arms and/or drugs, or planning to conduct crime or actions that threatens the national security. The remoteness of border guard posts and the high concentration of solar energy make it ideal for this application.

This presentation will summarize the present PV achievement and the potential of PV energy in Saudi Arabia.

Keynote Speech:

Solar Photovoltaics: The Current Status of All Generations

by, Nowshad Amin [1,2,3]
[1]Department of Electrical, Electronic and Systems Engineering
Faculty of Engineering and Built Environment
The National University of Malaysia, 43600 Bangi, Selangor, Malaysia
[2]Solar Energy Research Institute, The National University of Malaysia, 43600 Bangi, Selangor, Malaysia
[3]Advanced Materials Research Chair, College of Sciences, King Saud University, Riyadh 11451, Saudi Arabia
e-mail: nowshad@ukm.edu.my

Short Biography:

Dr. Nowshad Amin is a Professor at the Dept. of Electrical, Electronic & Systems Engineering of The National University of Malaysia (@ Universiti Kebangsaan Malaysia), where he also leads the Solar Photovoltaic Research Group at the Solar Energy Research Institute (SERI). After the higher secondary education from native country, Bangladesh, he received the Japanese Ministry of Education (MONBUSHO) scholarship, where he achieved a diploma in Electrical Engineering (1994) from Gunma National College of Technology, Bachelor (1996) in Electrical & Electronic Engineering from Toyohashi University of Technology, Masters (1998) and PhD (2001) on solar photovoltaic technology from Tokyo Institute of Technology (Tokyo, Japan). His areas of expertise include Microelectronics, Renewable Energy, Solar Photovoltaic Applications and Thin Film Solar PV Development. Additionally, his research focuses on the commercialization of Solar Photovoltaic Products from his patented entities, as such he is also serving as the CTO of a University Spin-off company financed by the Malaysian Technology Development Center (MTDC). He has been serving as the project-leader as well as co-researcher of many government (Malaysia) and international (Saudi National Grant, Qatar Foundation etc.) funded projects. He has authored more than 200 peer-reviewed publications, a few books and book chapters. He has been holding a visiting professorship position at the King Saud University of Saudi Arabia since 2009. He is actively involved in promoting Renewable Energy to the developing countries in South and South East Asia, working as an enthusiastic promoter for the affordable solar photovoltaic technologies.

Abstract:

We have come across solar cells of generations after being demonstrated first at Bell Labs (6% in 1954) to today's multi mega watt-peak solar farms with the utmost achievable conversion efficiencies (over 22%) for electrical power generation. So far, researchers around the world try to find energy harvesting in the form of electricity with many kinds of solar cells starting from inorganic silicon based to organic based ones. Even though, the first generation solar cells that are mainly crystalline or multicrystalline silicon based ones are still dominating, the quest for other options presented many other potential candidates such as amorphous silicon, cadmium telluride, copper-indium-suphide, etc. since early 70s. Ever since the second generation solar cells came into the scenario, most of these are thin films based which require many supporting layers to form the complete cells in homo or hetero junction configurations but within a total thickness of 2-10 micron. Semiconductor material science including fabrication technology on many compound semiconductors has been evolving over the period of time to take them to commercialization stages whereas conversion efficiencies continue to mark over 20% till present (e.g., CIGS, CdTe, CZTS). This talk will include thin film solar cells from its inception in research arena toward successful commercialization till to date. However, this will also include the current status on many novel materials like Perovskites based solar cells as they have tremendously achieved conversion efficiencies to the extent in just 2 years that 2nd generation e.g. thin films have got in 20-30 years. This will boost the hope for alternatives in the coming era of energy crisis.

Keywords: Solar Photovoltaics; Thin film solar cells; Novel Materials; 3rd Generation PV

Keynote Speech:

Genetic modification of plant cell walls by application of bacterial genes for lignin degrading enzymes

by, Hirofumi Hara[1], Shinya Kajita[2] and Eiji Masai[3]
[1]Department of Environmental Engineering and Green Technology,
Malaysia-Japan International Institute of Technology, UniversitiTeknologi Malaysia,
[2]Graduate School of Bio-Applications and Systems Engineering
Tokyo University of Agriculture and Technology,
[3]Department of Bioengineering, Nagaoka University of Technology

Short Biography:

Dr. Hirofumi Hara is now associate professor at Malaysia-Japan International Institute of technology (MJIIT), UniversitiTeknologi Malaysia (UTM) since 2013. He received Associate degree from Kurume National College of Technology, Japan in 1999 specialize in Industrial chemistry, Bachelor degree and Master degree from Nagaoka University of Technology, Japan in 2001 and 2003, respectively, and PhD degree in 2003, specialized in Information Science and Control Engineering. After getting PhD, he worked at Department of Microbiology and Immunology, The University of British Columbia, Canada, and Graduate school of Agricultural and Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, as a pot-doc for 5 years. During this time, he published several paper of complete genome sequence of Actinomycetes, such as Streptomyces sp. and Rhodococcus sp. and developed microarray technology. After that, he worked at Okayama University of Scienceas lecturer and then associate professor. His research activities are now focused on applied microbiology and metabolic engineering using tropical microbes from ASEAN region.

Abstract:

Urgent actions for energy generation based on biomass utilization should be needed to cut its emission of greenhouse gas, and retain the secure and reliable energy supply. Woody biomass, which is primary composed of lignocellulose is expected to be the larger source of renewable energy. Structure and chemical composition of plants cell walls with lignocellulose by genetic engineering can contribute to efficient generation of bio-energy from woody biomass. Sphingobium sp. SYK-6 is able to catabolize a variety of phenolic compounds by its unique enzymatic system. Some of the phenolic compounds catabolized in SYK-6 are also found in plant cells as monolignol precursors and lignin dimmers. Therefore, genetic manipulation of lignin biosynthesis in transgenic plants can be performed by expression of the catabolic genes from the bacterium. Our manipulation of lignin is expected to realize efficient saccharification of the lignocellulose from the transgenic plants

Keynote Speech:

Solar Energy: Bangladesh Perspective

By, M. Rezwan Khan

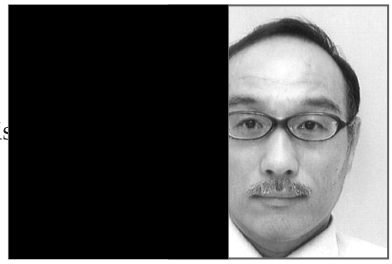
Short Biography:

Prof. Dr. M. Rezwan Khan completed his B.Sc. in Electrical and Electronic Engineering in 1980 from Bangladesh University University of Engineering and Technology (BUET) and subsequently joined BUET as a lecturer in the same year. Prof. Khan did his M.Sc. and Ph.D. from University College London in 1982 and 1986 respectively and served BUET till 2004 before joining UIU. He is presently serving as the Vice Chancellor of United International University, Dhaka. Prof. Khan has been working in the fields of energy efficiency and renewable energy for a long time. He served as a consultant for Grameen Shakti (1999-2000), the renowned organization involved with dissemination of renewable energy technology in Bangladesh. Right from the beginning of the IDCOL (Infrastructure Development Company Limited) Solar Home System micro financing project (REREDP), initially funded by World Bank, Prof. Khan served as the Chairman of the Technical Standard Committee contributing significantly in designing the solar home systems, setting the standards and monitoring the technical aspects of the dissemination process. The tremendous success of IDCOL within a very short period of time was highly appreciated at home and abroad and Prof. Khan received the Prime Ministers award for his outstanding contribution in popularizing Solar Home System in Bangladesh (September 2005). Prof. Khan leads the Bangladeshi teams in two DFID/EPSRC, UK funded ongoing projects namely 'Solar Nano-grids as an Appropriate Solution to the Limitations of Solar Home Systems in Rural Communities in Kenya and Bangladesh' and 'The Next Generation of Low Cost Energy-efficient Appliances and devices to Benefit the Bottom of the Pyramid' with Loughborough University and Open University as the lead partners respectively. Under these projects Prof. Khan is involved in designing nanogrids as an inexpensive solution to energy access for off grid rural communities, development of low cost improved cooking stoves and low cost irrigation systems. He has published more than 100 research papers in different journals and conference proceedings. He was awarded the Bangladesh Academy of Science gold medal in 2005 for his outstanding research in Electrical Engineering.

Abstract:

With the falling price of solar PV, application of solar energy as a economically viable power source has opened up a number of possibilities. Grid connected solar PV systems are the larger schemes that is becoming competitive to diesel or furnace oil based power generating units - the only limitation seems to be the requirement of vast amount of land that raises the question of food security in an agricultural country like Bangladesh. Solar Home System (SHS) in Bangladesh is one of the most successful programs in the world with more than 3 million systems already installed in the rural areas. However, the main Today, the total installed capacity of the SHSs is around 120 MW. Despite the success of SHS, it has the limitations in generating energy high enough for directly incorporating any economic activities. Bangladesh being an agricultural country, the most demanded application of power in the rural Bangladesh is irrigation. There are some efforts to replace some of the diesel irrigation systems by solar PV - the main difficulty to make it economically viable comes from a very different direction. Irrigation is a season phenomenon with a typical demand for irrigation is 100-120 days in a year. In diesel based irrigation cost of diesel incurs only when diesel pumps are run. On the other hand in PV based irrigation system the energy will be wasted if irrigation is not required over a significant part of the year making the solar PV based irrigation more expensive. Hence, alternative usage of the energy from the solar PV has to be incorporated with the irrigation schemes. Recent studies indicate that stand alone mini/micro grids or nanogrids with the facilities for irrigation can be very attractive in rural Bangladesh as these small grid systems always have alternative loads connected to them and seasonal variation of sunshine is very efficiently taken into consideration. Another very interesting application of solar PV could be energizing small scale cold storages where farmers would have the opportunity to keep their agro-products for 1-2 weeks. This is particularly important when the perishable crops like tomato, carrot and other vegetable are harvested and the market gluts. Sometimes farmers even fail to earn back their investment on the crops. A small scale cold storage can give the farmers a breathing space to look for alternative markets for their crop. Besides there are opportunities for applications like solar PV driven ferry boats, aeration of the fish ponds, lighting of the poultry farms and drug preservation.

Keynote Speech:



Crisis of democracy in Japan behind clean Energy and other is

by, Hiroyuki MIYAKE

Short Biography:

Hiroyuki MIYAKE, professor, Dept. of policy studies, the University of Kitakyushu, Japan

Abstract:

In March of 2011, the biggest sized earthquake hit the east part of Japan with much victims and damages. Explosion of Fukushima nuclear power station, which shocked all of people living in the world, lead to give big opportunity to reconsider the life style. Japanese government decided to all of nuclear power station stopped and look for a new energy policy with clean energy like solar power. But recently, present government has generated much political confusion. It ignored public opinion on many issues representing enacting process of security bills.

Keynote Speech:

Indigenous efforts in Biomedical Engineering

by, K Siddique-e Rabbani

Short Biography:

Dr. Rabbani taught Electronics and Medical Physics in the Department of Physics, Dhaka University, Bangladesh from 1978 to 2008 where he was also active in carrying out research in Solar Energy, Biomedical Physics and Engineering, and supervised more than 80 Masters students and a few PhD and MPhil students during that period. A Professor since 1988, he was given the responsibility of establishing a new department of Biomedical Physics & Technology as its founding Chairperson in 2008 which he continued till 30 June 2015 since when he is on leave preparatory to retirement. Of course he still continues to lead all research activities of the department. His vision is to establish research that helps the common people, particularly in the low resource countries like Bangladesh who have been deprived of a quality life through the huge technology disparity growing over the last few centuries. Therefore he started with only PhD and MPhil programmes, and started Masters programmes later, about three years back. Professor Rabbani currently supervises 15 PhD/MPhil students and Research Fellows and a good number of MS students for their research projects. Under his leadership these young researchers have already been able to develop several Medical Devices that are ready to go to the market or for technology dissemination. Professor Rabbani has given more than 90 invited lectures at home and abroad and has published more than 100scientific papers, one text book, and has written chapters in 5 books.

He organised several associations related to Electronics and Healthcare technology like 'Centre for Technology Equalisation', 'Relevant Science & Technology Society, Bangladesh', 'Bangladesh Institute for Biomedical Engineering and Appropriate Technology' which later led to 'BiBEAT Ltd.', a non-profit company for dissemination of indigenously developed medical devices. Under his leadership his team has a philosophy of not patenting inventions related to healthcare, rather they would make these open once matured. The main aim is to bridge the global technology gap through which, he feels, the global disparity in economy and quality of life can be alleviated to a great extent.

Abstract:

ECG and X-ray equipment were invented more than a century back, but 80% of the global population is yet to get their benefits. These two examples are enough to speak of the failure of the current commercial model for dissemination of technology that has created a large technological disparity throughout the globe, which in turn has led to an unacceptable state of human disparity and deprivation. A solution to this global problem is only possible if people are empowered in technology globally; there should be capability for design, development and manufacture of technology based products in each country, and medical devices form the topmost priority.

This realisation made the author dedicate his career into design and development of medical devices that are needed by a majority of the population in the Low Resource Countries (LRC) and in inducing and training the younger generation in this vision. He and his team of students at the Department of Physics and now at the Department of Biomedical Physics & Technology of Dhaka University have developed several equipment which are being used in hospitals, clinics or by patients themselves. The devicesinclude, i) Very low cost solar water Pasteuriser and rainwater collector for providing safe drinking water in rural areas, ii)Telemedicine system with integrated diagnostic devices like ECG, Respiration monitor, Microscope, Stethoscope, etc., for providing a better healthcare in rural areas, iii) Computerised EMG/Nerve conduction equipment, iv)Computerised ECG, v)Computerised dynamic Pedograph, vi)Iontophoresis equipment for treatment of excessive sweating, vi)Muscle & Nerve stimulator, vii) Intraoperative Neuro Monitor, etc. The costs are significantly lower than that of similar imported ones and can survive the extreme weather and power line conditions of our country giving decades of service. The author's team is also carrying out R&D on a number of methods for medical diagnosis where the outcomes of their innovations have drawn international attention with several already taken up by researchers in advanced countries as well. These include i) Focused Impedance Method (FIM), an electrical impedance technique which is being tried for application in the detection of childhood pneumonia, localized lung ventilation and cervical cancer; in the measurement of stomach emptying, stomach acid secretion, abdominal subcutaneous fat thickness and blood vessel stiffness; in the characterization of breast tumour, ii) Distribution of F-Latency (DFL), a new nerve conduction parameter innovated by the author which has been established to give Distribution of Conduction Velocity (DCV) of large motor fibres, which in turn has been established to provide an early detection of neuropathy due to compression of nerve roots or of spinal cord in the Cervical or Lumbo-sacral regions; making it a potential screening tool in peripheral neuropathy.

The author's group is not patenting their innovations. They intend to open up the technology once mature so that persons in other low resource countries can provide similar services to their own people.