中国科学院上海应用物理研究所
Shanghai Institute of Applied Physics, Chinese Academy of Sciences

Nuclear-Energy Comprehensive Utilization Center

# 2024 International Symposium on High-Temperature Ceramic Cells

# CONFERENCE BROCHURE

June 25th-27th, 2024
No.2019 Jia Luo Road, Shanghai

# CONTENTS

**Shanghai Institute of Applied Physics,**
**Chinese Academy of Sciences**

Established in 1959 and formerly known as Shanghai Institute of Nuclear Research before June 2003, Shanghai Institute of Applied Physics (SINAP), Chinese Academy of Sciences is a national institute of comprehensive nuclear science and technology. It has two campuses, located in the Jiading district of Shanghai (27 hectares), a key supporting area for the Shanghai Technology Innovation Center, and Wuwei (67 hectares), the hub of the famous Silk Road in ancient Chinese history in Gansu Province.

The main research fields of SINAP include advanced energy science and technology, represented by Thorium molten salt reactor nuclear energy system (TMSR), efficient energy storage and conversion, as well as the application of nuclear technology in the environmental, health and materials fields.

SINAP is responsible for the Thorium-based Molten-Salt Reactor (TMSR) nuclear energy system, one of the Chinese Academy of Sciences' Strategic Priority Research Programs. The goal is to develop the fourth-generation fission reactor nuclear energy system and thorium-uranium cycle technology, with industrial applications within 20 years.

SINAP led the establishment of the Innovation Academy for Advanced Nuclear Energy, CAS. It also has the Key Laboratory of Interfacial Physics and Technology, Chinese Academy of Science, and Shanghai Key Laboratory of Cryogenics and Superconducting RF Technology.



SINAP launched China's first nuclear power project "Project 728". The initial goal of the project was to build a 25 MWe TMSR. Constrained by the state of the art at the time, the goal was changed after the construction of a zero-power molten salt reactor in 1971, and a 300 MWe pressurized water reactor (Qinshan NPP-I) was built in 1973, which has been operating since 1991.

SINAP established the Shanghai Synchrotron of Radiation Facility (SSRF), the largest research project in China at that time. It is a high-performance light source for the third generation of median electron energy, and a groundbreaking ceremony was held on December 25, 2004 for the project proposed and supported by the Chinese Academy of Sciences and the Shanghai Municipal Government. The project was completed on schedule in April 2009, and has been effectively operated by SINAP for 10 years.

Over the years, SINAP scientists have made over 600 scientific achievements, more than 200 of which have been awarded by the nation, Chinese Academy of Sciences or Shanghai city. Typical examples include the 1.4 m cyclotron, on which 202Pt was synthesized, a Chinese breakthrough in new nucleotide synthesis and identification; the world's first mini cyclotron mass spectrometer; and 67Ga-labeled citrate, which is the first radiopharmaceutical in Chinese Pharmacopeias; three achievements in the field of heavy ion physics and one in bioanalytical chemistry, which won the second prize of the State Natural Science Award; and the SSRF, which won the first prize of the State Scientific and Technological Progress Award.

SINAP has always attached great importance to academic exchanges and cooperation with international communities of science and technology. It has established collaborations with a number of the world's leading research institutions, including Diamond and UMAN of UK;PSI of Switzerland; BESSY-II of Germany; ELETTRA and INFN of Italy; Japanese institutions of SPring-8, KEK; PLS of South Korea; SSLS of Singapore; ANSTO of Australia; Laboratories of DOE,USA; CNL of Canada; MUCTR & NRC-KI of Russia; ICSI of Romania; POLOMI of Italy; KIT of Germany; IAEA in Austria; DNI of England; EMDIDI of Ethiopia; IETP KazNU & INP of Kazakhstan and RISP/IBS of Korea etc..

SINAP sponsors and edits academic journals Nuclear Techniques (in Chinese), Nuclear Science and Techniques (in English), and Radiation Research and Radiation Processing (in Chinese). Shanghai Nuclear Society, Radiation Research and Radiation Processing Society under Nuclear Society of China, with its headquarters in SINAP.

## 2024 International Symposium on High-Temperature Ceramic Cells

High-temperature ceramic cell technology is pivotal in the conversion and storage of renewable energy sources. In a concerted effort to foster collaboration and advancement in this crucial field between China, South Korea, Australia, and Germany, the 2024 International Symposium on High-Temperature Ceramic Cells, hosted by the Shanghai Institute of Applied Physics (SINAP), Chinese Academy of Sciences, will be held on June 25th to 27th, 2024.

This symposium will serve as a platform to delve into the multifaceted opportunities and challenges within the high-temperature ceramic cell domain. Through academic exchanges, our primary aim is to facilitate interdisciplinary integration, drive technological innovation, and catalyze the development of novel materials and systems. Moreover, this event seeks to bolster communication and collaboration between China, South Korea, Australia, and Germany, fostering mutually beneficial partnerships across industry, academia, and research sectors. By deepening resource coordination and integration, we endeavor to make significant strides towards energy transformation and sustainable development goals.

CONVENERS:

Guntae Kim
Researcher

Jianqiang Wang
Researcher

Linjuan Zhang
Researcher

LOCATION:
The Jiading Campus of the Shanghai Institute of Applied Physics,
Chinese Academy of Sciences.
No.2019 Jia Luo Road, Shanghai



INVITED EXPERTS:

| Name | Work Unit |
|---|---|
| Suk Won Cha | Professor, Seoul National University |
| Jeong Woo Han | Professor, Seoul National University |
| Ikwhang Jang | Professor, Wonkwang University |
| Jaeha Myung | Professor, Incheon National University |
| WooChul Jung | Professor,<br>Korea Advanced Institute of Science and Technology |
| Taeho Shin | Dr. /Executive Director,<br>Korea Institute of Ceramic Engineering and Technology |
| Jong-Eun Hong | Principal Researcher, Korea Institute of Energy Research |
| Songho Choi | Vice President, MiCo Power |
| Francesco Ciucci | Professor, University of Bayreuth |
| Zongping Shao | Professor, Curtin University |
| Guoxiong Wang | Professor, Dalian Institute of Chemical Physics, CAS |
| Chusheng Chen | Professor, University of Science and Technology of China |
| Fei Song | Researcher, Shanghai Synchrotron Radiation Facility |
| Chengxin Li | Professor, Xi’an Jiaotong University |
| Shaorong Wang | Professor, China University of Mining and Technology |
| Tao Li | Professor, Southeast University |
| Hao Ren | Editor, Wiley Journals |
| Yu Chen | Professor, South China University of Technology |
| Yan Chen | Professor, South China University of Technology |
| Bote Zhao | Professor, South China University of Technology |
| Yunfei Bu | Professor,<br>Nanjing University of Information Science and Technology |

**AGENDA:**

| Day 1 Tuesday (June 25, 2024) | | |
|---|---|---|
| All day | Registration | |
| 6:00pm-9:00pm | Dinner | |
| **Day 2 Wednesday (June 26, 2024)** | | |
| Time | Speaker | Title |
| 9:00am-9:10am | Welcome & opening | |
| 9:10am-9:30am | Zongping Shao | New Progress in Protonic Conductor Based on Grain Boundary Diffusion |
| 9:30am-9:50am | Suk Won Cha | Application of Sputtering Process for Solid Oxide Fuel Cell Fabrications for Low Temperature Operation |
| 9:50am-10:10am | Guoxiong Wang | Metal/Perovskite Interface for $CO_2$ and $CH_4$ Electrolysis |
| 10:10am-10:30am | Tea break | |
| 10:30am-10:50am | Jeong Woo Han | Low Temperature Exsolution: Mitigating Sintering for Enhanced Reactivity and Stability |
| 10:50am-11:10am | Chengxin Li | Numerical Analysis of Segmented-in-Series Tubular Solid Oxide Fuel Cells and its Performance |
| 11:10am-11:30am | Ikwhang Chang | Electrochemical Impedance Spectroscopy for Fast Diagnosis Using AI |
| 11:30am-1:00pm | Lunch time | |
| 1:00pm-1:20pm | Jong-Eun Hong | Utilization of Ammonia in Solid Oxide Fuel Cells |
| 1:20pm-1:40pm | Tao Li | From Biomass to Power - Study on Biomass Gasification Coupled with SOFC |
| 1:40pm-2:00pm | Fei Song | High-Energy-Resolution Spectroscopy in E-Line SSRF and Applications in Energy Materials Science |
| 2:00pm-2:20pm | Tea break | |
| 2:20pm-2:40pm | Shaorong Wang | Introduction of SOC Research Activity in CUMT |
| 2:40pm-3:00pm | Songho Choi | Various Technical Approaches for SOC (Solid Oxide Cell) Applications in MiCo Power |
| 3:00pm-3:20pm | Yan Chen | Electrochemical Conversion of Biomass Derived Products |
| 3:20pm-3:40pm | Tea break | |
| 3:40pm-4:00pm | Yunfei Bu | Engineering Low-Dimensional Heterostructure Oxide Electrodes for Efficient Energy Conversion and Storage |
| 4:00pm-4:20pm | Bote Zhao | Dynamic Catalyst Design |
| 4:20pm-4:40pm | Guntae Kim | Advancements in Metal-$CO_2$ Systems for Sustainable Carbon Capture and Conversion Technologies |
| 4:40pm-6:00pm | Visiting activity (SINAP) | |
| 6:00pm-9:00pm | Banquet | |



| Day 3 Thursday (June 27, 2024) | | |
|---|---|---|
| Time | Speaker | Title |
| 8:30am-8:40am | Welcome & opening | |
| 8:40am-9:00am | Jianqiang Wang | Research Progress of Nuclear Energy High-Temperature Electrolysis for Hydrogen Production |
| 9:00am-9:20am | Taeho Shin | New Strategies for Boosting SOCs Performance at KICET |
| 9:20am-9:40am | Chusheng Chen | All-Ceramic Solid Oxide Cells for Efficient Separation of Oxygen from Air |
| 9:40am-10:00am | Tea break | |
| 10:00am-10:20am | Jaeha Myung | Controlling the Exsolution Mechanism for Diverse Applications |
| 10:20am-10:40am | Yu Chen | Efficient Catalysts for Protonic Ceramic Fuel Cells Using Ammonia |
| 10:40am-11:00am | WooChul Jung | An Ideal Surface Reveals How Active It Is and Why It Degrades: Atomically-flat $SrTi_{0.5}Fe_{0.5}O_{3-\delta}$ Model Thin Film – a Case Study |
| 11:00am-11:20am | Tea break | |
| 11:20am-11:40am | Hao Ren | Publishing with Wiley In-House Chemistry Journals |
| 11:40am-12:00am | Francesco Ciucci | Cobalt-Free Air Electrodes for Protonic Ceramic Cells |
| 12:00am-1:00pm | Lunch time | |
| 1:00pm-3:40pm | Visiting activity (Qingcheng Company) | |
| 3:40pm-3:50pm | Closing remarks | |
| Attendees leaving | | |

**Zongping Shao**
**Professor**
**Curtin University**

Prof. Shao is currently a John Curtin Distinguished Professor at Curtin University, Australia, he has experience in ceramic fuel cell research for more than 20 years, up to , he has published more than 800 peer-reviewed papers with a total citations of > 70 K, a H-index of 130, with five papers in Nature, 1 in Science.

### New Progress in Protonic Conductor Based on Grain Boundary Diffusion

Protonic ceramic fuel cells have received considerable attention due to their advantages for operating at reducing temperature with higher efficiency. During the past, the proton was believed to be introduced through hydration of oxygen vacancies in perovskite lattice. Recently, we demonstrated that another way for introducing proton through hydrogenation of metal ions. In this report, we will mainly discuss a new mechanism of proton introduction through hydrogenation of oxygen at grain boundary based on TOF-SIMS and HR-TEM. We further report superior cell performance as achieved for the cell based on such new electrolyte. Such new findings may inspire new research direction for SOFCs.

**Suk Won Cha**
**Professor**
**Seoul National University**

2004 - Ph.D. in Mechanical Engineering, Stanford University
2005 - Professor, Dept. of Mech. Eng., Seoul National University
2023 - President, Advanced Institute of Convergence Technology, Seoul National University
2022 - Editor-In-Chief, International Journal of Precision Engineering and Manufacturing - Green Technology
2024 - General Member, National Academy of Engineering of Korea

### Application of Sputtering Process for Solid Oxide Fuel Cell Fabrications for Low Temperature Operation

We demonstrate a metal supported thin film SOFC fabricated by PVD process. We developed a pore-controlled metal support for extremely thin SOFC MEA. Especially, YSZ-GDC bilayer thin film electrolyte was applied to contribute to the electrochemical performance improvement of the fuel cell. In addition, detailed analysis including crystallinity and thermal stability were conducted.

**Guoxiong Wang**
**Researcher**
**Dalian Institute of Chemical Physics, CAS**

Guoxiong Wang is a professor at Dalian Institute of Chemical Physics, Chinese Academy of Sciences. In 2000 and 2006, he received his bachelor's degree at Wuhan University in 2000 and Ph. D degree at Dalian Institute of Chemical Physics, Chinese Academy of Sciences in 2006. After postdoctoral research in Catalytic Research Center of Hokkaido University, Japan for three and half years, he came back to Dalian Institute of Chemical Physics, Chinese Academy of Sciences. His research interests focus on the electrocatalytic conversion of carbon-based small molecules such as $CO_2$, CO and $CH_4$ to fuels and chemicals, including catalyst design and preparation, electrochemical in-situ dynamic characterization, electrolytic devices and technologies, etc.

## Metal/Perovskite Interface for $CO_2$ and $CH_4$ Electrolysis

Solid oxide electrolysis cell (SOEC) is promising in $CO_2/CH_4$ conversion and renewable clean electricity energy storage. Perovskite-type oxides have the advantages of excellent doping ability, carbon deposition resistance and redox stability. However, the application of perovskite electrodes is limited due to insufficient electrocatalytic activity. Herein, we propose a strategy to promote exsolution of RuFe alloy nanoparticles on $Sr_2Fe_{1.4}Ru_{0.1}Mo_{0.5}O_{6-\delta}$ perovskite by enriching the active Ru underneath the perovskite surface via repeated redox manipulations. SOEC with RuFe@$Sr_2Fe_{1.4}Ru_{0.1}Mo_{0.5}O_{6-\delta}$ interfaces shows over 74.6% enhancement in current density of CO2 electrolysis compared to that with $Sr_2Fe_{1.4}Ru_{0.1}Mo_{0.5}O_{6-\delta}$ counterpart as well as impressive stability for 1000 h at 1.2 V and 800 °C. Furthermore, through the fine-tuning of average exsolution energy of the B-site components, high-density CoFe alloy nanoparticles are exsolved on the surface of $La_{0.6}Sr_{0.4}Ti_{0.3}Fe_{0.5}Co_{0.2}O_{3-\delta}$ anode after reduction, which shows superior anodic $CH_4$ reforming performance with the $CH_4$ conversion of 86.9% and CO selectivity of 90.1% at 800 °C. Moreover, stable operation over 1250 h with a CO selectivity above 95% is achieved. The electrical energy consumption for CO decreases from 3.46 kWh $m^{-3}$ for conventional SOEC to 0.31 kWh $m^{-3}$ for $CH_4$-assisted SOEC.

**Jeong Woo Han**
**Professor**
**Seoul National University**

Education
Ph.D. Chemical & Biomolecular Engineering, Georgia Tech, 2010
M.S. Chemical Engineering, Carnegie Mellon Univ., 2007
B.S. Chemical & Biological Engineering, Seoul Nat'l Univ., 2005

Experience
2023~Present: Associate Professor, Vice Head of Research Affairs/BK21, Department of Materials Science and Engineering, Seoul Nat'l Univ.
2018~2023: Associate/Full Professor/Mueunjae Chair Professor, Department of Chemical Engineering, POSTECH
2022~2023: Visiting Professor, SUNCAT Center for Interface Science and Catalysis, SLAC National Accelerator Laboratory & Stanford Univ.
2021~Present: Associate Editor, Korean Journal of Chemical Engineering (Springer)
2020~Present: Member, Young Korean Academy of Science and Technology (Y-KAST)
2017~Present: Editor, Molecular Catalysis (Elsevier)
2012~2018: Assistant/Associate Professor, Department of Chemical Engineering, University of Seoul
2010~2012: Postdoctoral Associate, Department of Nuclear Science and Engineering, MIT



## Low Temperature Exsolution: Mitigating Sintering for Enhanced Reactivity and Stability

Exsolution, a process wherein metal nanoparticles are liberated from ceramic hosts under specific reduction conditions, leads to the establishment of distinctive interfaces between the exsolved metals and perovskite hosts. These nanoparticles integrate with the surfaces, either through embedding or forming new chemical bonds. They not only furnish numerous catalytic active sites uniformly across the oxide surface but also demonstrate robust thermal and redox stability. Our ongoing research focuses on Pt exsolution catalysts supported by $LaFeO_3$ perovskite, which exhibit remarkable stability, particularly in demanding environments like high-temperature water gas shift reactions. Structural analyses have revealed a significant retention of dispersion in the exsolved particles, indicating an advantage in preventing metal sintering. To probe how exsolution particles maintain stability during reactions, we conducted various analyses, examining factors such as differences in intermediates, reaction pathways, and reactant sensitivity. Our ultimate aim is to pinpoint the reasons behind reduced coking tendencies. These findings underscore the exceptional stability of exsolution particles in high-temperature water gas shift reactions and emphasize potential benefits in water or hydrocarbon-based reactions. Notably, their potential incorporation into Solid Oxide Fuel Cell (SOFC) electrode research holds promise for addressing challenges like metal particle agglomeration and coking.

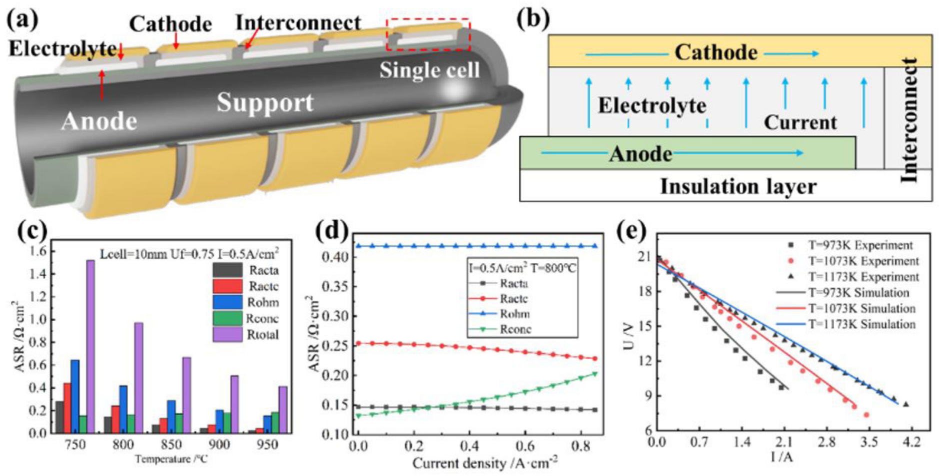
**Chengxin Li**
**Professor**
**Xi'an Jiaotong University**

Prof. Cheng-Xin Li is the chief of the National Key Research and Development Program of China, Deputy Director of the Engineering Research Center for Energy Storage Materials and Devices of the Ministry of Education, Director of the Xi'an International Joint R&D Center for Advanced Functional Coatings Technology. He was a visiting scholar at the Georgia Institute of Technology in the United States. He has focused on basic research in protective coatings and functional coatings and their applications in solid oxide fuel cells. He has published more than 200 papers, which have been cited over 10,000 times with an H-index 57. He has also applied for over 30 invention patents.



## Numerical Analysis of Segmented-in-Series Tubular Solid Oxide Fuel Cells and its Performance

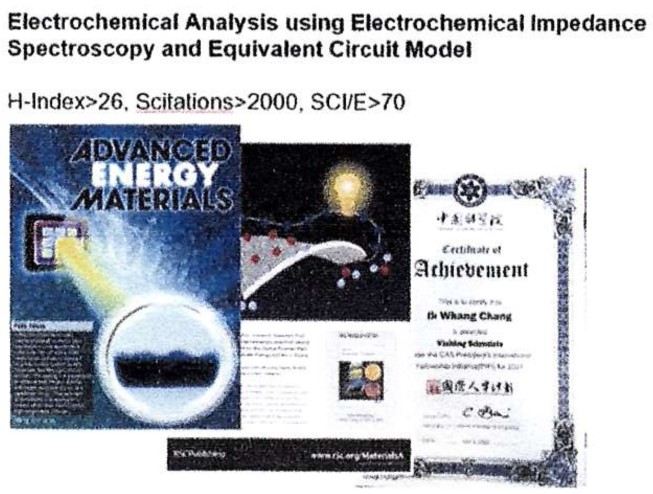
Tubular solid oxide fuel cells (SOFC) have the characteristics of high temperature and high pressure resistance, making them suitable for large-scale stacking. It is necessary to establish three-dimensional or simplified models to study the geometric structure, polarization characteristics and temperature distribution of tubular SOFCs. Based on the series structure characteristics and gas flow characteristics of the existing tubular SOFC, a one-dimensional steady-state model was established to analyze and optimize the performance influencing factors of the tubular cell from the micro-scale and macro-scale respectively. Aiming at the multi-series series structure of tubular cells, the study takes the power generation units composed of a single cell and a interconnect as the research object. It is found that there are various design schemes for tubular cells under a fixed battery tube length, and the optimal number of units is determined. Under the condition of a certain length, the output power of the cell can be effectively improved by changing the number of units, which provides a theoretical basis for the design. The study also gives the average output characteristics of a single cell in a hundred-watt-level cell under multiple working conditions and the temperature distribution of a single-tube cell under the same flow, which will provide basis data support for the future operation of cell tube and kW-level stacks.




Graphical Abstract (a) SIS tubular SOFC, (b) Schematic of current path, (c) the proportions of each type of polarization loss under different temperature, (d) the the proportions of each type of polarization loss under different current density, (e) the comparison between calculated and experimental results.

**Ikwhang Jang**
**Professor**
**Wonkwang University**

Associate professor, Mechanical Engineering @ Wonkwang University
Ph.D. Mechanical Engineering @ Seoul National University
Post-Doc, Fellow @ Georgia Institute of Technology
Post-Doc, Fellow @ McGill University




### Electrochemical Impedance Spectroscopy for Fast Diagnosis using AI

Various electrochemical systems are required for diagnosis for an optimal operation, a lifetime prediction and a failure confirmation. To identify system conditions, the measurement time should be sub-minutes of 1 min. In this presentation, several cases will be introduced.



**Jong-Eun Hong**
**Principal Researcher**
**Korea Institute of Energy Research**

2016~current :
Principal Researcher, Korea Institute of Energy Research (KIER)
2021~current :
Associate Professor, University of Science and Technology (UST)
2014~2016 :
Research Fellow, University of Birmingham

### Utilization of Ammonia in Solid Oxide Fuel Cells

Direct ammonia fueled solid oxide fuel cells (DA-SOFCs) have been attracting much attention to achieve high efficiency power generation with zero $CO_2$ emission. An effective way to utilize DA-SOFCs will be introduced in terms of materials development and elucidation of electrochemical behavior.

**Tao Li**
**Professor**
**Southeast University**

Tao Li is a professor of power engineering in the School of Energy and Environment, Southeast University. He got his PhD degree from Imperial College London in 2015 and joined Southeast University in 2021. His research interests include ceramic fuel cell/electrolyzer, membrane reactors, gas separation, $CO_2$ capture and conversion, etc. He has published over 55 research articles and is now the PI of more than 10 projects.

### From Biomass to Power - Study on Biomass Gasification Coupled with SOFC

The biomass gasification coupled with SOFC provides an efficient route for power generation from solid waste. However, some problems remain such as syngas possesses a complex composition including a high concentration of inert gases, coking, etc. This study developed a multi-channel, hierarchical structural design based on the commercial NiO-YSZ material system, realizing high-performance power generation. Coking mechanism was investigated using FIB-SEM assisted with model based on generative adversarial network (GAN). Finally, a kilowatt system was assembled, demonstrating stable power generation from direct utilization of gasification syngas.



**Fei Song**
**Researcher**
**Shanghai Synchrotron Radiation Facility**

Fei Song is a professor and a doctoral advisor at SARI, has received funding through high-level talent programs. He obtained his Ph.D. jointly from Zhejiang University and Aarhus University in Denmark, and later conducted postdoctoral research at the Norwegian University of Science and Technology and the University of Groningen in the Netherlands. His main research interest is the development of high-resolution synchrotron-based X-ray spectroscopy. Based on this, he has carried out detailed characterization of atomic/electronic structures at interface in low-dimension materials and property correlations, particularly focusing on the construction of novel nanostructures and defect regulation. He has undertaken general projects and major plan cultivation projects from the National Natural Science Foundation of China (NSFC), and the key research and development projects from the Ministry of Science and Technology.

### High-Energy-Resolution Spectroscopy in E-Line SSRF and Applications in Energy Materials Science

Energy Materials Beamline (E-line) is one of the most representative beamlines in the Shanghai Synchrotron Radiation Facility (SSRF), with the photon energy covering both the soft and hard X-ray range. Equipped with unique spectroscopic methodologies, E-line primarily focuses on key scientific issues in the field of energy materials, such as the influence and regulation of the electronic structures and fine atomic structures at interface and bulk on the structure-property relationship during energy conversion processes, including the accurate identification of interfacial active sites under *in-situ*/operando conditions, the real-time tracking of reaction processes, and so on.

**Shaorong Wang**
**Professor**
**China University of Mining and Technology**

Shaorong Wang is a professor and doctoral advisor at China University of Mining and Technology. He is a Jiangsu Provincial Double Innovation Talent and the chief of an innovation team. He is also a member of the Hydrogen Energy Professional Committee of the China Renewable Energy Society, a council member of the Solid State Ionics Branch of the Chinese Ceramic Society, and a member of the Fuel Cell Standards Committee. Professor Wang has been working in the field of solid oxide fuel cells/electrolyzer cells (SOFC/EC) for nearly 30 years, has published over 160 academic papers, applied for more than 50 national invention patents, and authored two monographs.

## Introduction of SOC Research Activity in CUMT

China University of Mining and Technology (CUMT) has been conducting significant work on solid oxide cells (SOC), focusing on materials and cell structure optimization, includes the optimization of preparation processes and fundamental research on the applications of both power generation and electrolysis.

**Songho Choi**
**Vice President & COO**
**MiCo Power Co.**

Songho Choi, the vice president of MiCo Power, is in charge of the technology development and business creation of SOFC and SOEC.

He graduated from the Georgia Institute of Technology in USA, with a Ph.D. in MSE.

He has also professionally served as a vice president of the Korean hydrogen & new energy society, a vice president of the Korean ceramic society, and a committee member of Korea gas safety code board (MOTIE).

## Various Technical Approaches for SOC Applications in MiCo Power

In this presentation, various technical progress and approaches including long-term reliability test, system integration, and manufacturing process for mass production for commercial SOFC systems will mainly be introduced and discussed.

**Yan Chen**
**Professor**
**South China University of Technology**

Yan Chen is a professor at the School of Environment and Energy at South China University of Technology. She received her B.S. and M.S. from Peking University, and Ph.D. from the Massachusetts Institute of Technology. Prior to her current position, she worked as a postdoctoral fellow at MIT. Her research focuses on the recycling and utilization of carbon-containing derivatives from solid wastes. In the past five years, she has published 42 corresponding author papers (8 ESI highly cited papers) in well-known journals such Nat. Commun(3), Angew. Chem. Int. ed., Energ. Environ. Sci.(2), ACS Catal., Adv. Funct. Mater., and worked as the principal investigator for the National Key Research and Development Plan Young Scientist Projects, and won the "Young Scientist Award" of the International Solid State Ionics Association. Other information please see group website: www2.scut.edu.cn/yanchen

## Electrochemical Conversion of Biomass Derived Products

Biomass energy, as a clean and sustainable energy source with reserves equivalent to fossil fuels, has received widespread attention. The technology of using electrocatalytic biomass refining to convert low-carbon organic small molecules derived from biomass (such as glycerol, 5-hydroxymethylfurfural, ethylene glycol, etc.) into fuel and raw material chemicals has broad prospects in alleviating fossil fuel consumption and reducing environmental pollution. From a systemic perspective, this reaction is a complex system with a cross scale structure that integrates multiple physical and chemical processes such as electron, ion, proton coupling transfer, and multiphase interface mass transfer. The reporter regulates the anionic characteristics (defect concentration, defect migration, etc.) in transition metal compounds to improve the adsorption and desorption, chemical bond activation, and selective cleavage of reactants, providing theoretical guidance for the rational design and regulation of biomass platform molecular catalytic activity based on material structure.

**Yunfei Bu**
**Professor**
**Nanjing University of Information Science and Technology**

Dr. Bu Yunfei, Professor, Doctoral Supervisor, Distinguished Professor of Jiangsu Province, and Member of the Fuel Cell Committee of the China Energy Research Society. From 2013 to 2015, he was at the Georgia Institute of Technology as assistant researcher, and from 2016 to 2018, he worked as a Postdoctoral Researcher at the Ulsan National Institute of Science and Technology (UNIST) in South Korea. In September 2018, he joined Nanjing University of Information Science and Technology as a Youth Professor and was promoted directly to Professor in July 2019. In 2020, he established the UNIST-NUIST Energy and Environment Joint Laboratory (UNNU).

His research areas include fuel cells/electrolyzers, electrocatalysis, and carbon dioxide reduction. He has published over 100 SCI papers in relevant fields, with 56 as the first author or corresponding author (among which 28 have an impact factor greater than 10) in well-regarded international journals such as Nature Communications, Angewandte, Advanced Materials, Advance Energy Materials, Advance Functional Materials, ACS Catalysis, and ACS Nano. He has led projects funded by the National Natural Science Foundation of China, both at the general and youth levels, the Jiangsu Provincial Youth Natural Science Foundation, and the China Postdoctoral Science Foundation. In 2020, he was awarded the Jiangsu Energy Research Society Young Energy Science and Technology Award.

## Engineering Low-Dimensional Heterostructure Oxide Electrodes for Efficient Energy Conversion and Storage

As the global pursuit for sustainable energy solutions intensifies, the development of efficient, low-cost electrode materials has become imperative.[1] Complex oxides, due to their cost-effectiveness and strong catalytic efficiency, have been extensively employed in fields such as high-temperature solid oxide fuel cells, metal-air batteries, and water electrolysis. In this regard, our research group has focused on the engineering of low-dimensional heterostructure oxide electrodes, aiming to further enhance the efficiency of energy conversion and storage. Employing techniques such as nanostructure engineering, doping, and surface modification, we successfully optimized the structure and performance of the electrodes, achieving higher electronic and ionic conductivity along with enhanced catalytic activity.[2-5] The presenter will summarize the significant achievements of our research group over the past three years, showcasing through experimental data and application case studies the remarkable progress made in energy conversion efficiency and storage stability with the optimized electrodes.[6] Our research demonstrates that engineering optimization of low-dimensional heterostructures significantly improves the performance of complex oxide electrodes, providing robust support for efficient energy conversion and storage. Our work offers valuable references for the broad application of complex oxide electrodes in the energy sector, and also provides precious insights for the future directions in electrode design and the research and development of energy conversion and storage technologies.

Reference:
1. Nature Catalysis, 2019, 2, 571–577.
2. Advanced Functional Materials, 2023, 202213523
3. Advanced Energy Materials, 2023, 202302384
4. ACS Materials Letters, 2023, DOI: 10.1021/acsmaterialslett.3c00132.
5. Applied Catalysis B: Environmental, 2023, 325, 122323.
6. Chemical Engineering Journal, 2022, 138710.

**Bote Zhao**
**Professor**
**South China University of Technology**

Bote Zhao is currently a professor at the School of Environment and Energy, South China University of Technology, China. He was a research scientist at the School of Materials Science and Engineering, Georgia Institute of Technology, USA. He received his B.S. and Ph.D. degrees from Nanjing Tech University, China, and continued his career as a postdoctoral fellow at Georgia Institute of Technology, USA. His research interests include the rational design, synthesis and in-situ/operando characterization of advanced materials for efficient energy storage and conversion.
To date, he has authored more than 110 publications in peer-reviewed journals, with >12000 citations and an h-index of 64. He has been recognised as a Clarivate Highly Cited Researcher (2022, 2023) and an Energy & Fuels Rising Star (2022). He has served as a technical or adjudicative reviewer for more than 70 journals (> 500 times).

## Dynamic Catalyst Design

The electrocatalyst exhibits dynamic behavior, which presents both challenges and opportunities. Skillful integration of this dynamic feature into its design could lead to the achievement of ultrahigh activity, benefiting SOC and other catalytic applications.

**Guntae Kim**
**Researcher**
**Shanghai Institute of Applied Physics,**
**Chinese Academy of Sciences**

Prof. Guntae Kim is currently a professor at SINAP (Shanghai Institute of Applied Physics, Chinese Academy of Sciences). He has extensive research experience in the field of Solid Oxide Fuel Cells (SOFCs) and Solid Oxide Electrolyzer (SOE). He has published more than 150 esteemed papers and holds over 100 patents in this field. Recently, he has been actively conducting research related to the hydrogen economy, including Metal-$CO_2$ Batteries and Ammonia Electrolysis Systems, with over 20 technology transfers related to these areas.

## Advancements in Metal-$CO_2$ Systems for Sustainable Carbon Capture and Conversion Technologies

Carbon capture and utilization (CCU) technologies provide a promising solution for addressing climate change while advancing sustainable development. By capturing $CO_2$ from various sources such as industrial emissions, direct air capture, and biogenic sources, CCU converts it into valuable products like fuels, chemicals, and building materials. This approach not only reduces greenhouse gas emissions but also fosters new economic opportunities and supports a circular carbon economy. In this study, we introduce metal-$CO_2$, an innovative system that effectively uses carbon dioxide ($CO_2$) to produce a variety of eco-friendly and economically viable products, including hydrogen, electricity, and carbonates. This breakthrough represents a significant advancement in combating climate change and fostering a more sustainable future.

**Jianqiang Wang**
**Researcher**
**Shanghai Institute of Applied Physics,**
**Chinese Academy of Sciences**

Prof. Wang is full professor and director of Key Laboratory of Interfacial Physics and Technology, Shanghai Institute of Applied Physics, Chinese Academy of Sciences. Prof. Wang's research expertise and scholarly activities focus on energy conversion and storage, such as hydrogen production by water electrolysis, molten salt chemistry, X-ray absorption technique.



## Research Progress of Nuclear Energy High-Temperature Electrolysis for Hydrogen Production

High temperature electrolysis (HTE) system can efficiently utilize the electrical and thermal energy generated by nuclear power plants to prepare carbon-free hydrogen, which can be supplied to applications such as metallurgy, chemical, electricity, and transportation industries.

Therefore, Shanghai Institute of Applied Physics (SINAP), Chinese Academy of Sciences, has been focusing on HTE research since 2012 under the Thorium Molten Salt Reactor (TMSR) nuclear energy system project. This report presents the recent HTE activities and advances in SINAP, including lab-scale experiments and technology demonstrations. We have developed several novel materials for solid oxide electrolysis cell (SOEC) and explored the degradation mechanism by using advanced techniques such as Synchrotron Radiation Facilities. A factory with an annual production capacity of 10 MW, has been constructed for mass production of high-performance SOEC cells and stacks. In terms of technology demonstration, we have successfully completed the integration and filed test of 20kW-HTE system and 200kW-HTE system. And the 200kW-HTE system will be coupled with the TMSR plant for the demonstration of nuclear hydrogen production.

**Taeho Shin**
**Dr. /Executive Director**
**Korea Institute of Ceramic Engineering and Technology**

Tae Ho Shin is an executive director at KICET, South Korea, with an M.S. from Yonsei University and a PhD from Kyushu University. He held a fellowship at the University of St Andrews, working with Prof. John T. S. Irvine. His research focuses on developing oxide electrodes for SOFC and SOEC, with an emphasis on crystal structure analysis. He has served on various committees related to fuel cell R&D and carbon neutrality in Korea. He has received numerous awards, including the KICET distinguished star researcher award in 2021.

### New Strategies for Boosting SOCs Performance at KICET

Several strategies for advanced manufacturing have been carried for competitive commercialization of LSGM based SOCs at KICET: (a) lowering temperature processing, (b) ultra-thinner self-standing electrolyte, (c) non-touchable electrode coating processing, and (d) optimal buffer layer. Our innovative activity on the recent LSGM based SOCs will be discussed in detail.



**Chusheng Chen**
**Professor**
**University of Science and Technology of China**

Chu-sheng Chen received his BSc and MSc degree in inorganic chemistry from University of Science and Technology of China (USTC) in 1983 and 1986, respectively, and PhD degree in materials science from University of Twente in the Netherlands in 1994. Dr. Chen joined the Department of Materials Science and Engineering at USTC in 1995, and promoted to full professor in 1998. He served as vice dean in the School of Chemistry and Materials Science from 2000 to 2004, (executive) dean of the same school from 2004 to 2008, and vice president of USTC from 2008 to 2019. Dr. Chen's research interests include transport of ions and electrons in solid oxides, ceramic membranes and processes in energy systems, and ceramic sensors.

### All-Ceramic Solid Oxide Cells for Efficient Separation of Oxygen from Air

The ceramic oxygen pump, a variant of solid oxide electrolysis cells, shows great potential for oxygen production from air. In this study, an all-ceramic oxygen pump was fabricated using phase-inversion tape casting, lamination, and co-firing methods, featuring a thin $Gd_{0.1}Ce_{0.9}O_{1.95}$ (GDC) electrolyte layer supported by symmetrical $La_{0.6}Sr_{0.4}Co_{0.2}Fe_{0.8}O_3$ (LSCF)–GDC composite electrodes. This ceramic pump achieved a current density of 2.0 A $cm^{-2}$ at 750°C with a low voltage of 0.34 V, yielding an oxygen flux of 6.84 mL(STP) $cm^{-2}$ $min^{-1}$. The oxygen pump also exhibited excellent thermal cycling durability. The all-ceramic oxygen pumps developed in this study hold promise for continuous and on-site production of high-purity oxygen with ease of control.

**Jaeha Myung**
**Professor**
**Incheon National University**

Professor Jaeha Myung obtained his doctoral degree in 2013 from the Department of Materials Science and Engineering at Yonsei University, Korea, focusing on the research of large-area SOFCs for direct utilization of hydrocarbon fuels. From 2013 to 2016, he held the post-doctor position in John T.S. Professor group at the University of St. Andrews, UK. During this time, He conducted research on solid oxide cells using exsolution materials and published the results in a Nature journal in 2016. Subsequently, he served at the Korea Institute of Energy Research from 2016 to 2018. Since 2018, he has been working as a professor in the Department of Materials Science and Engineering at Incheon National University.

## Controlling the Exsolution Mechanism for Diverse Applications

In the realm of high-temperature fuel cells, there's active research into developing composite materials that leverage both the high catalytic activity and electrical conductivity of metals, alongside the ionic conductivity and stability of oxides. These composites rely on nano-sized metal catalysts to enhance the active reaction area. Various nano processes such as solution methods, chemical vapor deposition (CVD), physical vapor deposition (PVD), etc., are being employed to increase the surface area of metal/oxide catalysts. However, these processes typically require additional steps and expensive equipment, which limits their practical use. Moreover, metal catalysts formed from these materials often exhibit a high initial specific surface area but are susceptible to poisoning at high temperatures or by various fuels.

To address these challenges and secure a high active area for nanocatalysts with durability, our research team is developing exsolution materials where nanoparticles self-grow within the oxide by controlling its crystal structure, composition, and oxygen partial pressure. By understanding the mechanism of the exsolution phenomenon, we've managed to grow single metals (such as Ni, Co, Fe, Cu, etc.) and alloy metals (like NiCo, CoFe, CuFe, etc.), while also successfully controlling the size, number, and shape of these metal particles. Utilizing exsolution-based nanocatalysts, my group is applying them in solid oxide fuel cells (SOFCs), solid oxide electrolysis cells (SOECs), reforming catalysts, and gas sensors to enhance performance tailored to each application, demonstrating the potential of exsolution materials.

**Yu Chen**
**Professor**
**South China University of Technology**

Yu Chen is currently a full professor at the School of Environment and Energy in South China University of Technology, China. He received his B.S. degree in Chemistry Materials from Anhui University, China in 2007 and his M. S. degree in Material Science and Engineering from the University of Science and Technology of China in 2010. He received his Ph.D. in October 2014 in Mechanical Engineering from the University of South Carolina, USA. His research interest focuses on the fabrication and characterization of novel electrodes for solid oxide fuel cells, electrolysis cells, and devices for ceramic membranes. He has published more than 100 papers in peer-reviewed journals such as Nature Energy, Science Bulletin, Energy Environmental Science, Joule, Advanced Materials, Nature Communications, etc., and applied for more than 10 invention patents.

## Efficient Catalysts for Protonic Ceramic Fuel Cells Using Ammonia

Ammonia protonic ceramic fuel cells ($NH_3$-PCFCs) are promising and attractive energy-conversion devices owing to their high energy density, zero-carbon emission, and safety. The development of $NH_3$-PCFCs, however, depends largely on the insufficient activity and poor durability of typical Ni-based anodes for ammonia decomposition. This presentation will highlight the critical scientific challenges facing the development of $NH_3$-PCFCs, the strategies for enhancing the reaction activity and durability of the anodes in proton-conducting ceramic cells, the latest developments in modeling, simulation, and in/ex-situ characterization techniques for unraveling charge and mass transport mechanisms, and the outlook for future-generation energy storage systems that exploit nano-scale materials of significantly improved performance.

**Hao Ren**
**Editor**
**Wiley journals**

Hao Ren earned his PhD in physical chemistry from the University of Science and Technology Beijing in 2016. Then he worked as a postdoctoral researcher at the University of California Riverside from 2016 to 2017. He went on to do postdoctoral research at Nanyang Technological University in Singapore until he joined Wiley in 2020. His research focused on material synthesis and energy storage and conversion. He works as an associate editor at *Angewandte Chemie, Batteries & Supercaps, and ChemElectroChem.*

## Publishing with Wiley in-house Chemistry Journals

This talk will briefly introduce the portfolio of Wiley's in-house chemistry journals, providing valuable insights and practical advice for authors. Attendees will learn practices for manuscript preparation, including tips for writing compelling abstracts, introductions, and the effective use of graphics. The talk will highlight the peer review process, offering guidance on how to respond to reviewers' comments and transfer cascades. This session may provide useful information to researchers to successfully publish their work in Wiley's in-house chemistry journals.

**WooChul Jung**
**Professor**
**Korea Advanced Institute of Science and Technology**

WooChul Jung received his PhD degree at MIT and served as postdoctoral fellow at Caltech. He joined KAIST of the Department of MSE in 2013 and currently serves as Associate Professor. The main goal of his research activities is to understand the reactions that occur at the interfaces between ionic solids (oxides in particular) and gases and thereby to improve the reaction kinetics for applications in chemical and electrochemical catalysis, such as solid oxide fuel cells, electrolyzers, and hydrocarbon reformers. He has been developing model oxide structures with well-defined interface geometries and analyzing true surface properties and reaction characteristics.

## An Ideal Surface Reveals How Active It Is and Why It Degrades: Atomically-flat $SrTi_{0.5}Fe_{0.5}O_{3-\delta}$ Model Thin Film – a Case Study

Surface cation segregation, particularly Sr, has been identified as a primary cause of performance degradation in perovskite-based oxide electrodes used in energy conversion devices such as solid oxide fuel cells or protonic ceramic fuel cells. However, due to the complex chemical and structural nature of the perovskite oxide surface, the mechanisms behind Sr segregation and its impact on electrode activity are not yet fully understood. Moreover, Sr segregation already occurs during the high-temperature calcination process used to synthesize the oxides, further complicating the matter.

In this study, we present an atomically-flat model thin film system with an ideal stoichiometric surface. $SrTi_{0.5}Fe_{0.5}O_{3-\delta}$ (STF) is chosen as a representative electrode material and thin films of STF are prepared via pulsed laser deposition on a pretreated single-crystal $SrTiO_3$ substrate. We observe changes in the surface structure, composition, and oxygen exchange kinetics according to temperature and time using analytical techniques including atomic force microscopy and atom probe tomography. Combined with computational calculations, these observations allow us to address fundamental questions such as: 1) how reactive is an ideal perovskite oxide surface? 2) can we quantify the degree of Sr segregation on the surface? and 3) what is the quantitative relationship between the degree of Sr segregation and the surface oxygen exchange rate?

**Francesco Ciucci**
**Professor**
**University of Bayreuth**

Professor Francesco Ciucci is a University Professor at the University of Bayreuth, Germany, specializing in electrode design for electrochemical energy storage. He completed his Ph.D. at Caltech. Prof. Ciucci has published extensively in the field of solid-state energy storage with publications in Nature Catalysis, Nature Chemistry, Nature Communications, Joule and Many more. He is a Fellow of the Royal Society of Chemistry. He is also a co-founder of Solid-X Ltd., a company focused on solid-state batteries.

## Cobalt-Free Air Electrodes for Protonic Ceramic Cells

This presentation explores new cobalt-free air electrodes for protonic ceramic cells. We first introduce a $Sr_{0.9}Ce_{0.1}Fe_{0.8}Ni_{0.2}O_{3\text{-}\delta}$ (SCFN) perovskite-based nanocomposite for air electrodes and Ni-Fe alloy support for fuel electrodes, improving RePCCs' performance [2]. The SCFN nanocomposite, exhibiting electrocatalytic surfaces enriched with $CeO_2$ and NiO nanoparticles, enables superior oxygen exchange and transfer. The produced RePCCs demonstrate excellent power density and stability.

In the second part of the talk [2], we analyze challenges encountered by protonic ceramic fuel cells. In particular, the cobalt-free perovskite, $Ba_{0.875}$ $Fe_{0.875}Zr_{0.125}O_{3-\delta}$, is developed using ab initio simulations and co-substitution. The prepared cell demonstrates superior electrochemical activity achieving a peak power density of $0.67\,W\,cm^{-2}$ at 500 °C. This work presents promising, efficient, and durable strategies protonic ceramic cells.

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