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GSESRE2022

Global Summit and Expo on Sustainable and Renewable Energy

June 16-18, 2022 **Copenhagen, Denmark**

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FOREWORD

Dear Colleagues,

It is a great pleasure to announce that The Scientistt will host the Global Summit and Expo on Sustainable and Renewable Energy (GSESRE2022) will be held in Copenhagen, Denmark during June 16-18, 2022.

GSESRE2022 aims to bring together the renowned researchers, scientists and scholars to exchange ideas, to present sophisticated research works and to discuss hot topics in the field and share their experiences on all aspects of Sustainable and Renewable Energy.

The GSESRE2022 will be a 3 days event that means to gather the key players of the Sustainable and Renewable Energy community and related sectors. This event is launched with the aims to become an established event, attracting global participants, intent on sharing, exchanging and exploring new avenues of Sustainable and Renewable Energy -related scientific and commercial developments.

A wide-ranging scientific program consisting of plenary lectures, keynote lectures, Invited lectures, parallel sessions, as well as poster sessions for young scientists covering all topics in Sustainable and Renewable Energy will be scheduled. This conference provides a wonderful opportunity for you to enhance your knowledge about the newest interdisciplinary approaches in Sustainable and Renewable Energy.

Moreover, the conference offers a valuable platform to create new contacts in the field of Sustainable and Renewable Energy, by providing valuable networking time for you to meet great personnel in the field.

We look forward to seeing you at GSESRE2022 in Copenhagen, Denmark.

COMMITTEES

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Francesca Ceglia	University of Sannio, Italy

Plenary Forum
Day-1

Andrew R. Barron[1,2,3*]

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Reducing Industrial Carbon Emissions - A Case Study in Making Real Impact Towards Net Zero

Abstract

The technological challenges for industry to reach UK's legislated Net Zero targets by 2050 represent an 'Apollo moment' for decarbonization. With less than 30 years to achieve Net Zero emissions it is too late for more research. Now, is the time to deploy at scale on industrial locations to demonstrate technology and de-risk with regard economic viability, system integration, operational safety, and social acceptance. However, attempting to implement single technologies within a single industry will not provide the solution. Instead there needs to be a holistic approach that considers the waste and emissions, as well as materials and energy needs of a region (or country) as a whole instead of the individual parts. Furthermore, the development must be symbiotic, with a mutually beneficial relationship between different stakeholders, i.e., the integration of heavy industry with agriculture, healthcare, tourism and domestic waste and needs. The Reducing Industrial Carbon Emissions (RICE) project is an example of the 'dress rehearsal' for such an approach, incorporating: green hydrogen as a replacement for natural gas as an energy source as well as an industrial reagent; biorefinery conversion of CO2 to protein for animal and human consumption as well as high value chemicals; carbon capture and conversion using electrolysis to alkanes and alkenes; waste resource recovery and re-use to lower raw material mining and transport; waste plastic re-cycling as high value products for Li-ion batteries and carbon conductors replacing copper, and decreasing emissions associated with water treatment.

Keywords

Decarbonization, green hydrogen, carbon utilization, circular economy

Biography

Prof Barron is the Sêr Cymru Chair of Low Carbon Energy and Environment at Swansea University, and Director of the Energy Safety Research Institute. As author of over 500 publications, his research focused on fundamental problems in energy and the environment. He is a Fellow of the Royal Society of Chemistry, and the recipient of the Star of Asia International Award and the World Technology Award. His latest commercialization ventures are technologies for water purification of produced water, anti-viral mask for the COVID crisis, and carbon negative hydrogen production. For relaxation Barron races cars on both sides of the Atlantic.

Rafiqul Gani[1,2]

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Sustainable Process Synthesis, Design, and Analysis: Challenges and Opportunities

Abstract

In a world with increasing population and finite natural resources that are not uniformly distributed, thechallenge for modern society is to satisfy the demands for new and improved products and their sustainable manufacturing [1]. With data showing increased emissions of greenhouse gases resulting in rapid rise of earth's temperature and other negative developments, urgent action is necessary to tackle the energy-water-environment-health-food nexus through sustainable alternatives. Improvementsin orders of magnitude are needed in technologies currently being employed in the conversion of resources to products that sustain modern society. It is, however, questionable if the currently available technologies and/or methods and associated tools for their development are able to deliver the needed improvements. Opportunities therefore exist for chemical and biochemical engineering and related disciplines to deliver truly innovative solutions by managing this complexity [2, 3]. The lecture will highlight the challenges and the opportunities within chemical and biochemical engineering and especially within process systems engineering to tackle the challenges through the development of a new class of systematic methods and computer-aided tools [4], where integration of ideas-disciplines, hybrid model-data analytics, design techniques based on the 'define-targets and match-targets" paradigm, and a systematic multi-scale analysis-solution approach play important roles. Results from case studies illustrating the main concepts and highlighting aspects of sustainable process synthesis, design and analysis will be presented.

Keywords

Process synthesis; Process design; Sustainability; Process systems engineering

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4. AK Tula, MR Eden, R Gani, 2019, Hybrid method and associated tools for synthesis of sustainable process flowsheets, Computers & Chemical Engineering, 131, 106572.

Biography

Prof Gani is currently an adjunct professor at KAIST (South Korea) and CEO of PSE for SPEED,

a company he co-founded in 2018. For 34 years, starting from 1985, Prof Gani worked at the Department of Chemical & Biochemical Engineering, Technical University of Denmark, where he co-founded CAPEC. Prof Gani served as an editor-in-chief of Computers and Chemical Engineering journal (2009-2015) and currently serves as editor for the Sustainable Production & Consumption journal. He is also a member of the editorial advisory boards of several international journals, including Computers and Chemical Engineering and Current Opinion in Chemical Engineering. Prof Gani has been awarded Doctor Honoris Causa degrees from University Politehnica Bucharest, University of Pannonia, Babes-Bolyai University and University of Maribor. Prof Gani is the ex-president of European Federation of Chemical Engineering, EFCE (2015-2018), a member of the Danish Academy of Science, a Fellow of AIChE and a Fellow of IChemE. He received the AIChE Computers in Chemical Engineering award in 2015, the EFCE Jacques Villermaux Medal in 2019, the AIChE Sustainability Engineering Forum award in 2020 and the IChemE Sargent Medal in 2021. Through his company, Prof Gani develops, implements and employs state of the art PSE methods and tools to solve a wide range of problems of industrial and research significance, reliably, efficiently and very rapidly. He has published 531 articles in peer reviewed international journals and proceedings plus 5 edited books and 1 text-book. His publications have given him a H-index of 73 in GoogleScholar, 61 in SCOPUS and 54 in Web of Science (December, 2021). Prof Gani's current research includes development and application of computer aided methods and associated tools for modelling; property estimation; process-product synthesis, design & intensification; and process-tools integration with emphasis on energy, sustainability and application of a systems approach.

Keynote Forum
Day-1

Birgitte Bak-Jensen
Aalborg University, Denmark

Integrated Energy Systems in Local Communities

Abstract

The high penetration of renewable energy in Denmark and Europe demands a flexible energy system with possibilities for demand response. At the same time, new regulations opens up for formation of local communities where citizens can go together in the formation of local energy systems. This talk will be about demonstrations to be done in local energy communities in two European H2020 projects SERENE and SUSTENANCE. The demonstration sites include integration of heat-pumps and EV charging possibilities in local villages in Denmark, the Netherlands and Poland, as well as formation of local energy systems in India. The demonstrations looks into setting up different technical solutions based on user perspectives and preferences, local regulation as well as business cases seen both from private user point of view as well as local DSOs and other stakeholder point of view.

Invited Forum
Day-1

Yannis Maniatis
University of Piraeus, Greece

Geopolitical and Social Dimensions of Green Deal in East Mediterranean

Abstract

The Eastern Mediterranean is a new source of energy supply for the EU, both with green energy and gas, following the discovery of new gas fields.

Many green installations are taking place in Northern Europe and South Africa, which shows how useful the two “green” cables are: Eurafrica interconnector (connecting Egypt-Cyprus-Greece), and EuroAsia interconnector (connecting Israel-Cyprus-Greece).These two, are the first step in upgrading the geopolitical role of the Eastern Mediterranean, in the context of the green deal.At the same time, the development of the conditions of green energy’s production, especially by North African countries such as Egypt, allows the development model of Egypt and the wider region, to adapt to the green transition, in order to be done with democratic and social criteria.

Due to the fact that, natural gas is the fuel for the transition to green energy, it is particularly important that in recent years, we have discovered deposits in the EEZ of Israel - Egypt - Cyprus. There are also very promising indications within the EEZ of Greece and especially in the Ionian and southern Crete. Particularly, on the occasion of the EU effort to escape its dependance from Russian gas, following Russia’s invasion of Ukraine, the support of the only new EastMed pipeline, that will transport gas from the Eastern Mediterranean fields to Europe via Cyprus and Greece, with a capacity of 10 bcm per year, is extremely important.

All of the above, raise important and positive developments on the energy model of the Eastern Mediterranean.

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Volkan Ş. Ediger
Center for Energy and Sustainable Development
Kadir Has University, Istanbul, Turkey

Can Natural Gas Support the Sustainable Energy Transition?

Abstract

The European Green Deal has set – in line with the Paris Agreement of 2015 – a highly ambitious goal of achieving net-zero emissions by 2050, which requiresthe world to stop using fossil fuels and transition to 100% renewable energy.For many, this target is quite reasonable; after all,pastenergy transitions from wood to coal and coal to oil and natural gas have succeeded, and today's transition is no different.Marchetti (1985)demonstrated that dominant energy sources are always substituted by new ones with higher hydrogen to carbon ratio, which makes fuels more energy efficient, easier to deliver and handle, and cleaner to burn. However, as Yergin (2021)recently remarked,the past energy transitions have always been as "energy additions,"that is to say one source added to an existing dominant source. Today's energy transition requires a complete switch from fossil fuels to renewables.

Therefore, today'senergy transition will be much more complicated.Will renewablesand zero-carbon technologies be sufficiently improved to fulfill the requirements of 100% deployment? Or will some fossil fuel energy sources be needed to support the transition?If such support is inevitable, natural gas iscertainly the best alternative since it is the cleanest fossil fuels and can be used with high efficiency. For this reason, natural gas is commonly considered a transition fuel for bridging fossil fuels and zero-carbon technologies. The European Commission recently revised its complementary climate delegated act (CDA) by adding certain nuclear and gas activities to its"transitional" package, provided that theseactivities do not hamper the development of low-carbon alternatives.

At present, roughlya quarter of primary energy usecomes from natural gas. It is the third most used energy source after oil (31.3%) and coal (27.2%) with a share of 24.7% and second in electricity generation after coal (35.1%) with a share of 23.4%. In 2020,gas production was 3,853.7 bcm,of which 67.7% was used domestically and 32.3% wastraded eitherby pipeline (19.68%) and as LNG (12.7%). However, most countries are natural gas-import dependent; out of 88 countries, 27 are exporters, six are self-sufficient, and 55 are importers.

In 2020, the remainingproven recoverable reserves of natural gas wasrecorded as 188.1 tcm. Since127.9 tcm hasalready been produced from 1885 to 2020, the ultimate recoverable reservesare 316 tcm.This means that 60% of the world's proven reserveswasstill available.However, new reserve discoveries have been declining for the last two decadesas are the annual additions of reserves, which were 10.5 tcm in 2001. This also decreased the reserves/production (R/P) ratio from 62.4 years in 2001 to 48.8 years in 2020. On the other hand, the rate of production versus the time curve prepared based on the R/P ratios of each country is asymmetric and bell-shaped: production decreasessharply from 3.85 tcm in 2020 to around half by 2050and to a quarter by 2075.After 2075, when Russia's gas production ends, production will continue in only 11 countries, of which Iran (244.2 bcm), Qatar (178.1 bcm), and UAE (62.5 bcm)have the highest rates. The Hubbert curve drawn based on production rates from 1885 to 2020 shows that a peak will be reached around

2030.On the other hand, a zero-emissions target by 2050requires an average annual reduction in consumption of around 10%, leaving 133 tcm (70% of proved reserves) underground. The analysis of the availability of natural gas using the R/P and Hubbert Curve methodologyshows that natural gas is the best candidate to support the ongoing sustainable energy transition.

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On Site Application of a Digital Twin - Using a Calibrated Building Energy Model for Fault Detection Diagnosis

Abstract

Nowadays there is a rising trend on worldwide energy prices, which clearly generates negative impacts on homesteads and business alike increasing the risk of communities falling into energetic poverty. Globally buildings final energy consumption can reach a staggering 32%, with an impact on primary energy consumption that reaches 40% [1,2], where the installed Heating, Ventilation and Air Conditioning (HVAC) systems can account for approximately for 50 to 60% of the total energy consumed by the building spaces [3]. It becomes clear that both, the building and it's HVAC systems, are crucial participants in worldwide energy consumption. Which is why many countries have established mandatory energy studies in all building projects, be that new or retrofit, to increase energy performance, reduce CO2 emissions, and improve maintenance costs[4]. After all, the Report of the Intergovernmental Panel on Climate Change (IPCC) indicates, the execution of building retrofits and the application of different Energy Conservation Measures (ECM) could achieve worldwide building energy savings in 50% to 90% for most cases [5]. Therefore, assessing correctly building energy performance becomes key to develop the right strategies to optimize energy savings and find new solutions that are cost efficient and avoid wasting resources. It is under this scenario that Building Energy Models (BEM) have become essential in regulatory compliance calculations, they are a non-intrusive way to assess the energy behavior of any site, aiming to capture the building physics and it's HVAC performance. In fact, the correct assessment of a building's and it's HVAC energy performance is a complex challenge comprised of multiple uncertainties and assumptions, where engineers estimate parameter values of the multiple passive and active systems in an attempt to emulate real conditions [6], in order to reduce the performance gap between the results obtained from the simulated environment of the BEM and measurable reality [7]. Here, the correct establishment of parameter values through a calibration process that defines the correct behavior of the building's HVAC equipment is critical for the reduction of this performance gap, increasing the accuracy of the BEM results [8,9]. For once this is achieved, the generated calibrated BEM can be stated as a Digital Twin of the building, representing the behavior of the building and it's HVAC installation. A BEM that can be used in conjunction with the Building Management System (BMS) to guide building management into developing and applying new energy saving strategies. Furthermore, since this digital twin includes a representation of the HVAC system installed inside the building, it can provide maintenance teams with information on how the different systems should operate in the building, providing them with a tool that can be used to establish preemptive maintenance on their equipment, optimize it's performance by regulating set-points and flag any component malfunctions through a Fault Detection Diagnosis (FDD) process. It is evident that establishing a digital twin of a building and its HVAC system will become a trend in the near future if we aim to improve building's performance and fight the ever-increasing prices of energy costs.

Keywords

Building Energy Models (BEM), HVAC, Calibration, Energy Simulation, Fault Detection Diagnosis (FDD), Digital Twin.

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[10]

Biography

Mr. Jose Eduardo PACHANO obtained his master's degree in Environmental Management and Design of Buildings from University of Navarre in 2019. Graduated top of his class as a Civil Engineer by the Pontificia Universidad Católica del Ecuador in 2007. He has ample experience in design and construction of buildings and worked on various renewable energy projects. Currently investigating on calibrated building energy models and simulation of HVAC equipment as a research assistant in the Department of Construction, Installations and Structures of the School of Architecture in the University of Navarre, Spain.

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Katinka Johansen
Lund University, Denmark

Something is Sustainable in the State of Denmark: A Review of the Danish District Heating Sector

Abstract

This paper provides a coherent review of district heating in Denmark, exploring past, present and future perspectives.Danish district heating is known as unique internationally in terms of heat planning strategies, technical solutions and combinations, energy efficiency and sustainability, ownership models and financing, and it has captured the attention of district heating communities and stakeholders worldwide from the early days. Historically, a ban on landfills incentivised waste incineration, and the strategic integration of combined heat and power plants and recycling of waste heat from industry was prioritized. This all increasedthe energy efficiency in the energy system, and ultimately contributed to the top World Energy Councilranking of the Danish energy system. A cooperative mind-set, welfare state values, the notions of energy efficiency, availability, independency, and sustainabilitywere all pivotal for the evolution of the district heating networks throughout Denmark. Other unique features of the Danish district heating sector include large-scale collective heat planning, the mandatory connection, the non-profit principle, the same approximate price for customers irrespective of heat density, and the relatively high average price of district heating. Moreover, district heating knowledge hubs have led to world-wide exports of district heating technologies and know-how. Future challenges for the Danish district heating sector include increasing biomass import dependency, the changing role of combined heat and power plants in the energy system, transitions to non-combustion heat supplies, and competition from individual heat pumps in single-family houses. However, future ‘smart’ thermal grids will increasingly facilitate sector coupling processes as more renewable energy resources are integrated into the energy system in Denmark and internationally.

Marceliano Eduardo de Oliveira
UEA Amazon State Univerity, brazil

Under the Sun: Aspects Beyond Solar Energy

Abstract

We must improve our discourse about solar energy. Not only about its green, clean and renewable energy, but also for who and what kind of application. Some technological applications of solar energy presents high level of viability and some other may be might not. Economics, logistics and political aspects have to be taken into account. At this speech we will talk about solar energy considering relationship with this complex point of view.

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Lara Perrin*, Mirella Al Katrib, Emilie Planes
Univ. Grenoble Alpes, Univ. Savoie Mont Blanc, CNRS, Grenoble INP, LEPMI, 38000 Grenoble, France

Electrodeposited Perovskite Layers Developed For Photovoltaic Application

Abstract
Electrodeposition is investigated as an alternative method to develop large area perovskite active layers for solar device application. Along with the simple $MAPbI_3$ perovskite [1], the electrodeposition of mixed $MAPbI_3$-xCl_x and $MA_{1-y}FA_yPbI_{3-x}Br_x$ perovskites will be presented. The present study is one of its kind, since these mixed perovskite were never developed using electrodeposition before. It was observed that using these mixed perovskites in a solar device enhances its photovoltaic activity and stability. The different perovskites fabricated using electrodeposition were also proved to experience a positive maturation phenomenon during their first 500 hours of life.

Keywords
Solar cells, perovskite, electrodeposition

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[1] M. Al Katrib, E. Planes, L. Perrin, Chem. Mater., 34, 5, 2218–2230 (2022).

Biography
Lara Perrin is Associate Professor at University Savoie Mont Blanc (France) since 2006, in the GUIDE team (Genesis, Usage of Durable Interfaces for Energy) of the LEPMI laboratory (Laboratory of Electrochemistry and Physical chemistry of Materials and Interfaces). This team is part of the National Institute of Solar Energy and is located at Le Bourget du Lac. She is a specialist in the chemistry of materials with specific properties, and her work combines chemistry, physical chemistry and physics. Her current research activities are mainly focused on materials for energy (third generation solar cells: organic and perovskite, electric cables, fuel cells ...). Her work focuses on both the Genesis and the Sustainability of these different systems.

Invited Forum
Day-2

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Jeyraj Selvaraj
Universiti Malaya, Malaysia

Power Quality Issues on Integrating Renewable Energy to the Grid

Abstract

Renewable energy (RE) is a growing component in electricity grids around the world due to its contributions to (1) energy system decarbonization, (2) long-term energy security, and (3) expansion of energy access to new energy consumers in the developing world. The amount of electricity produced with renewable energy, especially wind and solar power, is growing rapidly throughout the world. Producing the power is one thing; getting it onto the electric grid and to consumers is another matter. Large amounts of power from renewable energy must be moved from the (often remote) locations where they are produced to the cities and towns that need power. Moving this much power will require more efficient use of existing high power transmission lines and the development of new transmission lines. Apart from new transmission infrastructure, many of the grid rules governing how to plan for, interconnect, and operate power on the grid also need to change to accommodate these power. Renewable energy, like the customer demand it serves, is often variable, meaning that it fluctuates up and down based on factors like weather and the time of day. Some of the current grid rules have been in place since the 1930s – well before renewable energy generation became available in significant amounts. Therefore integrating renewable energy into the utility grid is very challenging. Steps must be taken in order to prevent the grid from becoming instable. Challenges and possible solutions must be identified and analyzed in order to maintain the stability and security of the grid. These foreseen challenges motivates this research to study the power quality problems that may arise from large penetration of renewable energy sources into the utility grid.

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[2]Faculty of Chemical Engineering and Technology, University of Zagreb, Savska cesta 16, 10000 Zagreb, Croatia; **Retired, independent scientist
[3]National Institute of Chemistry, Hajdrihova ulica 19, 1000 Ljubljana, Slovenia; Faculty of Science, University of Nova Gorica, Vipavska 13, 5000 Nova Gorica, Slovenia

Solving the Problem of Sustainability of Cities Worldwide with Integrated Seawater Steam Engine System

Abstract

Despite all efforts, there is currently no sustainable city in the world. In some cities there are positive changes towards sustainability (RES instead of fossil fuels, using electric cars, waste recycling, reduction of CO2 emissions, etc.), but in order to achieve the sustainability of the Earth as a planet, all cities in the world should be made sustainable, as they account for about 80% of total energy consumption. This means that future sustainable cities will be able to produce all the necessary energy and drinking water using the RES system, applying pump storage hydroelectric (which technology can balance seasonal surpluses and shortages of solar energy), as well as applying seasonal heat storage technologies. On the other hand, despite the efforts of the signatories of the Paris Agreement, it is questionable whether these objectives can be achieved at all due to political, economic and other obstacles. In addition, current EU policy might even take a step backward by trying to introduce a green label for nuclear energy and natural gas (European Commission taxonomy proposal), which calls into question the implementation of The European Green Deal by 2050.Recognizing the importance of this historic moment in stopping climate change, the paper presents a way to address the sustainability of cities in the world, proposing a systematic approach to this problem, taking into account the most relevant criteria: size, climate and natural disasters. Considering that about 50% of the world's population lives within the area 20˚ N and 40˚ N and that over 30% of the population lives in cities with less than a million inhabitants; but also the fact that cities outside this geographical area may also have relatively large amounts of direct solar radiation; the cities of Zagreb and Copenhagen (which cities have practically the same amounts of direct solar radiation) were selected as case studies, for which original solutions for achieving overall sustainability were given. In doing so, Seawater Steam Engine (SSE) technology[1-3], which uses renewable energy for simultaneous energy and drinking water production, is presented, as well as original strategies for solving the problem of accommodating SSE collectors in cities (with canopies), but also the original concept of energy and drinking water distribution (with loops). However, just as SSE technology is basically open-source technology that can use other renewable energy sources, it also means that it could make other cities in the world up to a million inhabitants without enough solar energy completely sustainable, whereby other RES would be used. In addition, the paper presents strategies for resolving cities with more than a million inhabitants all the way to the metropolis. This paper also introduces the next generation of RES technologies, whose originality lies in the fact that, in the future, they can simultaneously produce energy and drinking water which is fully consistent with the new "Philosophy of Sustainability".[4]With this concept, the cities in the world could become the "basic building blocks" that would "build" the overall sustainability of the Earth.

Keywords
Sustainable cities, Climate change, Seawater Steam Engine, Renewable energy sources, Drinking water, Philosophy of sustainability.

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Biography
Dr. Karmen Margeta
Senior Scientist, Ph.D. in the field of basic technical sciences. She works at the Institute for Development and International Relations (IRMO),Department for Resource Economics, Environmental Protection and Regional Development, Croatia. She is an expert in the field of water treatment and zeolite nanomaterial and she is involved in applied research related to material science for energy technologies, desalination systems, and water treatment technologies. She has published extensively and presented numerous papers on these topics. She is an inventor of Seawater Steam Engine technology (WO/2013/072709)that could stop climate change and the original concept for solving the problem of sustainability of all cities worldwide.

Prof. Zvonimir Glasnovic
Full Professor with the University of Zagreb (retired),Croatia, independent scientist, received the B.Sc. degree in electrical engineering from the University of Zagreb, the M.Eng. degree from University of Belgrade, and Ph.D. degree from University of Zagreb. He worked as leading designer in the area of electrical engineering,i.e., power supply systems in many industrial structures throughout the world. He is involved in applied research related to the application of integrated RES systems. He has published numerous papers on these topics and he has four patents (WIPO, EU) in this field. He is an inventor of Seawater Steam Engine technology(WO/2013/072709)that could stop climate change and the original concept for solving the problem of sustainability of all cities worldwide.

Kristina Berzina
Riga Technical University, Latvia

Challenges in Assessing the Competencies of Specialists in the Field of Innovative Technologies according an Obvious Increase in the Share of Renewable Energy Resources

Abstract

The energy sector is undergoing a period of transition andsignificant structural changes to ensure universal access to affordable, reliable, sustainable and modern energy for all. the highlight is the transformation of energy systems by integrating various traditional and renewable energy sources in a wide range of capacities.

By creating different political, market and regulatory conditions, countries are attracting investment and accelerating innovation through renewable energy and smart grids, which are efficient, reliable and sustainable technologies.

Many countries are faced with a shortage of specialists to solve this issue, various methods are used, such as attracting specialists from abroad, etc.

The Center for Certification of Specialists in its work faced the issue of the need to increase the synergy of basic knowledge and innovative technologies in the field of design, installation, control and operation of integrated power supply installations. In this issue, there are many options for the development of improving the qualifications of specialists. As one of the options in Latvia, narrowly focused, modular lifelong education programs are used.

To improve the quality, it should be noted that the programs need to be improved, made more responsive to the adoption of innovative technologies and complementary, we also stated the need to update the theoretical foundations and specialists working in the industry for more than 10-15 years. Potentiallythere is an opportunity to use an integrated approach in the framework of the training of specialists, with their subsequent certification and control.

Sofia Agostinelli,
Sapienza University of Rome, Italy

Data-Driven Strategies for Smart Grid Optimization Towards Cognitive Buildings

Abstract

The Digital Twin of building systems can be extremely valuable both for macroscopic and microscopic purposes and scales (from district to apartment), especially for energy management applications. In detail, it can be related to specific components of technological systems, as well as to the digitalization of infrastructures and real estate assets, technological systems, or networks of technological systems.

Digital Twins enable the capability of improving and enriching their knowledge and available data, receiving input and signals from sensors, developing self learning capabilities and predictivity through the integration with Artificial Intelligence systems.

DT based real time monitoring can reduce the gap between building energy performance simulated through energy diagnosis, and the effective building performance coming from data analysis, which allows to get more refined energy management strategies, identifying inadequate users' behaviors and policies.

Machine Learning and DT-based management strategies can integrate self production and supply systems in terms of both thermal and electrical loads in an energy smart grid digital management system. Such approach allows to achieve an intelligent optimization and automation system for energy management of buildings using three dimensional data model, Internet of Things, Artificial Intelligence and Machine Learning systems towards the configuration of "Cognitive Buildings". The combined use of integrated dynamic analysis algorithms allows the evaluation of different scenarios for energy efficiency intervention, keeping the internal comfort and climate conditions.

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Philip Agee,[1] Xinghua Gao[2], KereshAfsari, PhD[3] and Andrew McCoy, PhD,[4]

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Leveraging Technology towards Affordability in Construction

Abstract

The emergence of innovative construction technologies provides varied and viable solutions to material and labor shortages as well as supply chain risk and introduces new opportunities for jobs with advanced skills. Construction 4.0, emerging from Industry 4.0, begins a shift from on-site tasks of manual labor (traditional trades) to technical roles that merge innovation and application. This presentation will highlight the digitization of construction, enabling robotic technologies, augmented and virtual reality, digital twins, materials science, and additive manufacturing, along with big data, enabling artificial intelligence and machine learning capabilities. Building upon our recent work, innovative construction technology has also shown great potential to address the needs of affordable housing in the United States and beyond. The researchers will also outline an educational curriculum that provides students, at all levels, with deep and broad training into the needs of technology and housing.

Keywords

Construction 4.0, Construction Technology, Affordable Housing, Higher Education

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J.B. Carda*

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Universitat Jaume I de Castellón. Inorganic and Organic Chemistry Dept. Avguda Sos Baynat s/n 12071 Castellón (Spain)

New Chalcogenide Photovoltaic Devices for Architectural Integration

Abstract

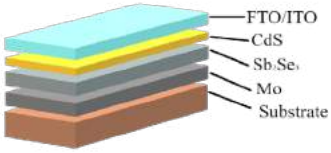

Figure 1: Scheme of $Sb_{2(S,Se)3}$ device

The development of wide bandgap, stable and low temperature processing materials will allow the extension of PV device concepts to new kinds of lightweight and/or mechanically flexible and/or semitransparent solar modules. This will enable novel applications for which traditional PV modules are incompatible, and address the needs for efficient, flexible and lightweight modules better adapted for advanced PV applications[1,2]Sb2(S,Se)^3, offer huge potential for advanced PV concepts such as tandem and semi-transparent devices, thanks to the unique combination of optical, electrical and structural properties of these materials. Figure 1 shown a typical Sb2(S,Se)3 device, that consist on: the absorber, a Sb2Se3 layer that is a p-type semiconductor, the buffer, a thin film done by CdS (an n-type semiconductor) and two conductive layers that help to close the circuit.

The work is focused on the development of new Sb2Se3 solar cell device. The above mentioned material have been prepared by solution-based chemical route: electroplated. Further, low-temperature annealing process will be applied to enhance material crystallinity and substrate adhesion. This method of preparation is easy to be applied at large scale production and could be very attractive for industrial application. Special attention was pressed on crystal structure and morphological characterization, thin film deposition and final product performances to develop high-performance photovoltaic devices based on antimony selenium based absorber compound.For this purpose, the obtained films were characterized by X-Ray diffraction (XRD), scanning electron microscope (SEM) andRaman spectroscopy. Also optoelectronicanalysis were done to obtain the dispositive efficiency.

Keywords

Thin films solar cells; ceramic materials; BIPV; renovable energy; circular economy; multifunctional ceramics.

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Biography

Dr. Juan B. Carda Castelló is Full Professor at the Jaume I University of Castellón (Spain). He is the leader of the Solid State Chemistry research group in the Inorganic and Organic Chemistry Department. The research group was created on the same dates as the University itself, in 1991. It has led his scientific career he has carried out more than 300 publications in national and international journals and has participated in the organization of numerous Conferences as well as technology transfer fair (Destaca fair). His activity has been directed to the study of ceramic materials and the search for new functionalities. For more than 15 years, these studies have been aimed at obtaining photovoltaic materials, through the development of chalcogenide layers and also in aspects of energy savings and obtaining materials through the circular economy.

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S. Porcar

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Transparent ZnO Based Photovoltaic Devices for Architectural Integration

Abstract

The development of wide bandgap andvery stable ceramic materials will allow the extension of PV device concepts to new kinds of lightweight. The mechanically flexible and transparent solar modules, generates a lot of possible applications for which the classic PV modules are incompatible, as the incorporation of that dispositives in builds without break they arquitecture and designs.[1]

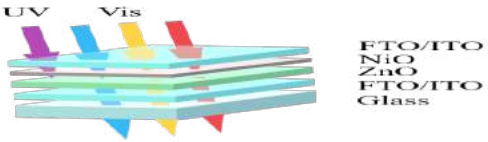

Figure 1: Scheme of a transparent solar cell.

ZnO based solar cells present a wide range of possible uses thanks to the high transparency of it films.[2] Figure 1 shown a typical ZnO device that consist on the two back ant top contact, that can be form by ITO or FTO, the absorber layer of ZnO (n-type semiconductor)which have between 150 and 200 nm, and a 50nm NiO thin film deposited on the ZnO to generate the p-n junction.

The present work is focused in the development of the metallic oxide thin films using easy reproducible and cheap chemical routes. For this reason, spray pyrolysis and chemical bath deposition were used. The ZnO and FTO thin films were synthetized using a spray pyrolysis method at 500ºC. The NiO film was deposited in two steps, first a $Ni(OH)_2$ film was deposited on the ZnO by chemical bath and then annealed at 500ºC. Special attention was pressed on crystal structures and morphological characterization, thin film deposition and final product performances to develop high-performance photovoltaic devices based metallic oxides.Figure 2.a. shown a uniform and continuous ZnO film with a slim NiO film on the top, in figure 2 b the transparency of the dispositive can be seen.

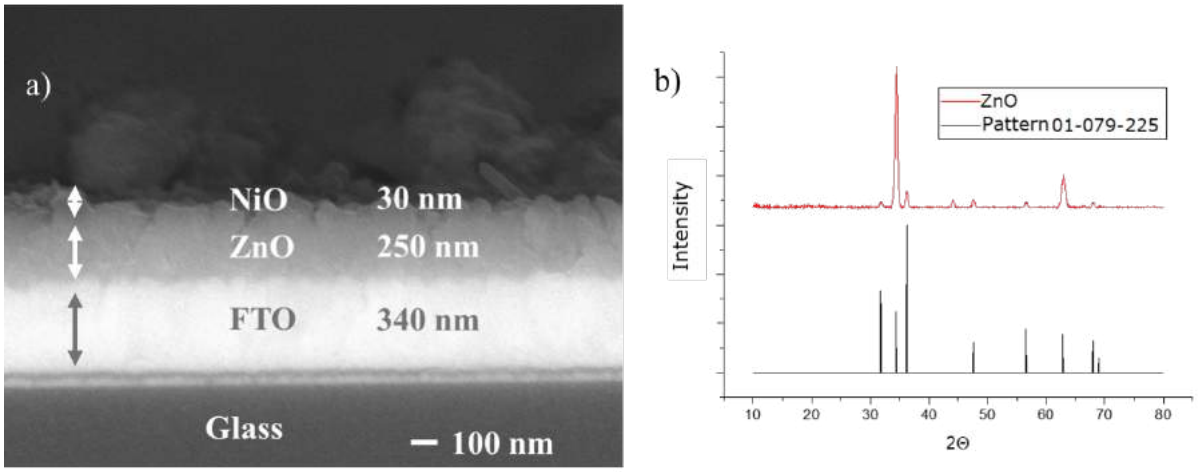

Figure 2: 2a) SEM section image of NiO/ZnO heterojunction; 2b) ZnO DRX against a ZnO pattern were a crystal orientation of the film can be sown.

Fundamental characterizations were obtained for the PV films. For this purpose, the obtained films were characterized by X-Ray diffraction (XRD), scanning electron microscope (SEM). Also electrical analysis was done to study the optoelectrical response.

Keywords
Thin films solar cells; ceramic materials; BIPV; renovable energy; circular economy; multifunctional ceramics.

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Biography
Samuel Porcar García is a PhD student in the Jaume I University of Castellón (Spain). He also studied a chemistry master and degree in The same university. His studies have been aimed at obtaining photovoltaic materials.

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Chua Kian Jon
Department of Mechanical Engineering; National University of Singapore, Singapore

Integrating Innovative Thermal Technologies for Energy Sustainability

Abstract

This presentation highlights the novel development ofseveral thermal energy technologies when integrated produces multiple utilities are generated simultaneously in an energy efficient manner, through maximizing the recovery of its generated waste energy. Specifically tailored for tropical countries, the plants can contribute to greater energy and cost savings, and is also more space-efficient. More importantly, it can significantly reduce energy consumption by 30 to 40%and trim the amount of carbon dioxide emitted to the environment by 2 to 4 per cent for countries at business-as-usual levels while meeting varying needs of electricity, potable water, cooling and heating The thermally-integrated smart plant uses natural gas as the main energy source to power micro turbines to produce electricity. Waste heat from exhaust gas generated in the process is efficiently recovered and channelled back to power chillers to produce chilled water, which is required to cool and dry air for air-conditioning. The plant is also able to recycle waste water of any kind to produce portable water. Hot water or steam can also be produced by tapping into the waste heat generated from the plant. The innovative aspect of this thermal plant entailsthe cascading of waste energy recovery to produce invaluable utilities in the smartest manner. It is designed and engineered to fulfil the demand of energy conservation and emission reduction duringnormal operation, as well as during peak-load demands to strengthen the energy-water-environmental nexus.

Biography

Dr Chua Kian Jon is currently an Associate Professor with the Department of Mechanical Engineering, National University of Singapore. He has been conducting research on renewable energy systems and heat recovery systems since 1997. He has conducted both modelling and experimental works for specific thermal energy systems. He is highly skilled in designing; fabricating; commissioning and testing many sustainable energy systems to provide for heating, cooling and humidity control for both small and large scale applications. He has been elected to several fellowships including Fellow of Royal Society and Fellow of Energy Institute.He has more than 200 international peer-reviewed journal publications, 6 book chapters and tworecent monographs on advances in air conditioning (https://www.springer.com/gp/book/9789811584763 and https://www.springer.com/gp/book/9783030808426). He was highlighted among the top 1% of scientists in the world by the Universal Scientific Education and Research Network and top 0.5% in the Stanford list of energy researchers. His works has garnered more than 11,000 over citations with a current h□index of 55. Further, he owns more than 10 patents related to several innovative cooling and dehumidification systems. On a regular basis, he has been invited to deliver many plenary and keynote talks on his research findings. He is the Principal Investigator of several multi-million competitive research grants. Additionally, he has been awarded multiple local, regional, and international awards for his breakthrough research endeavours.

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Yusuke Yamauchi*
The University of Queensland

Materials Space-Tectonics: A Conceptual Paradigm for Creating Second-Generation Porous Materials

Abstract

Different types of inorganic nanomaterials have been designed by using various methods including sol-gel, electrochemical/chemical reduction, calcination, hydrothermal reaction, etc. The dimensionality of these nanomaterials (x, y, z) can be classified as zero-dimensional (0D), one-dimensional (1D), two-dimensional (2D), or three-dimensional (3D), respectively. Accordingly, for 0D nanomaterials dimensions are measured on the nanoscale (< 100 nm for each dimension). 0D nanomaterials, for example nanoparticles (or sometimes, nanocrystals), most commonly have isotropic morphologies where the usually thermodynamically stable planes of lower reactivity are exposed at the nanoparticles' surfaces. For 1D nanomaterials, a single dimension is extended beyond the nanoscale. This class of nanomaterials includes nanotubes, nanorods, and nanowires. In contrast to 0D and 1D nanomaterials, 2D nanomaterials have recently attracted great interest for the next generation of promising. However, such 2D materials are often formed by stacking/assembly, processes that vastly reduce their active surface areas, and negatively affects their performance in potential applications. Despite recent and significant advances in inorganic nanomaterials of different dimensionalities, we still remain active in making substantial efforts to develop new nanomaterials to help address energy- and environmental-related issues. Our group is fully aware of the serious limitations of the currently available materials' designs. The continued use of the current nanomaterials design paradigm based on traditional 0D, 1D, 2D nanomaterials obscures the innovative approaches required to address the aforementioned serious issues. Therefore, we have developed a new conceptual paradigm "materials space-tectonics" which is defined as the creation of novel mesoporous/nanoporous materials with precisely controlled internal space (or pore size), composition, and morphology with the assistance of nanomaterials informatics to optimize their functional applications (Figure 1).

The overarching aims are to:
Control and enhance the "space-tectonics" of conductive nanoporous materials (carbons, metals, sulfides, phosphides, etc.): (i) large increase in accessible surface area, (ii) selection of exposed crystal facets (e.g., facet selection, chirality), (iii) generation of catalytically ultra-active sites on kinks and step sites (e.g., high index facets), and (iv) increased diffusion rates of guest molecules (reactants) inside the components, especially in the case of 2D materials.

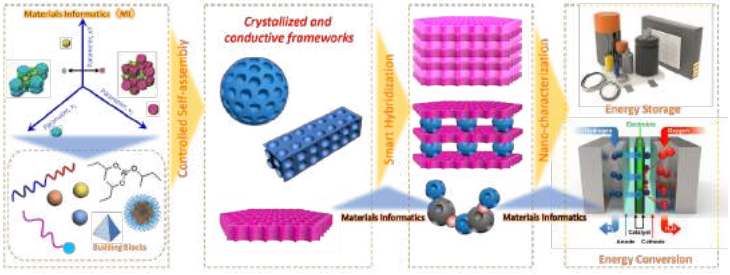

Fig. 1. Concept of "materials space-tectonics" for achieving precise control of the design of conductive nanoporous materials towards energy and environmental applications.

- Connect nanoporous components in hybrid nanoarchitectures: development of methodologies for the hybridization of novel nanoporous conductive materials with precisely controlled building blocks (like Lego®) for hybrid architectures to bring out many advantages beyond what is currently known, such as (i) unlimited increases in the interface between different components (e.g., hetero-junctions, charge-separation), (ii) maintaining high diffusion rates of guest molecules (reactants) inside the hybrid materials through the introduction of multiple and hierarchical pore structures, and (iii) formation of gradient potential energy or polarization within assembled materials (e.g., one-directional electron/energy transfer, light-harvesting, up-conversion, multi-electron reduction).
- Combine “machine learning (MI)” with inorganic synthetic techniques: this will accelerate the optimization of synthetic parameters for target nanomaterial design and enable selection of the optimal combinations of parameters for each inorganic building block for effective integration of the materials.

Increasing demand for sustainable energy and environmental remediation has accelerated research of various technologies, such as energy storage and conversion (e.g., fuel cells, water splitting, secondary battery). These technologies rely heavily on the catalyst (or electrode) materials, which can significantly increase the efficiency of chemical reactions by reducing their activation energy or by modulation of the reaction mechanism. Although traditional porous materials (including mesoporous silicas, zeolites and coordination polymers) have been extensively studied, the poor electrical conductivity of those materials has restricted their utilization in future potential applications, esp. electrochemical-based applications. Therefore, our main target is to establish a platform for the synthesis of a second generation of highly conductive materials. We strongly believe that our new synthetic concept of “second-generation porous materials” can be considered to have significant potentials for the further development of secondary battery electrodes, (electro)catalysts, optical or electronic sensors, etc. Today, we will present several important examples from our on-going projects.

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former Dean & CEO, Asian Development Bank Institute.

Environmental Investment, the Allocation of Portfolio Assets and GHG Tax

Abstract

Our planet is facing serious environmental problems. In order to achieve a sustainable planet, financial allocation must be changed based on environment, social, and governance (ESG) criteria. Thus, the importance of ESG investment and green investment is widely discussed today. The purpose of this paper is to show that different rating agencies provide different criteria for ESG investment currently, and how this affects effective ESG and green investment. The theoretical part shows the distortion of asset allocation based on which rating agency is consulted by portfolio investors. Empirical analysis uses actual ESG scores of various companies. It will show numerically how portfolio allocation is different depending on which rating agencies are selected. The same argument can be applied to green bonds. Some bonds are 90% green (and 10% gray) and other bonds have 80% greenness (and 20% gray). However, both these bonds can be issued as green bonds. Therefore, current green bonds can lead to distorted portfolio allocation in green sectors. This chapter recommends imposing greenness adjusted greenhouse gas (GHG) taxes on emissions of carbons, plastics, etc., by each company to make investors watch after-tax rates of return for their portfolio investment. Another proposal is to establish a single credit rating of each company based on its emissions of pollutants. Otherwise, distorted portfolio allocation can persist.

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Recent Development of Pressure Retarded Osmosis between Seawater and Fresh Water

Abstract

Power generation using osmotic pressure difference, which is called Pressure Retarded Osmosis (PRO), is one of the excellent future technologies utilizing the salinity gradient power. PRO has two significant advantages as renewable energy, one is to reduce greenhouse gas emission because fossil fuels are not used, and the other to avoid unstable supplies as seen in solar and wind power generations. Our PRO system was firstly tested in 2001 between the concentrated brine (ca.7wt.%), discharged from a seawater desalination plant, and the freshwater. They were conducted in a model plant using an 8-inch CTA hollow fiber module (by ToyoboTM). In 2014, we constructed the demonstration plant and tested in Fukuoka-City, using concentrated brine from the desalination (SWRO) plant and treated wastewater from the sewage treatment plant. Using a 10-inch hollow fiber module, a net power output reached to 4.5 W / m2 [1].We,recently, are planning to construct commercial PRO plant between seawater(ca.3.5wt.%) and freshwater from the waste water.According to our estimation 6.5 W / m2 for membrane output is required. In order to obtain PRO commercially feasible, it is essential to develop the novel modules and membranes, and dramatically increasing the volume flow rate of fresh water by controlling membrane structure. If those were achieved, PRO plant using one million cubic meters of seawater per day would have a power generation cost of $ 0.24 / kWh, comparable to the other renewable energies. Therefore, PRO becomes a promising system utilizing renewable energy.

Keywords

Pressure retarded osmosis, Desalination, Sewage, Sea Water, Membranes, Modules

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Biography

Professor Dr. Akihiko TANIOKA,
Emeritus Professor of Tokyo Institute of Technology. Appointed Professor of Shinshu University, Visiting Professor of The Open University of Japan, and CTO of Zetta Ltd(Nanofiber Company). Education in Organic and Polymeric Materials, Tokyo Institute of Technology, and Dr. of Engineering Science, Tokyo Institute of Technology, March, 1975. Leader of Pressure Retarded Osmosis(PRO) Research in “Megaton Water System” by First Program of Cabinet Office of Japanfrom 2010 to 2014. Research activities areapplications of nanofibers, and membranesfor water and energy production. More than 500 publications(including scientific papers, review articles and books).

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Investigation on Operation Condition of Membrane Reactor for Biogas Dry Reforming to Produce H_2

Abstract

The fuel cell is thought to be a promising energy conversion technology since environmentally toxic gases such as NO_x, SO_x and CO_2 are not emitted. H_2 is a fuel for the fuel cell, produced from different resources. However, CO_2 would be emitted upon the production of H_2 from fossil fuels such as coal, oil, and natural gas. Therefore, we should develop H_2 production technology without CO_2 emission for the sustainable world. This study focuses on H_2 production from biogas. Biogas is a gaseous fuel consisting of CH_4 (55 – 75 vol%) and CO_2 (25 – 45 vol%), mainly produced upon fermentation of CH_4 by the action of anaerobic microorganisms on raw materials such as garbage, livestock excretion, and sewage sludge. In addition, it can be said that the conversion of biogas to H_2 is carbon neutral, which means reduction of carbon footprint.

Biogas is usually available as a fuel in the gas engine or micro gas turbine to generate the power by energy conversion. Since biogas contains CO_2 of approximately 40 vol%, the heating value is low compared to natural gas, resulting in a decrease in the efficiency of power generation. Therefore, this study adopts the biogas dry reforming process to produce H_2, which can be used as s fuel for solid oxide fuel cell (SOFC). CO which is by-product from biogas dry reforming can be used as a fuel for SOFC. This study adopts the Ni as catalyst since Ni-based catalyst is the most common catalyst for biogas dry reforming process. This study also pays attention to a membrane reactor to improve the performance of biogas dry reforming. Since the biogas dry reforming is an endothermic reaction, it is expected that the performance of producing H_2 is improved especially at lower temperature. Some studies investigated the membrane reactor for CH_4 dry reforming. However, it can be said that the impact of operation condition such as pressure difference between reactor and sweep chamber, molar ratio of supplied gas and reaction temperature on the performance of biogas dry reforming has not been investigated well. Therefore, the purpose of this study is to understand the impact of operation condition such as pressure of sweep chamber, molar ratio of supplied gas and reaction temperature on the performance of biogas dry reforming. The pressure of seep chamber was set below atmospheric pressure and changed. The molar ratio of supplied CH_4 : CO_2 was changed by 1.5 : 1, 1 : 1 and 1 : 1.5. The reaction temperature was changed from 673 K to 873 K. The Pd/Cu alloy membrane (Cu of 40 wt%) was adopted for H_2 separation.

As a result, it is revealed that CO which is by-product from dry reforming is produced mainly at 500 □ compared to H_2 irrespective of the pressure of sweep chamber as well as the molar ratio of supplied CH_4:CO_2. Since the reaction temperature is relatively lower and H_2 selectivity increases with an increase in reaction temperature, high CO selectivity is obtained at 500 □.

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An Assessment of Solar Energy Potential and Policy Implication as a Sustainable Solution to Nigeria's Energy Deficit

Abstract
Residents in Nigeria has long endured energy deficit. In 2016, it is capable of producing about 13 GW of electricity, but only 7.141 GW was generated. To enhance electricity generationthe Nigerian government has promoted renewable energy adoption into nation's power grid. The National Energy Policy (2018), for example, highlighted the need for producing more energy from renewable energy resources and set a 15% target forrenewable energy shareby 2030. This study aims to examine Nigeria's national renewable energy policy implementation. We reviewed government documents and secondary sources that pertained to solar energy potential in Nigeria.The government of Nigeria has prioritized the use of solar energy for the long-term electricity supply as itsyearly solar radiation varies from 12.6 to 25.2MJ/m2-day fromthe coastal regionto the Northern part. Based on the Rural Electrification project (REA), 1000 projects has been completed by the federal government. However, the project to install 3 solar-powered mini-grids in each of the 36 federal states failed owing to low consumption density and low power purchasing potential mainly in rural areas. Based on the findings of this research, we recommendthat Nigeria accelerate household solar adoption in realizing all the solar energy policy objectives.

Keywords
Renewable Energy, Solar Energy, Energy Deficit

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Nanofluidic Osmotic Energy Conversion with Thermal Modulation for Salinity-Gradient Power Utilization

Abstract
Osmotic energy conversion (OEC) is becoming attractive for salinity-gradient power utilization. However, the OEC still faces a challenge of relatively low power density owing to the limited ionic mass transfer in nanopores. In this presentation, we offer several enhancement technologies for OEC under thermal modulation. A similarity principle is firstly constructed for ion selective transport in a nanofluidic channel through dimensionless analysis, and the derived dimensionless governing parameters are grouped into four categories according to their different physical meaning, which lays a theoretical foundation for experimental design and data analysis to develop engineering correlations in OEC under salinity-gradient. Then, a sensitivity analysis is also carried out to evaluate the dominance order of multi-physical parameters in salinity-gradient based OEC. Furthermore, nanoparticles with photothermal conversion characteristics are applied to thermally ameliorate the osmotic power density. When a 1% mass fraction of silver nanoparticles are immersed in the aqueous solution under 1 sun solar irradiation, its equilibrium temperature is raised from 297.2 K to 340.9 K, and the corresponding osmotic power density is effectively enhanced from 2.41 W/m2 to 8.43 W/m2 by 249.79% under artificial seawater and river water. Finally, the designed interfacial nanostructures are used to consolidate OEC under hybrid salinity and temperature gradients. A principle "Strengthening the electric double layer with high original thickness adjacent to low salt concentration reservoir" is constructed for salinity-gradient power utilization using OEC. The current research work offers a promising route to directly convert salinity-gradient energy into electricity with thermal modulation.

Keywords
Salinity-gradient energy; Osmotic Energy Conversion; Thermal modulation; Similarity principle; Photothermal conversion; Designed interfacial nanostructures.

Biography
Qinlong Ren, Associate Professor, Xi'an Jiaotong University, China. He received the Ph. D degree from The University of Arizona, U.S. at 2016 for Mechanical Engineering. His research interests include multiscale heat and mass transfer, renewable energy conversion, energy storage, and electrokinetic phenomena. He has published 41 SCI Journal papers, including 25 papers as first or corresponding author. He has received research grants from NSF of China and several industrial companies.

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Transitions of Biogas Policies in China (2001–2019): A Policy-Instrument-Based Analysis

Abstract

China has emerged as global significant producer of biogas during the last two decades. The Chinese government promoted various types of policy instruments to facilitate the emergence and further development of biogas. This article used the method of content analysis to study the transitions of biogas policy instruments in China. We in sum surveyed 108 policy documents issued by the central government of China from 2001 to 2019. We analyzed the number, stringency, forms and institutions of these biogas policies and compared the evolution of different types of policy instruments in the different periods of time. The results showed that the number and stringency of biogas policy instruments in China fluctuated from 2001 to 2019. There were 11 institutions issuing biogas policies, and the core institutions were the ones responsible for planning economic and energy transitions as well as agricultural development. The majority of policy instruments was issued on the low level of Notices. Among the different types of policy instruments, environmental-type instruments have been the priority, and supply-type instruments have been the second main focus. Demand-type instruments have been supplementary to both.

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Control System Fault Diagnosis of Small Pressurized water Reactors Based on Deep Learning

Abstract

The small pressurized water reactor (SPWR) has the advantages of good economy, high safety, and wide application, which is fast developing and recognized as an effective solution for the long-term power supply in remote inland areas, island areas, and other areas far from the main grid. While compared with large reactors, SPWRs, especially those installed on the marine floating platforms and ships, exhibit the complex structures, compact arrangements, harsh external environments, and variable operating conditions. As a result, SPWRs show very complex dynamic characteristics and are difficult to control, causing higher probabilities of faults especially those occurring in control systems. In this study, deep learning-basedfault diagnosis methods for sensors and actuators in the control systems of SPWRs were proposed based on long short-term memory (LSTM) networksand temporal convolutional network (TCN), and an innovative labeled fault dictionary was established to map the complex fault modes. The established LSTM- and TCN-based fault diagnosis models can directly learn features from multivariable time-series data of SPWRs to realize the end-to-end fault diagnosis. Simulation test results on a SPWR fault dataset indicate that the developed LSTM- and TCN-based fault diagnosis models can effectively diagnose the locations, types, and extents of sensor and actuator faults during steady-state and transient operating conditions from raw time-series signals, with the average accuracies of 92.06% and 98.3%, respectively. All the faults can be diagnosed within an average time of 2.7s after their occurrences. Moreover, the model can also accurately predict the occurrence and location of the fault with a completely new degree that are not learned in the model training process. The comparison with the existing fault diagnosis methods based on support vector machine, backpropagation artificial neural network, and deep convolutional neural network demonstrates the superiority of the proposed deep learning-based fault diagnosis methods for SPWRs. Finally, the diagnosis results on the SPWR fault dataset injected with different noise signals demonstrate the strong noise immunity capability of the established fault diagnosis models. To verify the feasibility of hardware implementation and engineering application of proposed fault diagnosis methods, a hardware-in-the-loop testing scheme of fault diagnosis models based on PXI and Raspberry Pi was designed. The diagnostic results are consistent with those in the virtual simulation environment, which proves the generality, effectiveness and portability of the established deep learning-basedfault diagnosis models.Therefore, the obtained results confirm that the deep learning techniques are extremely suitable for fault diagnosis of SPWRs with complex structure and operational conditions, providing operators with reliable fault information and contributing to the improvement of plant safety.

Keywords

Small pressurized water reactors; Fault diagnosis; Sensor and actuator; Long short-term memory; Temporal convolutional network

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Biography

Pengfei Wang, Associate Professor, School of Energy and Power Engineering, Xi'an Jiaotong University, China. He received the Ph. D degree from the Xi'an Jiaotong University at 2016 for Nuclear Science and Technology. His research interests include the modeling, simulation, and control of nuclear power plants, intelligent fault diagnosis and autonomous control of nuclear power plants, operation optimization and coordinated control of integrated nuclear-renewable energy systems. He has published more than 30 SCI Journal papers, including 17 papers as first or corresponding author. He has received research grants from NSF and NKRDP of China and several companies.

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Sustainable Development of Green Small Hydropower (GSHP) under the Carbon Neutrality Goals: a Perspective from China

Abstract

Hydropower as the primary renewable resource among the world contributes to almost one-fifth of all electricity production in the world. Global development of the small hydropower has significantly outpaced the available scientific knowledge about its environmental impacts, leading to huge uncertainties in environmental management. Research on the sustainable development of small hydropower towards green small hydropower (GSHP) is of great significance for achieving many country's renewable energy strategic goals. This study reviews the development of the GSHP concepts, certification system, and the state of current credited GSHP in China. Specifically, we discussed the challenges of environmental flows assessment for GSHP as one of the most key environmental indicators. Investigations are also been devoted to the contributions of small hydropower to energy conservation and greenhouse gas emissions. At last, advices were given to the sustainable development of GSHP as vital renewable energy solution.

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Novel Electrode Design and Diagnostic in Water Electrolysis for Hydrogen Production

Abstract

Sustainable energy resources, including solar, wind, and tide etc., generate electricity intermittently, which lead to the challenges to supply continuous power to the current electrical grid. Therefore, a high-efficiency and robust electrochemical energy storage or conversion system coupled with the sustainable energy resources to accommodate seasonal, daily or even hourly changes becomes critical. Proton exchange membrane electrolyzer cells (PEMECs), which act as a reverse proton exchange membrane fuel cells, have been regarded as a very promising energy storage method for hydrogen production from water splitting. To reduce the loading and improve the utilization rate of the noble metal electrocatalysts for oxygen evolution reaction (OER), several methodologies have been proposed and demonstrated.

In this study, iridium (Ir) catalysts are proposed on novel titanium thin/tunable liquid/gas diffusion layers (TT-LGDLs) for serving as anode gas diffusion electrodes (GDEs) in high-efficiency PEMECs or Ir-based catalyst is deposited onto Nafion membrane to form a patterned electrode. Our previous studies revealed that the triple-phase boundary significantly affects the OER sites on catalyst layer in a PEMEC, and there is a large portion of catalysts is not effectively utilized. Therefore, a novel thin/tunable GDE is developed by depositing the catalyst on a tunable pattern that is observed to be active for the OER. The Ir loadings of the novel thin GDEs are varied from 0.027 to 1.307 mg/cm2, and their in-situ electrochemical properties are comprehensively investigated in a PEMEC. The PEMEC performance and efficiency can be improved with higher Ir loading, while the Ir catalyst mass activity increases for the sputter deposited GDEs and decreases for the electroplated GDEs with higher Ir loading. An electroplated GDE with lower Ir loading of only 0.208 mg/cm2 exhibits a high Ir mass activity of about 2.602 A/mg at 1.6 V. The stability of the GDEs is also examined and analyzed, and the lowest degradation rate that has been obtained is about 24.4 μV/h. The novel thin GDEs and the novel patterned electrode can remarkably improve the catalyst mass activity with an acceptable PEMEC performance by improving the catalyst efficiency with a very simple fabrication process and low cost. In addition, the novel thin GDEs significantly reduce thickness from hundreds of micrometers to only 25μm. This concept shows promise for the future electrodes development in low temperature and high efficiency PEMECs, which will help to greatly reduce the cost, thickness, and weight of the electrode itself and the system as a whole.

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The water-Energy Nexus in Public water Transport and Distribution Networks

Abstract

Hydropower traditionally covers the largest part of renewable energy production in the world, with a large range of nominal powers going from the 18 GW of the three-gorges plant in the Yangtze river (China) to the few kW produced by off-grid installations. It has a very high power density and very low dismantlement cost. The claimed environmental impact of Hydropower Plants (HP) refers only to the effect of water storage provided by dams or weirs and affecting the natural flow regime. Small flowing-water HP in rivers or reaction turbines installed along pipes provide zero environmental impact, are consistent with the general strategy of diffused energy production but need to cope with the problem of a flow rate strongly variable in time. Moreover, in aqueduct installations, or where the continuity of water service must be guaranteed, a set of expedients must be put in place, to allow the turbine to be by-passed and maintain the continuity of the water supplyeven during the failure of the national electric network. A commonly practiced plant solution is the construction of a turbine by-pass pipe, equipped with pipe cutting valves and pressure reducing valves or flow adjuster, as well as aUPS for the supply of monitoring equipment(hydraulic measuring instruments,PLC,SCADA,etc.), able to move also the engines of the electricvalves.

Although apparently simple, this solution leads to an increase in the complexity f the hydroelectric/ hydraulic plant, even with an increase in construction and management costs, which can be significant for small power plants.

Analternativesolution is the switch of the electricgenerator, in the case of electric network failure, from grid-connected to stand-alone condition,assuming the hydroelectric plant and the electrical equipment present insideit as an electric micro-grid, independent ofthenationalelectric network. This requires the dissipation of the exceeding power and can be done with both synchronous and asynchronous generators.

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Novel Engineered Ceramics for High Temperature Receivers of Concentrated Solar Radiation

Abstract
The solar absorber element is one of the main bottlenecks for Concentrating Solar Power (CSP) temperature increasing. The ideal sunlight absorber for high temperatures must possess a combination of good mechanical and chemical stability, high ratio between sunlight absorptance and thermal emittance, good thermo-mechanical properties.The talk is focused on the class of Ultra-High Temperature Ceramics (UHTCs), which include borides, carbides and nitrides of group IV and V and are characterized by the highest melting points of known materials, elevated temperature strength, oxidation resistance and other peculiar properties such as high thermal and electrical conductivity. This combination of excellent properties makes them the election materials for extreme applications. They were mainly investigated in the literature for military and aerospace applications, but our group proposed and extensively studied their use for solar applications from more than a decade. We proved their promising properties such as low thermal emittance and high spectral selectivity, identifying the relevant parameters and best strategies to optimize them [1-7].

Keywords
Concentrating Solar Power; Concentrating Solar Thermal; Ultra-High Temperature Ceramics; solar receiver; optical properties; borides.

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Biography
Elisa Sani, PhD. (ORCID ID: 0000-0001-9854-2892),Researcher at CNR-INO, Italy; Principal Investigator of Smart &Solar Energy Materials Laboratory (S2EMA Lab). Her research activity is focused on optical properties of materials, spanning from solids for high-temperature solar thermodynamic receivers, colloidal suspensions for mid-temperature solar thermal, optical property tailoring of surfaces, fundamental optical constants of liquids, nonlinear optical phenomena in liquids and colloids and solar-enabled hybrid power generation in different materials and by different effects. Dr. Sani co-authored 110+journal papers, 2 book chapters and holds 3 patents. She is Editorial Board member of the journalsScientific Reports, Energies, Applied Sciences, Energy Storage and Saving.

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Sustainable Geothermal Energy, the potentiality of the 3-E Approach Exergy, Exergo-economic, and Exergo-environmental

Abstract

Among renewables,geothermal energyhas the advantage of having the highest resource availability, not depending on weather conditions. Geothermal energy can be exploited for the production ofelectricity, heating, and cooling. This multi-scope characteristic enhances its prospective of utilization in the direction of aclean, sustainable future.

The sustainability of geothermal energy is a pivotal objective in relation to the meeting of the expected climate goals determined in the 2015 Paris agreement and in the recent COP26.

The purpose of this presentation is to demonstrate the potential of the exergy, exergo-economic, and exergo-environmental analyses (3E-Approach), to improve the performance of geothermal power plants.

Particularly, exergy analysis is exploited for thermodynamic optimization which includes the evaluation of the irreversibility of each component of a system.

The exergo-economic approach allows for the assessment of the trade-off between the construction costs and the cost related to the exergy destruction, providing a means to calculate the final costs of the products (e.g. electricity and/or heat) and the build-up of the cost throughout the process.

The exergo-environmental approach is identical in structure to the exergo-economic one, but differs from it, as it considers the environmental costs, which are obtained through a life cycle analysis study of the process, including normalization and weighting steps.

Hellisheidi power plant will be presented as a reference case study to demonstrate the potential of the 3-E analysis.

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Wall Impact on Efficiency of Packed-bed Thermocline Thermal Energy Storage System

Abstract

Packed-bed single-tank thermocline system is a lower cost alternative to the conventional two- tanks system for thermal energy storage. This work explores the wall impact on the thermocline behavior of packed-bed tanks. For this purpose, adapted transient numerical models were developed and fully exploited for the first time. Two tanks configurations were investigated and compared: a high-temperature pilot-scale tank with a steel wall and a low-temperature lab-scale tank with a polycarbonate wall, both tanks being insulated by mineral wool. Results showed that the maximum energy stored in the wall at fully charged state can be up to 10% of the total stored energy. The energy stored in the wall tank has a negative impact on the discharging efficiency, causing up to 15% increase of the thermocline thickness. Because the energy stored in the insulation is very small compared to the total energy stored, the insulation layer can be simplified as a thermal resistance in the model. The optimal wall parameters study for packed-bed TES tanks showed that a small thickness of the wall has to be preferred in order to improve the energy and exergy efficiencies. The findings of study could provide useful design guideline for pack-bed thermocline TES tanks for different industrial applications.

Keywords

Thermal energy storage, Packed-bed, Wall impact, Thermocline, Heat loss

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Adverse Power Quality Effects in Renewable Energy Systems

Abstract

Wordlwide, societies are suffering the already devastating effects of global warming and climate change. These are present in many forms, e.g atypical weather phenomena of inceasing intensity, in the form of powerful hurricanes, tornadoes, floods, droughts, massive kelp arrival on beaches, forest fires, sea and desert tsunamis, among others.

It is well documented that one of the main causes contributing to the ongoing fast earth warming and climate change is the generation of electrical energy using fossil fuels, e.g. in thermoelectric and carboelectric power plants. It has been acknowledged that a fast transition to renewable energy sources is imperative for the power generation worldwide in order to reduce the fast increasing effects of the environment pollution and to satisfy the increasing needs of growing societies in many different areas, such as industry, health, education, commerce, economy, trasportation, art, etc.

The gained experience on the electrical energy generation using renewable energy sources indicates that regardless of the undisputed benefit to the environment, their operation may be intermittent and could adversely affect power quality and at some extent the stability of the power grid to which they are connected to. This research centres on the analysis od different power quality adverse effects due to the operation of renewable energy sources. Wind generation systems are linked to the production of harmonics, interharmonics and flicker, whereas photovoltaic systems are associated with the presence of harmonics and interharmonics components. Besides, during the dynamic operation of reneawable energy systems other phenomena such as sags, swells, disturbances/ faults and temporary interruptions, among others, may take place.

This reseach work reports an analysis of power quality adverse effects during the operation of renewable energy systems. Harmonics, total harmonic distortion, electromagnetic transients, load transients and voltage sags are assessed. Details are given on the modeling of the wind generator (Type IV) and the photovoltaic array. The last model considers the maximum power point tracking controller, the voltage source DC/DC converter model with a pulse width modulation (PWM) controller, the DC/AC interconnection converter for single-phase and three-phase analysis with sinusoidal PWM controller. The case studies are validated against the PSCAD/EMTDC® simulator, widely accepted by the power industry.

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Biography

Aurelio Medina-Rios. Obtained the Ph.D. degree from the University of Canterbury, Christchurch, New Zealand, in 1992. He was a Postdoctoral Fellow of the University of Canterbury, New Zealand (one year; from 1992-1993), and the University of Toronto, Canada (two years; from 1993-1995). He joined the Facultad de Ingeniería Eléctrica, Universidad Michoacana de San Nicolás de Hidalgo (UMSNH), Morelia, in 1995. His research interests are in the analysis of power quality phenomena, dynamic and steady state analysis of power systems, renewable energy systems, and the applications of advanced numerical and computer techniques to power system analysis.

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Direct Steam Generation Solar Plants

Abstract

The continuous demographic growth, the growing industrialization of the least developed countries and the emergency of climate change, require reducing as much as possible the use of fossil sources and to increase the use of renewable energies. Among renewable energies, the most abundant is certainly solar energy. This energy is currently used to produce electricity, both through photovoltaic systems and through concentrated solar power plants. Among the latter, solar power plants with direct steam production have the advantage of using a single fluid (water) both as a heat carrier and as a working fluid of the thermodynamic cycle. The use of water for both scopes, in addition to avoiding a heat exchange, with a consequent exergetic advantage, also has environmental and economic advantages as the water is flooding, inexpensive, non-corrosive for the system and definitely ecological. This work describes the plant characteristics and the energy and environmental advantages of DSG (direct steam generation) solar power plants. The machines used for the expansion and production of work are also described. Finally, the current levels of efficiency and the prospects for future use of these plants are reported.

Keywords

Concentrated solar power, direct steam generation

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Biography

Associate Professor of Fluid Machines and Energy Systems at the Department of Industrial Engineering of the University of Naples “Federico II” since 2018. He was researcher at the same University since 2002. Currently lecturer in the courses of “Fluid Machines”, “Thermal generation plants”, “Thermo mechanical Technologies for the Energy Transition”, for students in Mechanical Engineering and the course of “Elements of Fluid Machines” for students in Electrical Engineering.

Author of more than 100 scientific publications all of which can be written in the sectors: - Energy Efficiency; - Renewable Energy: Solar energy, thermodynamic cycles for CSP, thermal photovoltaic systems; - Systems for the abatement of gaseous pollutants: scrubber for desulphurization of exhaust gases.

He is currently engaged in research activities concerning the production of electricity from solar sources, with particular reference to concentrating solar power (CSP) plants and those with direct steam generation.

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High Spatial-Temporal Imaging of Carrier Transport and Energy Flow Dynamics

Abstract

Charge carrier transport properties and energy flow dynamics are key to the performance of various optoelectronic devices. For example, the ability of photogenerated excitons to move to the donor-acceptor interface is crucial for photovoltaic applications. Driving force of the separation of electron and hole at the micro-nano scale device interface is key to device performance.Ultrafast charge carrier dynamics have been extensively studied by ultrafast spectroscopy. However, most of the previous works are based on ensemble measurements. Carrier transport in nanostructures and energy flow at nano/micro scale interfaces remain obscured.We developed home-built high spatial-temporal imaging technique and have achieved simultaneous high spatial precision (20nm) and temporal resolution (200 fs). With our novel method, we directly visualized competition between electron transport and electron-phonon coupling in metal thin films. We also observed transport behavior of the optically dark exciton in organic nanocrystals and unraveled novel cooperative exciton transport mechanism.Ultrafast charge transfer rate on 2-3 ps timescale, and energy transfer rate on ~40 ps timescale are observed at a 2D-organic heterostructureinterface. Interlayer excitons with high transport rates are found to facilitate charge separation at the nanointerface. This spatial-temporal imaging method can be well extended to other photon-electron conversion systems.

Keywords

High spatial-temporal resolution imaging, exciton transport, charge carrier dynamics, electron transfer, ultrafast pump-probe

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Biography

Tong Zhu is a full professor at Lab of Laser Micro/Nano Fabrication, School of Mechanical Engineering, Beijing Institute of Technology. She also serves as the associate chair of Manufacturing Engineering Department at BIT. Her research focused on imaging charge carrier dynamics and transport by high spatial-temporal resolution imaging techniques as well as manipulating electron dynamics during ultrafast laser micro/nano fabrication. She earned her Ph.D. at Purdue University, United States in 2017, followed with postdoctoral experience before joining the BIT faculty. Prof. Zhu authored high quality academic articles such as Science Advances, Nature Chemistry, Advanced Materials, ACS Energy Letters, Accounts of Chemical Research, etc. She is now serving as reviewer of multiple ACS and Elsevier publications, as well as guest editor of the journal Materials.

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