THE HONG KONG POLYTECHNIC UNIVERSITY 香港理工大學

FACULTY OF 理學院 SCIENCE

PolyU 85th Anniversary
PolyU Science Workshop Series
International Workshop on Organic and Perovskite Electronics

19 -21 September 2022 (Monday to Wednesday)

09:00 – 12:00 ; 14:00 – 18:00 (HKT)

Day 1 Hybrid Mode (AG710 & Zoom)

Day 2 & 3 Online via Zoom

(Zoom Meeting ID will be sent to successful registrants)

Organising Committee

Prof. Wai-yeung WONG, Raymond
Dean, Faculty of Science
Chair Professor of Chemical Technology
The Hong Kong Polytechnic University

Prof. Thomas ANTHOPOULOS
Professor, Material Science and Engineering
King Abdullah University of Science and Technology (KAUST)

Prof. Feng YAN
Professor, Department of Applied Physics
The Hong Kong Polytechnic University

Please register online at **https://polyu.hk/hlOaw**

Enquiries: 2766 5057 / fs.info@polyu.edu.hk

Introduction

We are pleased to welcome you to the **PolyU Science Workshop on Organic and Perovskite Electronics** hosted by the Faculty of Science of The Hong Kong Polytechnic University (PolyU), which is also one of the workshop series as the celebrating events of the PolyU 85th anniversary.

Being different from conventional semiconductor materials, organic semiconductors can be prepared by convenient solution process with low cost, making organic semiconductor devices compatible with printing process. In Hong Kong, this is one of the hottest research areas in both science and engineering fields. Hong Kong Research Grant Council (RGC) also supported a number of collaborative research fund (CRF) and Area of Excellence (AoE) projects in the topics related to Organic Electronics.

A number of PolyU colleagues have been intensively working on the fundamental physics and chemistry, information science, and clean energy, etc. PolyU has previously organized the *International Workshop on Recent Advances in Organic Biolectronics* in 2017 and *Emerging Energy and Materials Sciences in Halide Perovskite*, Symposium EN05 in MRS Fall Meeting 2021 in Boston, which provide a platform for researchers in the field to share their most recent research findings.

This 3-day workshop is another attempt made by PolyU to foster exchange among over 30 international and local experts in this field and to cultivate international collaborations. We hope that you will enjoy the programme in the next few days, and that we could not only bring worldwide researchers in this field to share their state-of-the-art results, but also promote inter-institutional collaborations on important scientific topics.

Organising Committee

Prof. Wai-yeung WONG, Raymond
Dean, Faculty of Science
Chair Professor of Chemical Technology
The Hong Kong Polytechnic University

Prof. WONG obtained his B.Sc.(Hons.) and Ph.D. degrees from the University of Hong Kong. After postdoctoral works at Texas A&M University (Advisor: Prof. F. A. Cotton) and the University of Cambridge (Advisors: Profs. Lord Lewis and P. R. Raithby), he joined Hong Kong Baptist University from 1998 to 2016 and he now works at The Hong Kong Polytechnic University as Chair Professor of Chemical Technology and Dean of Faculty of Science. He was awarded the RSC Chemistry of the Transition Metals Award, FACS Distinguished Young Chemist Award, State Natural Science Award from China and RGC Senior Research Fellow Award, etc. His research focuses on synthetic inorganic/organometallic chemistry, especially aiming at developing metal-organic molecules and polymers for organic optoelectronics and metal-based nanomaterials.

Prof. Thomas ANTHOPOULOS
Professor, Material Science and Engineering
King Abdullah University of Science and Technology (KAUST)
KAUST Solar Centre, Saudi Arabia

Prof. ANTHOPOULOS is a Professor of Material Science and Engineering at King Abdullah University of Science and Technology (KAUST) in Saudi Arabia. He received his B.Eng. and D.Phil. degrees from Staffordshire University in the UK. He then spent two years at the University of St. Andrews (UK) where he worked on organic light-emitting diodes before joining Philips Research Laboratories in The Netherlands to focus on printable microelectronics. From 2006 to 2017 he held faculty positions at Imperial College London (UK), first as an EPSRC Advanced Fellow and later as a Reader and full Professor of Experimental Physics. His research interests are diverse and cover the development and application of novel processing paradigms and the physics, chemistry and application of functional materials.

Prof. Feng YAN
Professor, Department of Applied Physics
The Hong Kong Polytechnic University

Prof. YAN has research interests on organic electronics, 2D materials, solar cells, thin film transistors, biosensors and smart materials. He received his PhD degree in physics from Nanjing University in 1997 and then worked at the Department of Physics of Nanjing University as Associate Professor until Jan 2001. He joined the Engineering Department of Cambridge University in Feb 2001 as a Research Associate and joined National Physical Laboratory in UK in April 2006 as a Higher Research Scientist. He became an Assistant Professor at the Department of Applied Physics of The Hong Kong Polytechnic University in September 2006 and was promoted to Full Professor in 2016. He has published more than 280 papers in peer-reviewed journals including Advanced Materials, Nature Communications, Science Advances, Nano Letters, ACS Nano, Chemical Society Reviews, Energy & Environmental Science, Angewandte Chemie International Edition and Journal of the American Chemical Society, and given more than 70 invited talks in international conferences. The publications have received more than 20,000 citations with h-index of 79 in google scholar. He is a “highly cited researcher” selected by ClarivateTM in 2021, a fellow of the Royal Society of Chemistry and a Senior member of IEEE.

Programme Rundown

Day 1 | 19 September 2022 (Monday) **| Organic Electronics/Materials | Hybrid Mode** (AG710 & Zoom)
Morning Session

Start Time (HK Time/GMT+8hrs unless specify)	**Title**	**Speakers**
09:30-09:35	Welcome and Opening Address	**Prof. Wai-yeung WONG, Raymond** Dean, Faculty of Science, Chair Professor of Chemical Technology, The Hong Kong Polytechnic University (PolyU)
Session 1 - **Organic Materials and Devices (I)**: Chaired by **Prof. Wai-yeung WONG, Raymond** & **Prof. Alex JEN**		
09:35-10:15	From Discrete Metal-Ligand Motifs to Supramolecular Assembly, Nanostructures and Light-Enabled and Electronic Functions	**Prof. Vivian Wing-Wah YAM** Dean (Interim), Faculty of Science, Chair Professor, Department of Chemistry, The University of Hong Kong (HKU)
10:15-10:55	Room-Temperature Ferromagnetism in Organic Semiconductor	**Prof. Yuguang MA** Professor, School of Materials Science and Engineering, South China University of Technology (SCUT)
10:55-11:15	Break	
11:15-11:55 *20:15-20:55* *18 Sep 2022 (PDT)*	Near-Infrared Materials: The Turning Point of Organic Photovoltaics	**Prof. Yang YANG** Professor, Department of Materials Science and Engineering, University of California, Los Angeles (UCLA)
11:55-12:25 *21:55-22:25* *18 Sep 2022 (MDT)*	Efficient and Stable Perovskite Solar Cells Enabled by Surface Engineering with Bulky Organic Molecules	**Prof. Kai ZHU** Senior Scientist, Chemistry and Nanoscience Center, National Renewable Energy Laboratory (NREL)
12:25	End of Morning Session	

Programme Rundown

Day 1 | 19 September 2022 (Monday) **| Organic Electronics/Materials | Hybrid Mode** (AG710 & Zoom)
Afternoon Sessions

Start Time (HK Time/GMT+8hrs unless specify)	**Title**	**Speakers**
Session 2 - **Perovskite Materials and Devices (I)**: Chaired by **Prof. Furong ZHU** & **Prof. Xinhui LU**		
14:00-14:40	Integrated Material, Interface, and Process Engineering for Highly Efficient Organic, Perovskite, and Organic/ Perovskite Hybrid Devices	**Prof. Alex JEN** Lee Shau-Kee Chair Professor and Director, Hong Kong Institute for Clean Energy, City University of Hong Kong (CityU)
14:40-15:10	Towards Improved Efficiency and Stability of Metal Halide Perovskite Devices Using 2D Perovskite Materials	**Prof. Aleksandra B. DJURIŠIĆ** Professor, Department of Physics, The University of Hong Kong (HKU)
15:10-15:40 *09:10-09:40* *19 Sep 2022 (CEST)*	A New Doping Strategy of Spiro-OMeTAD: Towards Instantly Efficient and Stable Perovskite Solar Cells	**Prof. Feng GAO** Professor, Department of Physics, Chemistry and Biology, Linköping University
15:40-16:00	Break	
Session 3 - **Organic Materials and Devices (II)**: Chaired by **Prof. Feng YAN** & **Prof. Chun-sing LEE**		
16:00-16:40 *11:00-11:40* *19 Sep 2022 (AST)*	Development of Fluorene-based Materials for Device Applications	**Prof. Donal BRADLEY** Vice President for Research and Innovation, NEOM University, Executive Director of the NEOM Education, Research and Innovation Foundation
16:40-17:10	Centimeter-Scale Hole Diffusion in Organic Light-Emitting Diodes	**Prof. Chun-sing LEE** Dean, College of Science, Chair Professor of Materials Chemistry, Department of Chemistry, City University of Hong Kong (CityU)
17:10-17:40 *12:10-12:40* *19 Sep 2022 (AST)*	Strategies for Increasing the Efficiency of Organic Solar Cells	**Prof. Thomas ANTHOPOULOS** Professor, Material Science and Engineering, King Abdullah University of Science and Technology (KAUST)
17:40-18:10	Narrowband Near-infrared Perovskite/ Polymer Hybrid Photodetectors	**Prof. Furong ZHU** Professor, Department of Physics, Hong Kong Baptist University (HKBU)
18:10	End of Day 1	

Programme Rundown

Day 2 | 20 September 2022 (Tuesday) **| Organic Electronics/Devices | Online via Zoom**
Morning Session

Start Time (HK Time/GMT+8hrs unless specify)	**Title**	**Speaker**
Session 4 - **Organic Devices-Transistors (I)**: Chaired by **Prof. Yanchun HAN, Prof. Feng YAN** & **Dr Peng TAO**		
09:00-09:40	2D Materials-Based Field-Effect Transistors for High-Performance Sensors	**Prof. Yunqi LIU** Professor, Institute of Chemistry, Chinese Academy of Sciences (ICCAS)
09:40-10:10 *10:40-11:10* *20 Sep 2022 (JST)*	Excited States Control of Organic Semiconductors	**Prof. Yong-jin PU** Team Leader, Emergent Supramolecular Materials Research Team, Center for Emergent Matter Science (CEMS), RIKEN
10:10-10:40	Control over Solution Phase Structure and Thin Film Morphology for High Performance Conjugated Polymers	**Prof. Yanchun HAN** Director and Professor, State Key Laboratory of Polymer Physics and Chemistry (Changchun), University of Chinese Academy of Sciences (UCAS)
10:40-11:00	Break	
11:00-11:40 *20:00-20:40* *19 Sep 2022 (PDT)*	Making Printable, Mechanically Agile Electronics and Opto-Electronics a Reality: Polymers, Heterojunctions, Amorphous Oxides	**Prof. Tobin J. MARKS** Vladimir N. Ipatieff Professor of Catalytic Chemistry and Chemical and Biological Engineering, Department of Chemistry, Northwestern University
11:40-12:10 23:40-00:10 *19 Sep 2022 (EDT)*	Semiconducting: Insulating Polymer Blends Targeted for Flexible Optoelectronic Applications	**Prof. Natalie STINGELIN** Professor, School of Materials Science and Engineering, Georgia Institute of Technology (Georgia Tech)
12:10	End of Morning Session	

Programme Rundown

Day 2 | 20 September 2022 (Tuesday) **| Organic Electronics/Devices | Online via Zoom**
Afternoon Sessions

Start Time (HK Time/GMT+8hrs unless specify)	**Title**	**Speaker**
Session 5 - **Organic Materials and Devices (III)**: Chaired by **Prof. Xunjin ZHU** & **Dr Linli XU**		
14:00-14:40	High Performance Polymer Semiconductors via Side Chain Functionalization	**Prof. Deqing ZHANG** Director, Institute of Chemistry, Chinese Academy of Sciences (ICCAS)
14:40-15:10	Functional Metal-Based Nanomaterials from Metallopolymers	**Prof. Wai-yeung WONG, Raymond** Dean, Faculty of Science, Chair Professor of Chemical Technology, The Hong Kong Polytechnic University
15:10-15:40	Stimuli-Responsive Materials for Information Recording and Anti-counterfeiting Applications	**Prof. Yun MA** Professor, State Key Laboratory for Organic Electronics and Information Displays & Institute of Advanced Materials, Nanjing University of Posts and Telecommunications (NUPT)
15:40-16:00	Break	
16:00-16:40 *09:00-09:40* *20 Sep 2022 (BST)*	Designing High Performing Semiconducting Polymers	**Prof. Iain McCulloch** Professor, Polymer Chemistry, Department of Chemistry, University of Oxford
16:40-17:10	Porphyrin Small Molecules for Photocatalytic Hydrogen Evolution	**Prof. Xunjin ZHU** Associate Professor, Department of Chemistry, Hong Kong Baptist University (HKBU)
17:10-17:40	Thermally Activated Delayed Fluorescence White OLEDs	**Prof. Hui XU** Dean, School of Chemistry and Materials Science, Deputy Director, Key Laboratory of Functional Inorganic Material Chemistry (Chinese Ministry of Education), Heilongjiang University
17:40	End of Day 2	

Programme Rundown

Day 3 | 21 September 2022 (Wednesday) **| Perovskite Material & Devices | Online via Zoom**
Morning Session

Start Time (HK Time/GMT+8hrs unless specify)	**Title**	**Speaker**
Session 6 - **Perovskite Materials and Devices (II)**: Chaired by **Prof. Yabing QI**, **Dr Songhua CAI** & **Dr Dianxiang JI**		
09:00-09:40 *21:00-21:40* *20 Sep 2022 (EDT)*	Defects, Efficiency and Stability of Metal Halide Perovskites	**Prof. Jinsong HUANG** Louis D. Rubin Jr. Distinguished Professor, Department of Applied Physical Sciences, University of North Carolina
09:40-10:10 *21:40-22:10* *20 Sep 2022 (EDT)*	From Lead Halide Perovskites to Lead-Free Metal Halide Perovskites and Perovskite Derivatives	**Prof. Yanfa YAN** Distinguished University Professor, Department of Physics and Astronomy, Wright Center for Photovoltaics Innovation and Commercialization, The University of Toledo
10:10-10:40 *11:10-11:40* *21 Sep 2022 (JST)*	Surface Science Studies on Metal Halide Perovskite Materials and Their Solar Cell Applications	**Prof. Yabing QI** Professor, Energy Materials and Surface Sciences Unit, Okinawa Institute of Science and Technology Graduate University (OIST)
10:40-11:00	Break	
11:00-11:40 *12:00-12:40* *21 Sep 2022 (JST)*	Perovskite Solar Cells That Challenge the Pinnacle of Printable Photovoltaic Device	**Prof. Tsutomu MIYASAKA** Professor, Faculty of Biomedical Engineering, Toin University of Yokohama
11:40-12:10	Microstructure Studies of Organic and Perovskite Solar Cells Based on Grazing Incidence Scattering Techniques	**Prof. Xinhui LU** Associate Professor, Department of Physics, The Chinese University of Hong Kong (CUHK)
12:10	End of Morning Session	

Programme Rundown

Day 3 | 21 September 2022 (Wednesday) **| Perovskite Material & Devices | Online via Zoom**
Afternoon Sessions

Start Time (HK Time/GMT+8hrs unless specify)	**Title**	**Speaker**
Session 7 - **Organic Devices-Solar Cells**: Chaired by **Prof. Zhicai HE & Prof. Yong-jin PU**		
14:00-14:40	Photovoltaic Materials for Polymer Solar Cells	**Prof. Yongfang LI** Professor, Institute of Chemistry, Chinese Academy of Sciences (ICCAS), Soochow University
14:40-15:10	Polymer Solar Cells Fabricated with Printed Transparent Electrode and Active Layers	**Prof. Zhiyuan XIE** Professor, Changchun Institute of Applied Chemistry (CIAC)
15:10-15:40	A Brief Story about the Water-/Alcohol-Soluble Interlayers in Organic Electronics	**Prof. Zhicai HE** Professor, School of Materials Science and Engineering, South China University of Technology (SCUT)
15:40-16:10	High Efficiency OLEDs Based on AIE Materials	**Prof. Dongge MA** Professor, Institute of Polymer Optoelectronic Materials and Devices, State Key Laboratory of Luminescent Materials and Devices, South China University of Technology (SCUT)
16:10-16:30	Break	
Session 8 - **Organic Devices-Transistors (II)**: Chaired by **Prof. Mingjie LI** & **Dr Miao ZHANG**		
16:30-17:10 *09:30-10:10 21 Sep 2022 (BST)*	Charge Transport Physics of Organic and Hybrid Perovskite Field Effect Transistors	**Prof. Henning SIRRINGHAUS** Hitachi Professor, Electron Device Physics, Royal Society Research Professor, Cavendish Laboratory, Department of Physics, University of Cambridge
17:10-17:40	Flexible Organic Transistors for Sensing Applications	**Prof. Feng YAN** Professor, Department of Applied Physics, The Hong Kong Polytechnic University (PolyU)
17:40	Closing Remarks	**Prof. Feng YAN** Professor, Department of Applied Physics, The Hong Kong Polytechnic University (PolyU)
	End of Day 3	

Plenary Speaker

Prof. Vivian Wing-Wah YAM

Dean (Interim), Faculty of Science
Chair Professor, Department of Chemistry
The University of Hong Kong (HKU)

Prof. YAM obtained both her BSc (Hons) and PhD from The University of Hong Kong, and is currently the Philip Wong Wilson Wong Professor in Chemistry and Energy and Chair Professor of Chemistry. She was elected to Member of Chinese Academy of Sciences, International Member (Foreign Associate) of US National Academy of Sciences, Foreign Member of Academia Europaea, Fellow of TWAS and Founding Member of The Hong Kong Academy of Sciences. She was the Laureate of 2011 L'Oréal-UNESCO For Women in Science Award. Her research interests include inorganic/organometallic chemistry, supramolecular chemistry, photophysics and photochemistry, and metal-based molecular functional materials for sensing, organic optoelectronics and energy research.

From Discrete Metal-Ligand Motifs to Supramolecular Assembly, Nanostructures and Light-Enabled and Electronic Functions

Recent works in our laboratory have shown that novel classes of light-absorbing and luminescent metal-containing molecular materials could be assembled through the use of various chromophoric metal-ligand coordination motifs. In this presentation, various design and synthetic strategies together with the successful isolation of new classes of chromophoric and luminescent metal complexes will be described. These metal complexes have been shown to display rich optical and luminescence behavior. Correlations of the chromophoric and luminescence behavior with the electronic and structural effects of the metal complexes have been made to elucidate their spectroscopic origins. A number of these simple discrete metal complexes are found to undergo supramolecular assembly to give a variety of nanostructures and morphologies. By understanding the spectroscopic origin and the structure-property relationships, different approaches and assembly motifs have been employed to tune their electronic absorption and emission characteristics. The exploration into the potential applications and functions of these metal-ligand chromophores and luminophores as efficient light-emitting materials, molecular optoelectronics and memories will also be described.

Plenary Speaker

Prof. Yuguang MA

Professor
School of Materials Science and Engineering
South China University of Technology (SCUT), China

Prof. MA is a professor at South China University of Technology and an academician at the Chinese Academy of Sciences. Professor Ma is engaged in the basic scientific research of organic/polymer optoelectronic materials. (1) He first realized electroluminescence of phosphorescent materials and proposed the principle of improving the efficiency of organic light-emitting diode using phosphorescent materials, which made original contributions to the development of the second generation of luminescent (phosphorescent) materials. (2) He proposed the mechanism of "hot exciton" and the structural design principle of hybridized local and charge-transfer materials, making original contributions to the development of a new generation of cheap luminescent materials. (3) He invented the processing method of insoluble organic polymer functional material film with high efficiency electroluminescence and high conductivity, leading the new direction of polymer materials.

Room-Temperature Ferromagnetism in Organic Semiconductor

Ferromagnetic semiconductors are expected to solve the "post-Moore era" problems due to their dual characteristics as semiconductors and magnetic materials. The reported diluted magnetic semiconductors are ferromagnetic only at low temperature. "Can we make magnetic semiconductors at room temperature?" is one of 125 most challenging questions, published on *Science* 125th anniversary. Pure organic magnets were discovered in 1991 year and its Curie temperature was only at 0.65 K. Although room temperature organic magnets have been reported occasionally in recent years, their saturation magnetization is very low and they are electrically insulated. Here, we have achieved the world's first room-temperature organic ferromagnetic semiconductor by constructing strong intermolecular interactions of radical anion. By controlling the self-assembly process of reduced perylene diimide, we prepared radical anion aggregates, and the intermolecular π-π distance was close to 3.30 Å, which solved the problem of weak correlation of electron spins among radical anion and promoted the formation of long-range ferromagnetic ordering. The prepared materials have both room temperature ferromagnetic and semiconductor characteristics, with Curie temperature over 400 K, saturation magnetization up to 1.2 emu g^{-1} and Hall mobility up to 0.5 $cm^2 V^{-1} \cdot s^{-1}$, which brings hope for the application of organic ferromagnetic semiconductors. We show that constructing strong intermolecular interactions of radical anion is an effective way to realize organic ferromagnetic semiconductors.

Plenary Speaker

Prof. Yang YANG

Professor
Department of Materials Science and Engineering
University of California, Los Angeles (UCLA), United States

Prof. YANG received his Ph.D. in Physics and Applied Physics from the University of Massachusetts. Prof. Yang has more than 500 refereed papers; more than 30 issued patents, and more than 200 plenaries, keynote, and invited talks. He has accumulated of more than 130,000 citations and his H-Index is ~171. His major research interests are in the solar energy and highly efficient electronic devices. Currently he is the Carol and Lawrence E. Tannas Jr. Endowed Chair Professor at UCLA.

Prof. YANG is a fellow of European Academy of Science, the American Association for the Advancement of Science, Materials Research Society, Royal Society of Chemistry, American Physical Society, Electromagnetic Academy, and SPIE, International Society for Optics and Photonics. Recently, he has received the following honors/awards: invited to join the Advanced Materials Hall of Fame (2021); Highly Cited Researcher in three major fields: Materials Science, Chemistry, and Physics, Thomson Reuters (now Clarivate Analytics) (Only ~20 people world-wide elected, 2017, 2018, 2019); 2019 Sustainable Energy Award by UK Royal Society of Chemistry; Highly Cited Researcher in both Materials Science and Chemistry Categories (2013-2016, & 2020).

Near-Infrared Materials: The Turning Point of Organic Photovoltaics

Near-infrared (NIR)-absorbing organic semiconductors have opened up many exciting opportunities for organic photovoltaic (OPV) research. For example, new chemistries and synthetical methodologies have been developed; especially, the breakthrough Y-series acceptors, originally invented by our group, specifically Y1, Y3, and Y6, have contributed immensely to boosting single- junction solar cell efficiency to around 19%; novel device architectures such as tandem and transparent organic photovoltaics have been realized. The concept of NIR donors/acceptors thus becomes a turning point in the OPV field.

Here, I will report the development of NIR-absorbing materials for OPVs. According to the low-energy absorption window, here, NIR photovoltaic materials (p-type (polymers) and n-type (fullerene and nonfullerene)) are classified into four categories: 700–800 nm, 800–900 nm, 900–1000 nm, and greater than 1000 nm. Each category covers the design, synthesis, and utilization of various types of donor (D) and acceptor (A) units.

The structure– property relationship between various kinds of D, A units and absorption window are constructed to satisfy requirements for different applications. Subsequently, a variety of applications realized by NIR materials, including transparent OPVs, tandem OPVs will be presented. Finally, challenges and future development of novel NIR materials for the next-generation organic photovoltaics and beyond will also be discussed.

Keynote Speaker

Prof. Kai ZHU

Senior Scientist
Chemistry and Nanoscience Center
National Renewable Energy Laboratory (NREL), United States

Prof. ZHU is currently a senior scientist in the Chemistry and Nanoscience Center at the National Renewable Energy Laboratory (NREL). He received his PhD degree in physics from Syracuse University in 2003, where he studied the electrical & optical properties and device physics of solar cells based on amorphous-silicon thin films and dye-sensitized mesoporous TiO_2 films. He then spent about one year at Kansas State University as a postdoctoral researcher, working on III-Nitride wide-bandgap semiconductors for high-power blue and UV light emitting diodes. In 2004, he joined NREL as a postdoctoral researcher in the laboratories of Dr Arthur J. Frank, working on fundamental charge carrier transport and recombination in photoelectrochemical cells, especially dye-sensitized solar cells. Since 2007, he has worked as a staff scientist at NREL.

Prof. ZHU's current research interests are focused on both basic and applied research on perovskite solar cells, including perovskite material development, device fabrication and characterization, and basic understanding of charge carrier dynamics in these cells. In addition to solar cell applications, his research interests have also included hydrogen production via photoelectrochemical cells as well as nanostructured electrodes for Li-ion batteries and supercapacitors.

Efficient and Stable Perovskite Solar Cells Enabled by Surface Engineering with Bulky Organic Molecules

Organic-inorganic hybrid halide perovskites have attracted significant R&D attentions in the photovoltaic community as a competitive future photovoltaic technology. The certified efficiency of single-junction perovskite solar cell (PSC) has reached near 26%. Using molecules or structures based on bulky organic cations (e.g., butylammonium or phenethylammonium) to improve the surface and interface properties have become a promising strategy to enhance both efficiency and stability of perovskite solar cells. However, significant issues still exist with the use of bulky organic molecules, including structure control, charge transport, bulk and surface morphology, and interfacial energy alignment. In this talk, I will discuss our recent studies on surface engineering of 3D perovskites by using structures based on bulky organic molecules. The use of bulky organic molecules often results in the formation of 2D perovskite structures, which usually exhibit significant transport barriers, especially in the out-of-plane transport direction. In addition, the use of bulky organic structures can disrupt the growth of 3D perovskites. A good understanding and control of the perovskite growth is critical to fully utilize the benefits associated with bulky organic molecules and related structures. I will present strategies based on our recent studies to suppress defect formation, improve bulk and surface morphology, and reduce transport barrier for better extraction. The physical and optoelectronic properties of perovskites can be affected by controlling the precursor chemistry and growth conditions. Some of our recent results on perovskite-based tandem devices will also be discussed.

Plenary Speaker

Prof. Alex JEN

Lee Shau-Kee Chair Professor of Materials Science
Director, Hong Kong Institute for Clean Energy
City University of Hong Kong (CityU)

Prof. JEN is the Lee Shau-Kee Chair Professor and Director of the Hong Kong Institute for Clean Energy at the City University of Hong Kong. He also served as the Provost of CityU during 2016-2020. He received his B.S. from the National Tsing Hua University in Taiwan and Ph.D. from the University of Pennsylvania in USA. Before arriving at CityU, he had served as the Boeing-Johnson Chair Professor and Chair of the Department of Materials Science & Engineering at the University of Washington, Seattle. He was also appointed as the Chief Scientist for the Clean Energy Institute endowed by the Washington State Governor. He is a distinguished researcher who published more than 1000 papers with > 78,000 citations and an H-index of 144. He also co-invented 65 patents and disclosures. His interdisciplinary research covers organic/hybrid functional materials and devices for photonics, energy, sensors, and nanomedicine.

For his pioneering contributions in organic photonics and electronics, Professor Jen was elected as a Fellow by both the European Academy of Sciences and the Washington State Academy of Sciences. He was also elected as a Fellow for several professional societies, including AAAS, MRS, ACS, PMSE, OSA, and SPIE. He was named by the Times Higher Education (THE) in 2018 as one of the “Top 10 university researchers in Perovskite Solar Cell Research”. In addition, he was recognized by Thomson Reuters as one of the "World’s Most Influential Scientific Minds of 2015 and 2016 and as a "Highly Cited Researcher" in Materials Science from 2014-2021.

Integrated Material, Interface, and Process Engineering for Highly Efficient Organic, Perovskite, and Organic/Perovskite Hybrid Devices

Minimizing energy loss and increasing the field factor are key aspects to transcend the current limitations on the performance of organic photovoltaics (OPV). However, an inherent limit has set for an organic bulk-heterojunction (BHJ) blends from prominent non-geminate recombination through non-radiative charge transfer states. Our recent study on charge recombination in BHJ and Planar-Mixed Heterojunction (PMHJ) blends comprising a crystalline polymer donor with Se-containing, Y6-derived non-fullerene acceptors has shown both high photovoltaic internal quantum efficiency and high external electroluminescence quantum efficiency. Crystallographic and spectroscopic studies reveal that the pseudo-2D, fused-ring molecular acceptors are not only intrinsically highly luminescent but also meets the criteria in achieving intrinsically radiative recombination within the blend, by promoting delocalized excitons with much longer luminescent lifetime and reduced exciton binding energies. These results provide the important demonstration of radiative non-geminate charge recombination in an efficient OPV blend. Moreover, a new concept of applying” Dilution Effect” is introduced to explain the commonly observed composition-dependent V_{oc} and reduced photovoltage loss in highly efficient ternary-based devices due to significantly reduced phonon-electron coupling. At the end, several novel interface engineering approaches will be introduced, which facilitated the demonstration of a record-high PCE of 24.8% in inverted perovskite solar cells.

Keynote Speaker

Prof. Aleksandra B. DJURIŠIĆ

Professor
Department of Physics
The University of Hong Kong (HKU)

Prof. DJURIŠIĆ obtained Ph. D. degree in Electrical Engineering from the School of Electrical Engineering, the University of Belgrade in 1997. She has been a postdoctoral fellow at the University of Hong Kong and Alexander von Humboldt postdoctoral fellow at TU Dresden. She joined the Department of Physics at the University of Hong Kong in 2003 as assistant professor and she is currently a professor. Her research interests include halide perovskite materials, nanomaterials, wide-bandgap semiconductors, and organic materials, and their applications in areas related to energy and environment, such as photocatalysis, solar cells, and LEDs. She has published 392 research articles including reviews, and has been cited over 22000 times. Her h-index is 66.

Towards Improved Efficiency and Stability of Metal Halide Perovskite Devices Using 2D Perovskite Materials

Metal halide perovskite materials have been attracting great attention for applications in optoelectronic devices due to their outstanding properties. These hybrid organic- inorganic materials offer the possibility of combining low cost and simplicity of solution processing common for organic materials with high device efficiencies common for inorganic semiconductors. In a recent decade, the efficiencies of both perovskite solar cells (PSCs) and perovskite light emitting diodes (PeLEDs) have rapidly increased. While significant progress in device stability compared to early days of perovskite research has also been made, the stability of these materials still remains a problem that must be addressed before the metal halide perovskite devices can be commercialized. The intrinsic instability of commonly used 3D lead halide perovskite materials with a formula $APbX_3$ (A is a monovalent organic or Cs^+ cation, X is a halide anion) upon exposure to ambient atmosphere, illumination, elevated temperature, and/or electrical bias limits the device stability since the exposure to bias, illumination, and elevated temperature is inevitable during device operation (ambient exposure can be mitigated with encapsulation).

While stability issues can be mitigated using optimized material composition and deposition conditions, defect passivating additives and interface modifications, for further improvements it is necessary to consider perovskite materials with improved stability. For this purpose, 2D and quasi-2D perovskites have been attracting increasing attention as they are generally more stable compared to 3D materials. These materials have a formula $C_zA_{n-1}B_nX_{3n+1}$ where C is monovalent (z=2) or divalent (z=1) bulky spacer cation, A is a small organic monovalent cation or Cs^+, B is a divalent metal cation (commonly Pb^{2+}), X is a halide anion, and n is the number of 3D perovskite layers which are separated from each other by spacer cations. The bulky spacer cations contribute to enhanced ambient stability and reduced ion migration, but also hinder the charge transport in the direction perpendicular to lead halide octahedral layers. In addition, the spin-coated films typically contain multiple n phases, resulting in complex film properties. Therefore, careful optimization of the perovskite composition and deposition conditions is necessary to achieve improved device performance. In this talk, I will first discuss the stability of different 2D perovskites, followed by the effect of 2D perovskite top layer on efficiency and stability of 3D/2D perovskite solar cells. This will include the selection of spacer cation, as well as overall effects of device architecture and interface modification layers on the performance. Then, the use of different quasi-2D perovskites in PeLEDs will be discussed. This will include different methods of controlling the phase composition, optimizing the charge transfer among different n phases and passivating defects. Finally, future outlook on the role of 2D perovskites in improving stability of PSCs and PeLEDs will be discussed.

Keynote Speaker

Prof. Feng GAO

Professor
Department of Physics, Chemistry and Biology
Linköping University, Sweden

Prof. GAO is a professor and Wallenberg Academy Fellow at Linköping University in Sweden. He received his Ph.D. from the University of Cambridge in 2011. He received career grants and awards from the European Research Council, the Royal Swedish Academy of Sciences, the Wallenberg Foundation, and Swedish Foundation for Strategic Research. His group currently focuses on research into solution-processed energy materials and devices, mainly based on organic semiconductors and metal halide perovskites.

A New Doping Strategy of Spiro-OMeTAD: Towards Instantly Efficient and Stable Perovskite Solar Cells

Record efficiencies of perovskite solar cells (PSCs) are obtained with spiro-OMeTAD as the hole transport layer. Spiro-OMeTAD is conventionally doped by hygroscopic lithium salts with the assistance of volatile 4-tert-butylpyridine, which, however, brings a time-consuming doping process as well as poor device stability. We successfully develop an instantly efficient and clean doping strategy to replace the conventional spiro-OMeTAD doping. As demonstrated by experimental and theoretical investigations, the radical dopant leads to significant increase of the conductivity through efficient hole polarons generation. The ionic salts can further modulate the work function with negligible effects on the film conductivity, critical for reaching optimal open-circuit voltage values by a favorable energetic level alignment. Spiro-OMeTAD based on our new doping strategy enables PSCs with a high power conversion efficiency over 25% and an excellent stability against moisture, heat and illumination. Our findings pave the way for achieving PSCs with high efficiencies and excellent stability at the same time. In addition, our doping strategy goes beyond traditional organic semiconductor doping, providing new understanding of organic doping mechanisms which can inspire further optimizations of different optoelectronic devices.

Plenary Speaker

Prof. Donal BRADLEY

Vice President for Research and Innovation
NEOM University
Executive Director of the NEOM Education, Research and Innovation Foundation, Saudi Arabia

Prof. BRADLEY's pioneering research covers many aspects of the fundamental understanding and development of soluble semiconductor materials, especially fluorene-based polymers, for device applications and has been recognized by numerous prizes and awards, including the E-MRS Jan Czochralski Award, IET Faraday Medal, Royal Society Bakerian Medal, IOP Faraday Medal, and SID Jan Rajchman Prize. His publications have received more than 94,000 Google Scholar citations (h-index = 134) placing him among the 0.05% most-cited applied physicists in the world. In addition, Professor Bradley has worked closely with industry to translate the outcomes of his research into technologies and is a co-founder of spinout companies Cambridge Display Technology, Molecular Vision and PeroLED, having also worked closely with Sunew and Solar Press in advisory/Board roles. He is a Commander of the Order of the British Empire, Fellow of the Royal Society and the US National Academy of Inventors, received a DSc honoris causa from the Hong Kong Baptist University and delivered the 2009 Chau Wai Yin Memorial Lecture at Hong Kong Polytechnic University.

Development of Fluorene-based Materials for Device Applications

In this Plenary Lecture I will describe research focused on developing an understanding of the underlying physics of fluorene-based systems and their potential for device applications. I will describe the control of device-relevant properties, with an emphasis on physical structure tuning through conformation and orientation. Examples will be provided in relation to LEDs, microcavities and lasers, with (i) conformation used to define optical structures,[1] optimize charge injection and transport,[2] luminescence efficiency,[3] colour saturation,[4] triplet diffusion,[5] nonlinear optical response[6] and polariton emission[7] and (ii) orientation to define optical structures,[8] generate highly polarized emission,[9]enhance oscillator strength for cavity exciton – photon coupling[10] and reduce polariton lasing thresholds. [11]

1. A. Perevedentsev, Y. Sonnefraud, S. Sharma, A.E.G. Cass, S.A. Maier, J.S. Kim, P.N. Stavrinou, D.D.C. Bradley, Nat. Commun. 6 (2015), 5977.
2. B. Wang, H. Ye, M. Riede, D.D.C. Bradley, ACS Appl. Mater. Interfaces 13 (2021), 2919-2931.
3. M. Ariu, D.G. Lidzey, M. Sims, A.J. Cadby, P.A. Lane and D.D.C. Bradley J.Phys.Condens.Matter 14 (2002), 9975-9986; A. Perevedentsev, N. Chander, J.-S. Kim, D.D.C. Bradley, Journal of Polymer Science, Part B: Polymer Physics 54 (2016), 1995-2006.
4. I. Hamilton, N. Chander, N.J. Cheetham, M. Suh, M. Dyson, X. Wang, P.N. Stavrinou, M. Cass, D.D.C. Bradley, J.-S. Kim, ACS Appl. Mater. Interfaces 10 (2018), 11070-11082.
5. N.T. Lambeva, C. Mullen, X. Gao, R.A. Taylor, Y. Tao, D.D.C. Bradley, (2022), at press.
6. A.J. Cadby, P.A. Lane, H. Mellor, S.J. Martin, M. Grell, C. Giebeler, D.D.C. Bradley, M. Wohlgenannt, C. An and Z.V. Vardeny, Phys. Rev. B 62 (2000), 15604-15609; T. Virgili, D. Marinotto, G. Lanzani, D.D.C. Bradley, Appl. Phys. Lett. 86 (2005), 091113.
7. F. Le Roux, D.D.C. Bradley, Phys. Rev. B 98 (2018), 195306.
8. Y. Shi, P.S. Salter, M. Li, R.A. Taylor, S.J. Elston, S.M. Morris, D.D.C. Bradley, (2020), Adv. Funct. Mater. (2020) 2007493.
9. K.S. Whitehead, M. Grell, D.D.C. Bradley, M. Jandke and P. Strohriegl, *Appl. Phys. Lett.* **76** (2000), 2946-2948; T. Virgili, D.G. Lidzey, M. Grell, S. Walker, A. Asimakis and D.D.C. Bradley, *Chem. Phys. Lett.* **341** (2001), 219-224.
10. F. Le Roux, R.A. Taylor, D.D.C. Bradley, *ACS Photonics* **7** (2020), 746-758.
11. F. Le Roux, A. Mischok, D.D.C. Bradley, M.C. Gather (2022), submitted. (arXiv: 2202.10417).

Keynote Speaker

Prof. Chun-sing LEE

Dean, College of Science
Chair Professor of Materials Chemistry
Department of Chemistry
City University of Hong Kong (CityU)

Prof. LEE obtained his BSc and PhD degrees from the University of Hong Kong in 1987 and 1991 respectively. He then furthered his research career at the University of Birmingham of UK with the support of the Croucher Foundation Fellowship. Prof. Lee joined City University of Hong Kong in 1994 and is currently a Chair Professor of Materials Chemistry and the Dean of College of Science. He also co-founded the Center Of Super-Diamond and Advanced Films (COSDAF) in 1998 and served as the Center's Director/ Deputy Director till 2022. Prof. Lee's current research interests include organic electronic devices and nanomaterials for energy, environmental and biomedical applications.

Centimeter-Scale Hole Diffusion in Organic Light-Emitting Diodes

It is well known that organic semiconductors typically have much higher hole mobilities than electron mobilities. Current balance between electron and hole transports in organic light-emitting diodes (OLEDs) is typically achieved by (1) leakage of holes through the whole devices or by (2) accumulation of holes inside the devices. These processes are known to reduce both efficiency and operation lifetime due to exciton-polaron annihilation, etc. In this work, we introduce a new way for balancing the electron and hole currents by exploiting lateral hole diffusion. By composition and interface engineering, we demonstrate a modified PEDOT:PSS bilayer which can sustains hole diffusion over distances of centimeter scale. This ultralong distance hole diffusion enables substantially enhanced hole diffusion current in the lateral direction perpendicular to the applied electric field. By introducing this lateral hole diffusion layer (LHDL) on top of the ITO anode, reduced hole accumulation, improved efficiency, and enhanced lifetime are achieved. The application of the LHDL provides a third strategy for current balancing with much reduced harmful effects from the previous two approaches.

Keynote Speaker

Prof. Thomas ANTHOPOULOS

Professor
Material Science and Engineering
King Abdullah University of Science and Technology (KAUST)
KAUST Solar Centre, Saudi Arabia

Prof. ANTHOPOULOS is a Professor of Material Science and Engineering at King Abdullah University of Science and Technology (KAUST) in Saudi Arabia. He received his B.Eng. and D.Phil. degrees from Staffordshire University in the UK. He then spent two years at the University of St. Andrews (UK) where he worked on organic light-emitting diodes before joining Philips Research Laboratories in The Netherlands to focus on printable microelectronics. From 2006 to 2017 he held faculty positions at Imperial College London (UK), first as an EPSRC Advanced Fellow and later as a Reader and full Professor of Experimental Physics. His research interests are diverse and cover the development and application of novel processing paradigms and the physics, chemistry and application of functional materials.

Strategies for Increasing the Efficiency of Organic Solar Cells

Organic photovoltaics (OPVs) represent an emerging technology for clean and renewable energy generation. Recent developments in the field of new materials combined with an improved understanding of the device operating principles have helped to increase the power conversion efficiency (PCE) of organic solar cells to over 18%. However, further improvement in materials, processing and microstructural engineering of the photoactive layer, charge transport interlayers and cell architecture, would be required to attain the maximum theoretically predicted level of performance. In this talk, I will discuss key recent developments in the field of OPVs with a focus on practical strategies for boosting the overall cell performance. Particular emphasis will be placed on the use of electronic dopants and advanced interlayer technologies for improving the cell’s efficiency and operational stability. Finally, the design and implementation of multi-junction cell architectures and their various advantages, but also limitations, will be discussed.

Keynote Speaker

Prof. Furong ZHU

Professor
Department of Physics
Hong Kong Baptist University (HKBU)

Prof. ZHU is a Professor in the Department of Physics, Associate Dean (Research and Postgraduate Studies), Faculty of Science, Director for Research Centre of Excellence for Organic Electronics, and Director for Institute of Advanced Materials at Hong Kong Baptist University (HKBU). He received his BSc and MSc in Physics from Fudan University, Shanghai China, in 1983 and 1987. He completed his Ph.D in Applied Physics at Charles Darwin University in Australia from 1990-1993. He did his post-doctoral research in the Department of Electrical and Electronic Engineering at Kyoto University in Japan from 1993-1995, and was a Research Fellow with the Department of Physics at Murdoch University in Australia from 1995-1997 working on silicon thin films derived from plasma enhanced chemical vapor deposition for device application. He joined Institute of Materials Research and Engineering (IMRE) in Singapore in 1997. Prior to HKBU, he was a Senior Scientist and a Program Manager leading the organic light-emitting diode and organic photovoltaic R&D activities at IMRE. His research interests include device physics, surface science, nanostructures and semiconducting materials-oriented research for application in organic semiconductor devices. He has graduated 15 PhD students. Currently there are 3 PhD students in his group. He has published over 200 refereed journal publications and also filed 10 patents in low processing temperature indium tin oxide (ITO) transparent electrodes and organic electronic devices. In 2019, Prof. Zhu established a start-up company, Crimson Vision Technology Limited (Crimson Vision). Crimson Vision is a technology company dedicated in developing and advancing the near-infrared (NIR) light detection techniques for fast and portable detection.

Narrowband Near-infrared Perovskite/ Polymer Hybrid Photodetectors

Solution-processable halide perovskite semiconducting materials have unique optoelectronic properties for applications in perovskite solar cells and photodetectors (PDs). The discrete perovskite PDs have a broadband photoresponse, which is sensitive over the visible wavelength range, while the polymer PDs exhibit a broadband photoresponsivity with extended absorption in the near-infrared (NIR) wavelength range, e.g., from visible light to the NIR wavelength of >1100 nm. The visible-blind NIR photodetection with these broadband PDs requires the use of the filters or the specially designed photonic structures for achieving the photodetection over a well-defined wavelength range. However, the rigidity of the filters and the difficulty of assembling small-size optical units containing them present technical limitations. Incorporation of a bandpass filter also reduces the overall radiometric performance of the photodetectors, which increases the cost and complexity of its device integration.

Different narrowband photodetection approaches have been attempted, e.g., incorporating a microcavity structure and using charge collection narrowing (CCN) effect in the PDs. In the CCN-type PDs, a relatively thick photoactive layer, e.g., > 2500 nm thick photoactive layer, is adopted to reduce the collection efficiency of the charge carriers generated by the visible light absorbed near the upper region of a thick photoactive layer. The use of a thick active photoactive layer in a CCN-type PD faces some technical challenges: (1) The responsivity of the CCN-type PDs is limited as a large amount of the incident light is attenuated by the thick photoactive layer. (2) Perovskite PDs with a thick photoactive layer often associates with a slower response speed due to the decrease in its carrier transit time limited cut-off frequency. (3) The photodetection spectrum in the CCN-type PDs is limited by the absorption edge of the photoactive layer. This talk discusses a novel hybrid PD with a heterostructure perovskite/polymer photoactive layer for alleviating the challenges: (1) to achieve high hole transport efficiency by incorporating a thinner perovskite, (2) to realize narrowband NIR detection through buildup of the space charges at the perovskite/polymer interface, and (3) to improve the device design freedom by incorporating different combinations of perovskite charge transporting layer and the NIR absorbing layer in the perovskite/polymer structure. The hybrid PDs with a thinner photoactive layer results in an obvious increase in the responsivity and response speed. The hybrid PDs thus demonstrated have a narrowband NIR detection and a -3 dB cut-off frequency of 300 kHz, offering an exciting option for a plethora of applications in bio-imaging, environmental detection, and security monitoring.

Plenary Speaker

Prof. Yunqi LIU

Professor
Institute of Chemistry,
Chinese Academy of Sciences (ICCAS), China

Prof. LIU was graduated from Nanjing University in 1975, received a doctorate from Tokyo Institute of Technology, Japan in 1991. Presently, he is a Professor at the Institute of Chemistry, Chinese Academy of Sciences (CAS), an Academician of CAS, and a Member of The World Academy of Sciences (TWAS). His current research interests include design and synthesis of molecular materials, including p-conjugated small molecules, polymers, and graphene, fabrication of related devices, including field-effect transistors and molecular electronics, and investigation of their electronic properties. He has published more than 700 papers in SCI journals, and cited by other researchers for more than 50,000 times with an h-index greater than 110. He was recognized as “Highly Cited Researchers” by Clarivate (Thomson Reuters) in Materials Science from 2014 to 2021. In addition, he has obtained 80 of granted patents, published three books and 17 book chapters. He received the National Natural Science Award (2nd grade) in 2007, 2016 and 2019, and Beijing Science and Technology Award in 2017 (1st grade). He serves on the Editorial Board Member or Advisory Board Members for Nanoscale, ACS Mater. Lett., Chin. J. Struct. Chem., SmartMat., etc.

2D Materials-Based Field-Effect Transistors for High-Performance Sensors

The evolutionary success in information technology has been sustained by the rapid growth of sensor technology. Among various sensing techniques, field-effect transistors (FETs) with channels made of two-dimensional (2D) materials attract increasing attention for advantages such as label-free detection, fast response, easy operation, and capability of integration. With atomic thickness, 2D materials restrict the carrier flow within the material surface and expose it directly to the external environment, leading to efficient signal acquisition and conversion. In this presentation, the preparation and characterization of a few 2D materials will be introduced, 2D FET sensors are fabricated, their sensor behaviour for detection of pesticide, chiral molecules, hydroxyl free radical and COVID-19 virous are investigated.

Keynote Speaker

Prof. Yong-jin PU

Team Leader
Emergent Supramolecular Materials Research Team
Center for Emergent Matter Science (CEMS), RIKEN, Japan

2017 Team Leader, Emergent Supramolecular Materials Research Team, Supramolecular Chemistry Division, The Center for Emergent Matter Science (CEMS), RIKEN, Japan
2010 Associate Professor, Graduate School of Organic Materials Science, Research Center for Organic Electronics, Yamagata University, Japan
2006 Assistant Professor, Department of Organic Device Engineering, Yamagata University, Japan
2004 Research Fellow, Department of Chemistry, Oxford University, UK
2002 Assistant Professor, Department of Applied Chemistry, Waseda University, Japan
2002 Ph.D., Department of Applied Chemistry, Graduate School of Science and Engineering, Waseda University, Tokyo, Japan

Excited States Control of Organic Semiconductors

Control of excited states of organic semiconductors has been fundamentally important in their light-related applications such as LEDs, solar cells, sensors, photocatalysts, etc. When neutral and closed-shell organic molecules are optically or electrically excited, spin multiplicity of the excited state will be either singlet or triplet. In general, without any heavy atoms, the singlet excited state is *bright* and the triplet excited state is *dark* because of a spin selection rule. Therefore, reverse intersystem crossing from triplet excited states to singlet excited states makes light emission efficient. Energetically low and long-lived triplet excited states are involved in unique photophysical characteristics: singlet exciton fission, triplet–triplet annihilation, delayed fluorescence, etc. We designed and synthesized the organic semiconductor molecules showing unique triplet excited states–related phenomena [1–4].

1. Singlet fission of non-polycyclic aromatic molecules in OPVs (Kawata, Pu et al., *Adv. Mater*. 2016, 28, 1585).
   Most singlet fission molecules are based on tetracene or pentacene structure. We synthesized non-acene type singlet fission molecules and investigated their OPV properties.

2. Absence of delayed fluorescence and triplet-triplet annihilation in OLEDs with spatially orthogonal bianthracenes (Pu, Satake et al., *J. Mater. Chem. C* 2019, 7, 2541).
   The anthracene molecules that we synthesized do not show the delayed fluorescence derived from triplet-triplet annihilation in OLEDs, suggesting that they do not electrically produce triplet excitons.

3. Kinetic prediction of reverse intersystem crossing in organic donor–acceptor molecules (Aizawa, Pu et al., *Nat. Commun*. 2020, 11, 3909)
   We can precisely predict reverse intersystem crossing rate of TADF materials by quantum chemical calculations with structure optimization along crossing seam of S1 and T2 geometry.

4. Delayed fluorescence from inverted singlet and triplet excited states (Aizawa, Pu et al. 2022, in press)
   Energetically lower S_1 state than T_1 state is experimentally demonstrated for heptazine type molecules.

Keynote Speaker

Prof. Yanchun HAN

Director and Professor
State Key Laboratory of Polymer Physics and Chemistry (Changchun)
University of Chinese Academy of Sciences (UCAS), China

Prof. HAN received her B. S. degree from University of Science and Technology of China (USTC) in 1990 and Ph. D. degree from Changchun Institute of Applied Chemistry (CIAC), Chinese Academy of Sciences (CAS) in 1995. From 1996-2000, she worked as a postdoc/visiting scholar at University of Naples, University of Kaiserslautern (Alexander von Humboldt Research Fellow) and University of Michigan. She joined the State Key Lab of Polymer Physics and Chemistry, CIAC as a full professor in 2000. She is the Senior Editor of POLYMER and in the editorial board of ACS Applied Materials & Interfaces, Polymer Chemistry, Polymer Crystallization, Chinese Journal of Polymer Science and Giant. Her current research interests include polymer thin films and inherent structure–property–processing relations of conjugated polymers.

Control over Solution Phase Structure and Thin Film Morphology for High Performance Conjugated Polymers

Conjugated polymers have attracted much attention for their (opto) electronic and biomedical applications. The solid-state properties of conjugated polymers depend sensitively on their morphologies across all length scales. This multiscale morphology in the solid state is largely affected by solution-state aggregates and their assembly pathways from solution to thin films. In this talk, I will address two issues, 1) how to control the precise solution-aggregate structures by changing the strength of attractive interactions between segments and 2) how the solid-state morphology and electronic and mechanical properties can be determined by solution-phase structure and assembly pathways in a controllable fashion.

Plenary Speaker

Prof. Tobin J. MARKS

Vladimir N. Ipatieff Professor of Catalytic Chemistry and Chemical and Biological Engineering
Department of Chemistry
Northwestern University, United States

Prof. MARKS received a BS from the U. of Maryland, and a PhD from MIT. Recognitions include: the U.S. National Medal of Science, Spanish Principe de Asturias Prize, MRS Von Hippel Award, Dreyfus Prize in Chemical Sciences, NAS Award in Chemical Sciences, ACS Joseph Priestley Medal, the Israel Harvey Prize, and the German Chemical Society Karl Ziegler Prize. He is a member of the U.S., German, Italian, European, and Indian National Academies of Sciences, the American Philosophical Society, the U.S. National Academy of Engineering, the American Academy of Arts and Sciences, and the U.S. National Academy of Inventors. Honorary Fellow: the U.K. Royal Society of Chemistry, the MRS, the ACS, and the Chinese Chemical Society. He has received more than 250 other national and international awards, prizes, lectureships, and fellowships. He has published 1670 peer-reviewed articles and holds 275 issued U.S. patents. ISI h-index = 168 on 117,758 citations; Google Scholar h-index = 188 and i10-index = 1224 on 148,889 citations. Honorary Doctorate Degrees: Hong Kong U. of Science and Technology, the U. of South Carolina, the Ohio State U, and the Technical U. of Munich. Marks has founded/co-founded two start-up companies and has served on advisory boards of more than 15 major corporations and/or start-ups.

Making Printable, Mechanically Agile Electronics and Opto-Electronics a Reality: Polymers, Heterojunctions, Amorphous Oxides

This lecture focuses on the challenge of designing, realizing via targeted synthesis and fabrication, characterizing via diverse physical techniques, hybridizing hard and soft matter, and understanding in depth, new, dissimilar materials families for unconventional electronics and opto-electronic devices to provide a number of targeted applications. Fabrication methodologies to achieve these goals will ultimately include high-throughput, large-area, high-resolution, environmentally benign printing and coating techniques. Materials design features to be discussed include: 1. Rationally designed high-mobility mechanically agile p- and n-type soft matter semiconductors for organic CMOS; 2. Polycrystalline and amorphous oxide semiconductors for printable, transparent, and mechanically agile electronics, 3. Hybrid organic + inorganic semiconductors for high carrier mobility, optical transparency, and mechanical agility, 4. Combining these materials sets to rapidly fabricate scalable, high-performance thin-film complementary transistors and complementary logic devices for future switching, sensing, and bioelectronics technologies.

Recent representative publications

1. Chen, Y.; Wu, J.; Lu, S.; Facchetti, A.; Marks, T.J.; Semiconducting Copolymers with Naphthalene Imide/Amide p-Conjugated Units: Synthesis, Crystallography, and Systematic Structure−Property−Mobility Correlations, *Angew. Chem.* **2022**, Online ahead of print. **DOI**:/10.1002/anie.202208201.VIP paper.
2. Chen, J.; Huang, W.; Zheng, D.; Xie, Z.; Zhuang, X.; Zhao, D.; Chen Y.; Su, N.; Chen, H.; Pankow, R.M; Gao, Z.; Yu, J.; Guo, X.; Cheng, Y.; Strzalka, J.; Yu, X.; Marks, T.J.; Facchetti, A.; Highly Stretchable Organic Electrochemical Transistors with Strain-Resistant Performance, *Nat. Mater.*, **2022**, *21*, 564–571. **DOI**:10.1038/s41563-022-01239-9.
3. Wang, B.; Huang, W.; Facchetti, A.; Marks, T.J.; Low-Temperature Thin-Film Combustion Synthesis of Metal Oxide Semiconductors: Science and Technology, in "Amorphous Oxide Semiconductors: IGZO and Related Materials for Display and Memory," Hosono, H.; Kumomi, H. Eds., First Edition, John Wiley & Sons Ltd., **2022**, Chapter 8, 159-184. **DOI**:10.1002/9781119715641.
4. Yao, Y.; Huang, W.; Chen, J.; Wang, G.; Chen, H.; Zhuang, X.; Ying, Y.; Ping, J.; Marks, T.J.; Facchetti, A.; Flexible Complementary Circuits Operating at Sub-0.5 V via Hybrid Organic-Inorganic Electrolyte-Gated Transistors, *PNAS* **2021**, *118*, e2111790118. **DOI**:10.1073/pnas.2111790118.
5. Wang, B.; Huang, W.; Lee, S.; Huang, L.; Wang, Z.; Chen, Y.: Chen, Z.; Feng, L.; Wang, G.; Yokota, T.; Someya, T.; Marks, T.J.; Facchetti, A. Foundry-Compatible High-Resolution Patterning of Vertically Phase-Separated Semiconducting Films for Ultraflexible Organic Electronics, *Nature Comm*. **2021**, *12*, 4937. **DOI:** 10.1038/s41467-021-25059-8.
6. Huang, L.; Wang, Z.; Chen, J.; Wang, B.; Chen, Y.; Huang, W.; Chi, L.; Marks, T.J.; Facchetti, A.; Porous Semiconducting Polymers Enable High-Performance Electrochemical Transistors, *Advan. Mater.* **2021**, *33*, e2007041. **DOI**:10.1002/adma.202007041.
7. Wang, B.; Thukral, A.; Xie, Z.; Liu, L.; Zhang, X.; Huang,W.; Yu, X.; Yu, C.; Marks, T.J.; Facchetti, A.; Flexible and Stretchable Metal Oxide Nanofiber Networks for Multimodal and Monolithically Integrated Wearable Electronics, *Nature Comm*. **2020**, *11*, 2405-2416. **DOI**: 10.1038/s41467-020-16268-8.
8. Wang, B.; Huang, W.; Chi, L.; Al-Hashimi, M.; Marks, T.J.; Facchetti, A.; High-*k* Gate Dielectrics for Emerging Flexible and Stretchable Electronics, *Chem. Rev.*, **2018**, *118*, 5690-5754. **DOI**: 10.1021/acs.chemrev.8b00045.

Keynote Speaker

Prof. Natalie STINGELIN

Professor
School of Materials Science and Engineering
Georgia Institute of Technology (Georgia Tech), United States

Prof. STINGELIN is a Full Professor at the Georgia Institute of Technology and Chair of the School of School of Materials Science & Engineering. She holds prior positions at Imperial College London, UK, at Queen Mary University of London, UK; the Philips Research Laboratories in Eindhoven, The Netherlands; the Cavendish Laboratories, University of Cambridge, UK; and the Swiss Federal Institute of Technology (ETH) Zürich, Switzerland. She is the Director of Georgia Tech's Center of Organic Electronics and Photonics, and was elected a 2021 Fellow of the U.S. National Academy of Inventors, a 2019 Fellow of the Materials Research Society; and is a Fellow of the Royal Society of Chemistry since 2012. Her research interests encompass the broad area of functional polymer materials, polymer physics, organic electronics & photonics, and bioelectronics.

Semiconducting: Insulating Polymer Blends Targeted for Flexible Optoelectronic Applications

In recent years, immense efforts in the flexible electronics field have led to unprecedented progress and to devices of ever increasing performance. Despite these advances, new opportunities are sought in order to widen the applications of organic-based technologies and expand their functionalities and features. Use of multicomponent systems offers a versatile approach with respect to increasing the mechanical flexibility and stability of organic electronic products as well as introducing other features such as self-encapsulation. One specific strategy is based on blending polymeric *insulators* with organic semiconductors; which has led to a desired improvement of the mechanical properties of organic devices, producing in certain scenarios robust and stable architectures. Here we discuss the working principle of semiconductor: insulator blends, examining the different approaches that have recently been reported in literature. We illustrate how organic field-effect transistors (OFET)s and organic solar cells (OPV)s can be fabricated with such systems without detrimental effects on the resulting device characteristics even at high contents of the insulator. Furthermore, we review the various properties that can be enhanced and/or manipulated by blending including air stability, mechanical toughness, H- *vs.* J-aggregation, *etc.*

Plenary Speaker

Prof. Deqing ZHANG

Director
Institute of Chemistry,
Chinese Academy of Sciences (ICCAS), China

Prof. ZHANG studied chemistry at Beijing Normal University from 1983 to 1987. He then joined in the Institute of Chemistry, Chinese Academy of Sciences (ICCAS) as a graduate student and obtained his MS. in Organic Chemistry in 1990. He conducted research on electron donor–acceptor cyclophenes at the Max-Planck Institute for Medical Research in Heidelberg (Germany) under the supervision of Prof. Dr H. A. Staab, and received his Doctor degree (DR. RER. NAT.) from Ruprecht-Karls University Heidelberg in 1996. He is now a Professor in the Institute of Chemistry, CAS. His research mainly focuses on the design and synthesis of new conjugated molecules and polymers for organic optoelectronic materials. He also show interests on external stimuli responsive molecules and supramolecules for molecular switches, logic gates and chemical sensors. He has published more than 360 papers in international refereed journals. He serves as co-editor of *ACS Omega*, and editorial advisory board or international advisory board members of *Acc. Chem. Res., Adv. Mater., Adv. Funct. Mater., Adv. Sci., Sci. China-Chem., C&EN, Asian J. Org. Chem., Polymer J., ACS App. Bio. Mater., Mater. Chem. Frontier, Aggregate*.

High Performance Polymer Semiconductors via Side Chain Functionalization

Semiconducting polymers with alternating donor and acceptor units in the backbones have been intensively investigated for the past decades. The applications of polymer semiconductors in field-effect transistors (FETs), inverters, memory devices and sensors have been successfully demonstrated. Currently, high performance polymer semiconductors are highly demanding for flexible electronics. Conjugated polymers with different backbones were explored aiming to enhance charge mobilities. Meanwhile, photo-tunable polymer semiconductors have received increasing attentions in recent years because they are inevitably needed for multi-functional devices. Furthermore, controllable photo-patterning of polymer semiconductors is the key step for device integration. In this presentation, I will discuss our recent works on boosting charge mobility, tuning the semiconducting performance, and achieving photo-patterning for conjugated D-A polymers by modification of side alkyl chains and incorporation of functional groups.

References

1. Yang, Y.; Liu, Z.; Zhang, G.; Zhang, X.; Zhang, D. Adv. Mater., **2019**, 31, 1903104.
2. Tian, J.; Liu, Z.; Wu, C.; Jiang, W.; Chen, L.; Shi, D.; Zhang, X.; Zhang, G.; Zhang, D. *Adv. Mater.,* **2021**, *33*, 2005613.
3. Tian, J.; Liu, Z.; Jiang, W.; Shi, D.; Chen, L.; Zhang, X.; Zhang, G.; Di, C.; Zhang, D. *Angew. Chem. Int. Ed.,* **2020**, *59*, 13844-13851.
4. Ma, J.; Tian, J.; Liu, Z.; Shi, D.; Zhang, X.; Zhang, G.; Zhang, D. *CCS Chemistry,* **2020**, *2*, 632-641.
5. Liu, Y.; Yang, Y.; Shi, D.; Xiao, M.; Jiang, L.; Tian, J.; Zhang, G.; Liu, Z.; Zhang, X.; Zhang, D. *Adv. Mater.,* **2019**, *31*, 1902576.
6. Tian, J.; Fu, L.; Liu, Z.; Geng, H.; Sun, Y.; Lin, G.; Zhang, X.; Zhang, G.; Zhang, D. *Adv. Funct. Mater.,* **2019**, *29*, 1807176.
7. Wu, C.; Li, C.; Yu, X.; Chen, L.; Gao, C.; Zhang, X.; Zhang, G.; Zhang, D. *Angew. Chem. Int. Ed.,* **2021**, *60*, 21521-21528.
8. Gao, C.; Shi, D.; Li, C.; Yu, X.; Zhang, X.; Liu, Z.; Zhang, G.; Zhang, D. *Adv. Sci.,* **2022**, *9*, e2106087.

Keynote Speaker

Prof. Wai-yeung WONG, Raymond

Dean, Faculty of Science
Chair Professor of Chemical Technology
The Hong Kong Polytechnic University

Prof. WONG obtained his B.Sc.(Hons.) and Ph.D. degrees from the University of Hong Kong. After postdoctoral works at Texas A&M University (Advisor: Prof. F. A. Cotton) and the University of Cambridge (Advisors: Profs. Lord Lewis and P. R. Raithby), he joined Hong Kong Baptist University from 1998 to 2016 and he now works at The Hong Kong Polytechnic University as Chair Professor of Chemical Technology and Dean of Faculty of Science. He was awarded the RSC Chemistry of the Transition Metals Award, FACS Distinguished Young Chemist Award, State Natural Science Award from China and RGC Senior Research Fellow Award, etc. His research focuses on synthetic inorganic/organometallic chemistry, especially aiming at developing metal-organic molecules and polymers for organic optoelectronics and metal-based nanomaterials.

Functional Metal-Based Nanomaterials from Metallopolymers

Metal-containing polymers represent an important research field due to their combination of unique and intriguing redox, electronic, magnetic, optical, and catalytic properties and their ability to be easily processed and fabricated into thin films, fibers, and other forms. As these metallopolymers can be readily shaped and patterned using various lithographic techniques, they offer a convenient synthetic access to patterned arrays of metal NPs with control of their composition and density per unit area. In the first part of this talk, the advances in developing new functional organometallic polyyne polymers as precursors to magnetic metal alloy nanoparticles and their lithographic patterning studies will be presented. These metallated polymers (both main-chain and side-chain polymers) are promising as building blocks in realizing high-density magnetic data storage media where the convenient and rapid patterning of magnetic NPs is highly desirable. The bottom-up synthesis of functional 2D metallopolymers from molecular precursors will also be presented in the second part and the resulting metal-complex nanosheets are shown to find wide applications in optoelectronics and catalysis.

References

1. M. Fang, L. Xu, H. Zhang, Y. Zhu and W.-Y. Wong, *J. Am. Chem. Soc.*, **2022**, *144*, 15143.
2. Y. Zhao, L. Xu, X. Wang, Z. Wang, Y. Liu, Y. Wang, Q. Wang, Z. Wang, H. Huang, Y. Liu, W.-Y. Wong and Z. Kang, *Nano Today*, **2022**, *43*, 101428.
3. L. Xu, J. Sun, T. Tang, H. Zhang, M. Sun, J. Zhang, J. Li, B. Huang, Z. Wang, Z. Xie and W.-Y. Wong, *Angew. Chem. Int. Ed.*, **2021**, *60*, 11326.
4. Z. Meng, G. Li, S.-C. Yiu, N. Zhu, Z.-Q. Yu, C.-W. Leung, I. Manners and W.-Y. Wong, *Angew. Chem. Int. Ed.*, **2020**, *59*, 11521.
5. Y. Liu, W. Deng, Z. Meng and W.-Y. Wong, *Small*, **2020**, *16*, 1905204.
6. Q. Dong, Z. Meng, C.-L. Ho, H. Guo, W. Yang, I. Manners, L. Xu and W.-Y. Wong, *Chem. Soc. Rev.*, **2018**, *47*, 4934.
7. R. Sakamoto, K. Hoshiko, Q. Liu, T. Yagi, T. Nagayama, S. Kusaka, M. Tsuchiya, Y. Kitagawa, W.-Y. Wong and H. Nishihara, *Nat. Commun.*, **2015**, *6*, 6713.
8. Q. Dong, G. Li, C.-L. Ho, M. Faisal, C.-W. Leung, P.W.-T. Pong, K. Liu, B.-Z. Tang, I. Manners and W.-Y. Wong, *Adv. Mater.*, **2012**, *24*, 1034.

Keynote Speaker

Prof. Yun MA

Professor

State Key Laboratory for Organic Electronics and Information Displays & Institute of Advanced Materials

Nanjing University of Posts and Telecommunications (NUPT), China

Prof. MA received his Ph.D degree in 2015 from Hong Kong Baptist University under supervision of Prof. Wai-Yeung Wong. He then joined the Institute of Advanced Materials, Nanjing University of Posts & Telecommunications, in 2015. He was promoted as a full professor in 2022. His research works are focused on the development novel stimuli-responsive materials for applications in information recording and anti-counterfeiting applications. Till now, he has published over 40 peer-reviewed papers in scientific journals, including *Science Advances, Nature Communications, Journal of the American Chemical Society, Angewandte Chemie International Edition, Matter, CCS Chemistry, Chemical Science*, etc. The research works were highlighted by Nature, Nature Asia, Science Daily, Chemical & Engineering News, etc.

Stimuli-Responsive Materials for Information Recording and Anti-counterfeiting Applications

In recent years, stimuli-responsive materials have attracted extensive attention due to their great potential in various optoelectronic devices. The photophysical properties of these materials can be regulated by external stimuli such as metal salts, vapors, temperature, light, electric field, and so on. The unique response behavior of these materials opened up a new way to develop optical information storage and anti-counterfeiting technologies, thus it has attracted wide attention in both scientific community and industry. Current efforts have focused on how to further improve the security level of the recorded information and the produced labels. In this talk, I will introduce our recent research works about the design, synthesis, and applications of stimuli-responsive materials: by varying the counterions and utilizing dynamic metal-ligand coordination of a series of metal complexes, their optical and responsive behaviors have been regulated on demand, and multilevel security printing have been successfully achieved.

Plenary Speaker

Prof. Iain McCulloch

Professor
Polymer Chemistry
Department of Chemistry
University of Oxford, United Kingdom

Prof. McCulloch is a Professor of Polymer Chemistry in the Department of Chemistry at the University of Oxford since 2020. Prior to this, he held joint appointments as Professor of Chemical Science and Director of KAUST Solar Center at KAUST, as well as a Chair in Polymer Materials in the Chemistry Department at Imperial College. Previously, he spent 18 years managing industrial research groups at Hoechst in the US and Merck in the UK. He is a Fellow of the Royal Society, the Royal Society of Chemistry, the European Academy of Sciences and a Member of Academia Europaea. He is the recipient of the 2022 Royal Society Armourers and Brasiers Company Prize. 2020 Blaise Pascal Medal for Materials Science, the Royal Society of Chemistry 2020 Interdisciplinary Prize, 2014 Tilden Medal for Advances in Chemistry and the 2009 Creativity in Industry Prize. His interests are in the design and investigation of organic semiconducting materials.

Designing High Performing Semiconducting Polymers

Organic semiconductors have been demonstrated to be attractive materials in a range of emerging products including flexible displays, transparent solar cells, biosensors and solar fuels. Understanding the impact of the organic semiconductor chemical design on the application properties, is critical for further advances. We have explored a range of synthetic strategies and molecular designs, and measured a range of relevant morphological, electrical and optical properties in order to establish fundamental structure-property relationships. This presentation will illustrate a case study design and characterisation of semiconducting polymers, their thin film morphology, demonstrating improvements in charge transport performance in field effect and electrochemical transistors.

Keynote Speaker

Prof. Xunjin ZHU
Associate Professor
Department of Chemistry
Hong Kong Baptist University (HKBU)

Prof. ZHU is currently Associate Professor at the Department of Chemistry, Hong Kong Baptist University. Prof. ZHU obtained his PhD degree in 2006 at the Department of Chemistry, Hong Kong Baptist University, and worked as post-doctoral fellow from 2006 to 2008 at the University of Texas at Austin and from 2008 to 2010 at Georgia Institute of Technology. He started his academic career as Research Assistant Professor in 2010 and continued as Assistant Professor from 2016 to 2019 at the Department of Chemistry, Hong Kong Baptist University. His current research interests focus on the design and synthesis of porphyrin materials for organic solar cells, artificial photosynthesis, and electrocatalysis.

Porphyrin Small Molecules for Photocatalytic Hydrogen Evolution

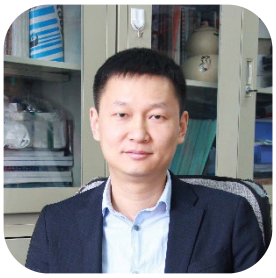
Recently, photocatalytic hydrogen evolution (PHE) has been intensively researched for producing H_2 as a clean energy and renewable fuel. Over the last few decades, porphyrins and their derivatives have received immense interest for artificial photosynthesis which mimics the natural photosynthesis of plants. To apply porphyrins as photosensitizer in PHE, we first reported that the conjugation of naphthalimide (NI) chromophore to the Zn(II)-porphyrin ring enhanced the PHE of porphyrin photosensitizers.[1] This is mainly because a Förster resonance energy transfer (FRET) from the NI energy donor to the porphyrin ring energy acceptor improves the light-harvesting property and stabilizes the photoexcited singlet states of porphyrin with a longer electron lifetime, and further facilitates an efficient photoinduced hole-electron separation and fast migration in the photocatalytic systems. Next, we further demonstrated that that NI-conjugated Pt(II)-porphyrins are capable of undergoing highly efficient cocatalyst-free PHE due to the FRET and the long-lived triplet excited states of Pt(II)-porphyrin. At the same time, the conjugation of Ir-complex onto Zn(II)-porphyrin through a phenyl linkage, leads to a synergistic effect of aggregation-induced emission (AIE), aggregation caused by quenching (ACQ) inhibition, and FRET.[2] As a result, this complex exhibits highly efficient cocatalyst-free PHE because of efficient UV-visible light-harvesting, longer photoexcited electron lifetime, and thereby more efficient electron transfer from the photoexcited porphyrin to the proton for water reduction.

References

1. Bodedla, G. B.; Li, L. L.; Che, Y. Y.; Jiang, Y. J.; Huang, J.; Zhao, J. Z.; Zhu, X. J. *Chem. Commun.* **2018**, *54* (82), 11614-11617.

2. Zheng, K. L.; Bodedla, G. B.; Hou, Y. Q.; Zhang, J.; Liang, R. H.; Zhao, J. Z.; Phillips, D. L.; Zhu, X. J. *J. Mater. Chem. A* **2022**, *10* (8), 4440-4445.

Keynote Speaker



Prof. Hui XU

Dean, School of Chemistry and Materials Science
Deputy Director, Key Laboratory of Functional Inorganic Material Chemistry (Chinese Ministry of Education)
Heilongjiang University, China

Prof. XU received his PhD degree in Organic Chemistry from Fudan University under the supervision of Professor Wei Huang. Then he joined the Key Laboratory of Functional Inorganic Material Chemistry of Heilongjiang University in 2006 and promoted full professor in 2011. From 2011 to 2013, he worked in Professor Xiaogang Liu's group of National University of Singapore as a postdoctoral researcher. From 2018 to 2019, he was supported by Humboldt Fellowship for Experienced Researchers and worked in Professor Meerholz group in Cologne University. He is dean of school of chemistry and materials science and deputy director of the Key Laboratory of Functional Inorganic Material Chemistry (Chinese Ministry of Education). He was elected in Young Scholar Project of Changjiang Scholars Program of China and Longjiang Scholars Program of Heilongjiang Province. He has published more than 100 peer-reviewed SCI papers in Nat. Photon., Sci. Adv., Nat. Commun., Chem, J. Am. Chem. Soc., Angew. Chem. Int. Ed., Adv. Mater., and so on, with citations over 4000, and awarded the first class of Heilongjiang province science and technology award. His current research focuses on phosphorus-containing functional materials, including small molecules, complexes and polymers, for optoelectronic applications, which encompasses chemistry, material science and device physics. The classical chemical techniques are used as the underlying approach for assembling phosphorus-containing building blocks into integrated systems and exploring new applications, e.g. organic light-emitting diodes, photodetectors and solar cells. In particular, he is interested in utilizing electronic and spatial effects of phosphorus-based functional groups to control excited-state characteristics and intermolecular interactions and discovering new scientific phenomena.

Thermally Activated Delayed Fluorescence White OLEDs

Keywords: TADF, OLED, Exciton Allocation, Energy Transfer, White, Lighting

White thermally activated delayed fluorescence (TADF) materials and devices emerge rapidly.[1] TADF materials based on organic molecular systems endow the devices with the merits of low cost, sustainability and environmental friendliness and so on. Therefore, white TADF diodes have the huge potential in daily lighting applications. However, the large polarity, serious quenching and marked dependence on device structures of TADF molecules induce the big challenges in developing high-performance TADF white OLEDs (WOLED). To avert these issues, most of TADF WOLEDs adopted complicated device structures of multiple hosts and emitting layers (EML).

Based on our previous works about blue TADF materials and devices, in recent years, we further realized high-performance single-EML TADF WOLEDs, through optimizing excite-state characteristics and aggregation behaviors of hosts and blue TADF molecules, and tuning carrier and exciton allocation processes between blue and yellow dopant.[2] The maximum external quantum efficiencies were beyond 20%, accompanied by effectively suppressed efficiency roll-offs, reaching the state-of-the-art levels of white phosphorescent OLEDs.

References

1. H. Uoyama, K. Goushi, K. Shizu, H. Nomura, C. Adachi, *Nature* **2012**, *492*, 234-238.

2. a) J. Zhang, D. Ding, Y. Wei, F. Han, H. Xu, W. Huang, *Adv. Mater.* **2016**, *28*, 479-485; b) D. Ding, Z. Wang, C. Li, J. Zhang, C. Duan, Y. Wei, H. Xu, *Adv. Mater.* **2020**, *32*, 1906950; c) C. Han, R. Du, H. Xu, S. Han, P. Ma, J. Bian, C. Duan, Y. Wei, M. Sun, X. Liu, W. Huang, *Nat Commun* **2021**, *12*, 3640.

Plenary Speaker

Prof. Jinsong HUANG

Louis D. Rubin Jr. Distinguished Professor
Department of Applied Physical Sciences
University of North Carolina, United States

Prof. HUANG is currently Louis D. Rubin, Jr. Distinguished Professor at University of North Carolina at Chapel Hill. He received his PhD degree in Material Science and Engineering from the University of California-Los Angeles in 2007. After working in a small business company for two years, he joined the University of Nebraska-Lincoln in 2009 as an assistant professor in the Department of Mechanical and Materials Engineering, and was promoted to associate professor with tenure in 2014, and professor in 2016. He joined the faculty in the department of Applied Physical Sciences of University of North Carolina at Chapel Hill in 2017. His current research interests include solution processed electronic materials for applications in energy, sensing, and consumer electronics. He has authored > 240 publications, >30 patents, >10 books and book chapters. He has been in Highly Cited Researchers List since 2016.

Defects, Efficiency and Stability of Metal Halide Perovskites

Electronic defects within the band gap of semiconductor materials play critical roles in determining the efficiency and stability of their photovoltaic devices. Eliminating deleterious defects in semiconductors or passivating them during the fabrication process of solar cells has become one of the most fundamental tasks for the solar cell society. This scenario is also prevailing in the metal halide perovskite solar cell community which has witnessed a rapid increase of the power conversion efficiency (PCE) of perovskite solar cells from 3.8% to close to 26% with overwhelming reported progress on defect passivation strategies which also enhance the stability of perovskite solar cells. Any further improvement of the efficiency or stability of perovskite solar cells toward their Shockley-Queisser limitations have to rely on deeper understandings on the nature of defects in perovskite to squeeze out all non-radiative charge recombination paths by eliminating or passivating them.

Defects in perovskites have already been intensively studied in recent years, but there is still no consensus on the defect chemical nature, their distributions, and their evolution during degradation. For example, calculations gave controversial results, i.e. different defects, including halide interstitials and metal vacancies (VPb) or antisite (IMA), that cause deep traps in the most studied and simplest perovskite of methylammonium lead triiodide (MAPbI3). In this talk, I will first present our demonstration that using the drive-level capacitance profiling (DLCP) technique to profile both the spatial and energetic distributions of charge traps in perovskite solar cells. Then I will report our progress in combining the DLCP technique with electrical poling to determine the charge states and eventually the chemical nature of mobile defects in perovskites. This study revealed some astonishing discovery on the defects in perovskites of different compositions, and mechanism of solar cell degradation under reverse bias and under illumination. If time allows, I will also present our progress in the development of efficient perovskite minimodules, including both single junction and tandem ones.

Keynote Speaker

Prof. Yanfa YAN

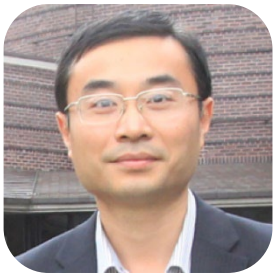
Distinguished University Professor
Department of Physics and Astronomy
Wright Center for Photovoltaics Innovation and Commercialization
The University of Toledo, United States

Prof. YAN is a Distinguished University Professor in the Department of Physics and Astronomy and Wright Center for Photovoltaics Innovation and Commercialization at The University of Toledo. He holds the Ohio Research Scholar Endowed Chair, since 2011. Previously, he was a Principal Scientist at the National Renewable Energy Laboratory. His expertise includes thin-film solar cell fabrication, defect physics of semiconductors, and nanoscale characterization of microstructures, interfaces, and defects in thin-film photovoltaic materials. He is a Fellow of the American Physical Society.

From Lead Halide Perovskites to Lead-Free Metal Halide Perovskites and Perovskite Derivatives

Lead (Pb) halide perovskites have attracted great attention in photovoltaic (PV) and light-emitting diode (LED) applications due to their outstanding optoelectronic and defect properties. Despite the exciting progress on device performance, the commercialization of these emerging technologies still face significant challenges, one of which is the inclusion of toxic Pb. Searching for Pb-free perovskite solar cell absorbers has been an attractive research direction. In this presentation, we discuss the approaches for Pb replacement and their consequences. We will report on the theoretical understanding of the electronic, optical, and defect properties of Pb and Pb-free halide perovskites and perovskite derivatives as well as the experimental results available in the literature. The theoretical understanding explains well why Pb halide perovskites exhibit superior photovoltaic properties, but Pb-free perovskites and perovskite derivatives do not. The application of Pb-free perovskites in LED applications will also be discussed.

Keynote Speaker



Prof. Yabing QI

Professor
Energy Materials and Surface Sciences Unit
Okinawa Institute of Science and Technology Graduate University (OIST), Japan

Prof. QI is Professor and Unit Director of Energy Materials and Surface Sciences Unit at Okinawa Institute of Science and Technology Graduate University in Japan. He received his B.S., M.Phil., and Ph.D. from Nanjing University, Hong Kong University of Science and Technology, and UC Berkeley, respectively. His research interests include surface / interface sciences, perovskite solar cells, lithi-um batteries, and organic electronics

Surface Science Studies on Metal Halide Perovskite Materials and Their Solar Cell Applications

Metal halide perovskite materials and their versatile applications have continued to attract immense attention from both academia and industry. In particular, perovskite-based solar cells have been considered a promising candidate for next-generation photovoltaic technology. In these solar cell devices, surfaces and interfaces play a pivotal role. My group at OIST has been utilizing surface science and advanced material characterization to obtain in-depth understanding about perovskite materials. In this talk, I will present our research progress on surface science studies on perovskite materials [1-4]. Also, I will briefly discuss about a few examples to illustrate how to utilize these surface science findings in perovskite solar cell device applications [5-7].

References

1. R. Ohmann, L. K. Ono, H.-S. Kim, H. Lin, M. V. Lee, Y. Li*, N.-G. Park*, Y. B. Qi*, “Real-Space Imaging of the Atomic Structure of Organic–Inorganic Perovskite”, *J. Am. Chem. Soc.* **137**, *16049* (2015).
2. J. Hieulle, X. Wang, C. Stecker, D.-Y. Son, L. Qiu, R. Ohmann, L. K. Ono, A. Mugarza, Y. Yan*, Y. B. Qi*, “Unraveling the Impact of Halide Mixing on Perovskite Stability”, *J. Am. Chem. Soc.* **141***, 3515* (2019).
3. A. Jamshaid, Z. Guo, J. Hieulle, C. Stecker, R. Ohmann, L. K. Ono, L. Qiu, G. Tong, W. Yin*, Y. B. Qi*, “Atomic-scale Insight into Enhanced Surface Stability of Methylammonium Lead Iodide Perovskite by Controlled Deposition of Lead Chloride”, *Energy Environ. Sci.* **14***, 4541* (2021).
4. C. Stecker, K. Liu, J. Hieulle, R. Ohmann, Z. Liu, L. K. Ono, G. Wang*, Y. B. Qi*, “Surface Defect Dynamics in Organic–Inorganic Hybrid Perovskites: From Mechanism to Interfacial Properties”, *ACS Nano* **13**, *12127* (2019).
5. Z. Liu, L. Qiu, E. J. Juarez-Perez, Z. Hawash, T. Kim, Y. Jiang, Z. Wu, S. R. Raga, L. K. Ono, S. Liu, Y. B. Qi*, “Gas-solid reaction based over one-micrometer thick stable perovskite films for efficient solar cells and modules”, *Nat. Commun.* **9**, *3880* (2018).
6. Z. Liu, L. Qiu, L. K Ono, S. He, Z. Hu, M. Jiang, G. Tong, Z. Wu, Y. Jiang, D.-Y. Son, Y. Dang, S. Kazaoui, Y. B. Qi*, “A holistic approach to interface stabilization for efficient perovskite solar modules with over 2,000-hour operational stability”, *Nat. Energy* **5**, *596* (2020).
7. T. Bu, L. K. Ono, J. Li, J. Su, G. Tong, W. Zhang, Y. Liu, J. Zhang, J. Chang, S. Kazaoui, F. Huang, Y.-B. Cheng, Y. B. Qi*, “Modulating crystal growth of formamidinium-caesium perovskites for over 200 cm2 photovoltaic sub-modules”, *Nature Energy* **7**, *528* (2022).

Plenary Speaker

Prof. Tsutomu MIYASAKA

Professor
Faculty of Biomedical Engineering
Toin University of Yokohama, Japan

Prof. MIYASAKA completed the Graduate School of Engineering, the University of Tokyo in 1981 (Doctor of Engineering). He was a senior researcher at the Ashigara Research Institute of Fuji Photo Film Co., Ltd. in 1981-2001, and has been a professor at the Graduate School of Engineering, Toin University of Yokohama (TUY) since 2001, serving as the Dean of the Graduate School of Engineering from 2006 to 2009. From 2005 to 2010, he was also a guest professor at the Graduate School of Arts and Sciences, the University of Tokyo. He founded Peccell Technologies Co., Ltd. in 2004 and is the CEO. He is currently a project professor at TUY and a fellow of Research Center of Advanced Science and Technology, the University of Tokyo. His research specializes in photoelectrochemistry and hybrid photovoltaic cells, especially halide perovskite solar cells. Awards include Rank Prize in Optoelectronics (2021), Clarivate Analytics Citation Honor Award (2017), Japan Society of Applied Physics Achievement Award (2019), Chemical Society of Japan Award (2017), PVSEC Hamakawa Award (2017), Ichimura Academic Award (2020), etc.

Perovskite Solar Cells That Challenge the Pinnacle of Printable Photovoltaic Device

Since our first discovery of perovskite solar cell (PSC) in 2006-2009, enormous efforts have been put into different aspects of PSCs and the progress has been incredibly fast leading to the present highest power conversion efficiency (PCE) of 25.7%. The current R&Ds of PSCs are focused on interfacial engineering for defect passivation, compositional engineering for improved durability, and fabrication of large area modules and muti-junction tandem cells.[1] We have been tackling the method of interfacial passivation with functional organic molecules, which enables high voltage output (close to theoretical limit) in photovoltaic performance with PCE>22%.[2] Although the photovoltaic performance has improved, the stability of the devices still remains an issue to be improved. Use of organic cations in halide perovskites and diffusible dopants in hole transport materials (HTMs) are responsible for low stability of perovskites at high temperatures (>120°C). In this respect, all-inorganic compositions of perovskite and use of dopant-free HTMs are highly desired. We are currently focus our R&D on inorganic $CsPbX_3$ (X=I, Br) perovskites in combination of dopant-free HTMs.[2] By compositional changes at hetero-junction interfaces, $CsPbI_2Br$ PSCs achieved PCEs of >17% under 1 sun and >34% under indoor LED illumination.[3] As inorganic perovskites, lead-free compositions such as Ag-Bi halides have become an important target for achieving environmentally kind PSCs.[4]

Applications of PSCs in space environments are also promising because thin perovskite photovoltaic films demonstrate high stability and tolerance against exposure to high energy particle irradiations (proton and electron beams).[5] Thin absorbers (<500 nm) avoid accumulation of particles and due to intrinsic defect tolerant nature of perovskites, radiation-induced collision damage is highly suppressed. Based on our current R&Ds, future perspectives of perovskite photovoltaics will be presented.

1. T. Miyasaka, editor, *Perovskite Photovoltaics and Optoelectronics —From Fundamentals to Advanced Applications—*, Wiley-VCH, Weinheim, 2021, ISBN: 978-3-527-34748-3.
2. G. M. Kim, H. Sato, Y. Ohkura, A. Ishii, and T. Miyasaka, *Adv. Energy Mat*. **2022**, 12, 2102856.
3. Z. Guo, A. K. Jena, I. Takei, M. Ikegami, A. Ishii, Y. Numata, N. Shibayama, T. Miyasaka, *Adv. Func. Mat*. **2021**, 31, 2103614.
4. T. Miyasaka, A. Kulkarni, Gyu Min Kim, Senol Öz, A. K. Jena, *Adv. Energy. Mat.* **2019**, 1902500.
5. Y. Miyazawa, M. Ikegami, H.-W. Chen, T. Ohshima, M. Imaizumi, K. Hirose, T. Miyasaka, *iScience* **2018,** 2, 148.

Keynote Speaker

Prof. Xinhui LU

Associate Professor
Department of Physics
The Chinese University of Hong Kong (CUHK)

Prof. LU is an associate professor in the Department of Physics, the Chinese University of Hong Kong. She received her bachelor's degree from Nanjing University and PhD degree from Yale University. Then, she worked as a postdoctoral research associate at Brookhaven National Laboratory before joining CUHK. Her research interest lies in energy related material science and experimental soft condensed matter physics, including morphology and device performance of organic and perovskite photovoltaic materials, bulk and surface structure of functional thin films and synchrotron x-ray scattering techniques. She is a council member of Physical Society of Hong Kong and Chinese Neutron Scattering Society, and Clarivate Highly Cited Researcher 2020.

Microstructure Studies of Organic and Perovskite Solar Cells Based on Grazing Incidence Scattering Techniques

Nowadays, solar industry becomes the fastest growing industry due to the rising demands to solve the energy crisis and environmental problems. Third-generation solar cells, such as organic and perovskite solar cells are all relying on a semiconducting thin-film active layer to harvest the solar energy. The bulk morphology of the active layer in terms of crystal structure, orientation, grain size and nanophase separation behaviors is known to be critical to the solar cell device performance. Here, we will present our recent studies on the process-structure-device correlation of organic and perovskite solar cells. In these studies, state-of-art grazing incidence scattering techniques using X-rays and neutrons were employed for various purposes, such as grazing incidence wide-angle/small-angle X-ray scattering (GIWAXS/GISAXS), grazing incidence transmission small-angle X-ray scattering (GTSAXS), grazing incidence neutron scattering (GISANS). These techniques can also be applied in material science, chemistry, biology and condensed matter physics studies. By modifying the wavelength of the probing beam and the experimental geometry, a variety of sample types, such as solutions, powders, surfaces and thin films, can be studied, covering wide length scales as well as versatile dynamic and kinetic behaviors.

Keywords：Organic Photovoltaics, Perovskite Solar Cells, GIWAXS, GTSAXS, GISANS

Reference

1. X. Xia, T-K. Lau, X. Guo, Y. Li, M. Qin, K. Liu, Z. Chen, X. Zhan, Y. Xiao, P. F. Chan, H. Liu, L. Xu, G. Cai, N. Li, H. Zhu, G. Li, Y. Zhu, T. Zhu, X. Zhan, X-L. Wang and **X. Lu***, Uncovering the Out-of-plane Nanomorphology of Organic Photovoltaic Bulk Heterojunction by GTSAXS, ***Nature Communications***, 2021, 12, 6226.
2. M. Qin, H. Xue, H. Zhang, H. Hu, K. Liu, Y. Li, Z. Qin, J. Ma, H. Zhu, K. Yan, G. Fang, G. Li, U-S. Jeng, G. Brocks, S. Tao*, and **X. Lu***, Precise Control of Perovskite Crystallization Kinetics via Sequential A-site Doping, ***Advanced Materials***, 2020, 2004630.
3. M. Qin, K. Tse, T.-K Lau, Y. Li, C.-J. Su, G. Yang, J. Chen, J. Zhu, U-S. Jeng, G. Li, H. Chen, and **X. Lu***, Manipulating the Mixed-Perovskite Crystallization Pathway Unveiled by In Situ GIWAXS, ***Advanced Materials*****,** 2019, 1901284.
4. J. Mai, Y. Xiao, G. Zhou, J. Wang, J. Zhu, N. Zhao, X. Zhan, **X. Lu***, Hidden Structure Ordering along Backbone of Fused-ring Electron Acceptors Enhanced by Ternary Bulk Heterojunction, ***Advanced Materials***, 2018, 1802888.

Plenary Speaker

Prof. Yongfang LI

Professor
Institute of Chemistry,
Chinese Academy of Sciences (ICCAS)
Soochow University, China

Prof. LI is a professor in Institute of Chemistry, Chinese Academy of Sciences (ICCAS) and in Soochow University. He received his Ph. D. degree from department of Chemistry, Fudan University in 1986, then did his postdoctoral research at ICCAS from 1986 to 1988. He became a staff in 1988 and promoted to professor in 1993 in ICCAS. He was elected as a member of Chinese Academy of Sciences in 2013. His present research field is photovoltaic materials and devices for polymer solar cells and perovskite solar cells. He has published more than 900 research papers and the published papers have been cited by others for more than 65000 times with h-index of 124.

Photovoltaic Materials for Polymer Solar Cells

Polymer solar cells (PSCs) are composed of a blend active layer of a *p*-type conjugated polymer (*p*-CP) as donor and an *n*-type organic semiconductor (*n*-OS) as acceptor, sandwiched between a transparent electrode and a metal electrode. The photovoltaic materials and devices of the PSCs have attracted great attention in recent years, due to their advantages of low-cost solution-processing, light weight, thin active layer, and capability to be fabricated into flexible and semitransparent devices. In this presentation, I will talk about the recent research progress of the photovoltaic materials of the PSCs, including the molecular design strategy of the high performance photovoltaic materials[1], the narrow bandgap small molecule acceptors (SMAs)[2,3], the wide bandgap *p*-CP donors matching with the narrow bandgap SMAs[4] and the low cost polymer donors[5], the conjugated polymer acceptors based on the polymerized small molecule acceptors (PSMAs) and all-polymer solar cells[6.7].

References

1. Yongfang Li, *Acc. Chem. Res*., **2012**, *45,* 723–733.
2. J. Yuan, Y. Zhang, L. Zhou, G. Zhang, H.-L. Yip, T.-K. Lau, X. Lu, C. Zhu, H. Peng, P. A. Johnson, M. Leclerc, Y. Cao, J. Ulanski, Y. F. Li, Y. Zou, *Joule*, **2019**, *3*, 1140.
3. X. Kong, C. Zhu, J. Zhang, L. Meng, S. Qin, J. Zhang, J. Li, Z. Wei, Y. F. Li, *Energy Envion. Sci*. **2022**, *15* (5), 2011–2020.
4. C. Zhu, L. Meng, J. Zhang, S. Qin, W. Lai, B. Qiu, J. Yuan, Y. Wan, W. Huang, Y. F. Li, *Adv. Mater.* **2021**, e2100474.
5. C. Sun, F. Pan, H. Bin, J. Zhang, L. Xue, B. Qiu, Z. Wei, Z. G. Zhang, Y. F. Li, *Nat. Commun.* **2018,** *9* (1), 743.
6. Z.-G. Zhang, Y. Yang, J. Yao, L. Xue, S. Chen, X. Li, W. Morrison, C. Yang, Y. F. Li, *Angew. Chem., Int. Ed.* **2017**, *56*, 13503-13507.
7. Z. G. Zhang, Y. F. Li, *Angew. Chem., Int. Ed.* **2021**, *60*, 4422-4433.

Keynote Speaker

Prof. Zhiyuan XIE

Professor
State Key Laboratory of Polymer Physics and Chemistry
Changchun Institute of Applied Chemistry (CIAC)
Chinese Academy of Sciences (CAS), China

Prof. XIE received his B. S. degree in 1993 and Ph. D degree in 1999 from Jilin University. In 2000-2003, he worked as a senior research assistant at City University of Hong Kong. He joined the state key lab of polymer physics and chemistry, Changchun Institute of Applied Chemistry, Chinese Academy of Sciences in 2004. He was selected to 100-Talent program of the Chinese Academy of Sciences in 2004 and got National Science Fund for Distinguished Young Scholars in 2013. His research interests include organic photovoltaic materials and devices and organic/inorganic hybrid perovskite light-emitting diodes. Prof. XIE has authored more than 200 scientific papers and 18 patents in the field of organic optoelectronic materials and devices. The published papers have been cited over 7000 times.

Polymer Solar Cells Fabricated with Printed Transparent Electrode and Active Layers

Polymer solar cells (PSCs) have advantages of light-weight, mechanical flexibility and high efficiency, and are compatible with low-cost solution-processed technology. Fabrication of high-performance PSCs with potential scalable coating and non-halogenated solvent processing is a necessity. In this talk, we will report our achievement on printed AgNWs-based transparent electrode and morphological manipulation of printed active layer for the printed PSCs. We used non-halogenated solvents combining with high-temperature blade-coating to prepare the PM6:Y6 blend layer. High-temperature blade-coating and non-halogenated *o*-XY:DMN solvent successfully suppress the excessive aggregation of Y6 and enhance crystallinity of PM6 and Y6 by regulating dynamic process of the active layer formation. We will also report a kind of AgNWs:metal oxide composite transparent conducting film prepared with blade-coating method. The printed flexible PSCs employing the AgNWs:metal oxide composite transparent electrode were fabricated.

Keynote Speaker

Prof. Zhicai HE
Professor
School of Materials Science and Engineering
South China University of Technology (SCUT), China

Prof. HE is currently a professor at South China University of Technology. He has won the second prize of the National Natural Science Award of China, the first prize of the Natural Science of the Ministry of Education of China, and has been supported by the National High-level Talent Programs.

Prof. HE is mainly engaged in the research of organic optoelectronic materials and device mechanism. In recent years, he has made important research achievements in the working mechanism of organic interface materials of Organic Solar Cells and has published more than 60 papers with more than 7,000 times citations.

A Brief Story about the Water-/Alcohol-Soluble Interlayers in Organic Electronics

Water-soluble/alcohol-soluble polyelectrolytes used in organic electronics are proposed to able to reduce the work function of the underlying surface due to the effect of interfacial dipoles, which may lead to a better charge transport in organic electronic devices. Here, I would like to introduce our researches on the formation mechanism of such interlayers, especially the formation dynamics of interfacial dipoles.

References

1. *Sol. RRL* 2021, 2000753, https://doi.org/10.1002/solr.202000753
2. *Langmuir* 2021, 37, 4347-4354, https://doi.org/10.1021/acs.langmuir.1c00413
3. *Nat. Photonics* 2012, 6, 591. https://doi.org/10.1038/nphoton.2012.190
4. *Adv. Mater.* 2011, 23, 4636. https://doi.org/10.1002/adma.201101319

Keynote Speaker

Prof. Dongge MA

Professor
Institute of Polymer Optoelectronic Materials and Devices
State Key Laboratory of Luminescent Materials and Devices
South China University of Technology (SCUT), China

Prof. MA received his B. S. degree from Liaoning University in 1989, and M.S. and Ph.D. degree from Jilin University in 1992 and 1995, respectively. From 1995-1998, he worked as a postdoct/associate professor at Changchun Institute of Applied Chemistry, Chinese Academy of Science. During 1998-2001, he became a visiting professor at Universidade Federal do Parana, Brazil, and a senior research fellow at Durham University and St Andrews University, UK. He joined State Key Lab of Polymer Physics and Chemistry, Changchun Institute of Applied Chemistry, Chinese Academy of Science as a full professor in 2001. Since 2016, he has been a full professor at State Key Laboratory of Luminescence Materials and Devices in South China University of Technology. He was highly cited scientist of Thomson Reuters (Clarivate) from 2014 to 2018. His research interests are on organic optoelectronic devices and physics, including organic light-emitting diodes (OLEDs) and its applications in lighting, organic photodetectors (OPDs), organic spintronics, organic lasers and exciton dynamics and electronic processes in organic semiconductors.

High efficiency OLEDs based on AIE materials

Aggregation-induced emission (AIE) luminogens (AIEgens) have become an promising electroluminscence material in organic light-emitting diodes (OLEDs) due to the important characteristic of a strong emission with 100% photoluminescence (PL) quantum efficiency in solid film, which has been attributed to the highly twisted conformation and weak intermolecular interaction. In this report, we fabricated high efficiency of over 7% blue OLEDs based on non-doped AIEs as emitter, and further improved it to 10.2% by the design of device structure. More recently, we found that the EL emission of AIE materials exists severe singlet–triplet annihilation (STA), and the STA can be efficiently suppressed by doping a triplet-triplet annihilation up-conversion organic molecule, thus the efficiency of the resulting blue OLEDs was enhanced to 11.8% with CIE coordinates of (0.15, 0.07). The detailed mechanisms were studied by theory calculation, and photophysics and magnetic electroluminescence (MEL) measurements. In addition, we found that AIEs are also excellent host of red, green and yellow phosphors, thus high efficiency phosphorescence OLEDs can be fabricated. On this basis, we have successfully developed white OLEDs based on highly efficient blue AIE molecules. The power efficiency reaches about the maximum value of 100 lm/W and 72.1 lm/W at the luminance of 1000 cd/m^2.

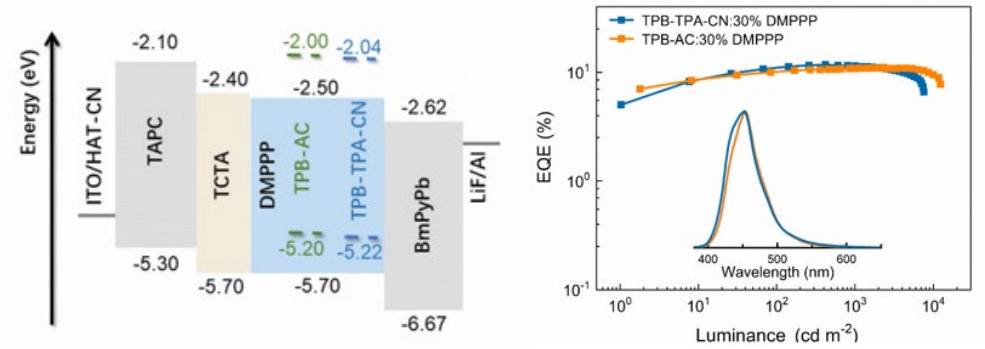


Figure 1. Device structure of two AIE materials doped OLEDs (left) and their EQE-luminance characteristics.

References

1. Xu, Z.; Gu, J.; Qiao, X. Qiao,; Qin, A.; Tang, B. Z.; Ma, D. *ACS Photonics* **2019**, *6*, 767.
2. Guo, X.; Yuan, P.; Qiao, X.; Yang, D.; Dai, Y.; Sun, Q.; Qin, A.; Tang, B. Z.; Ma, D. *Adv. Funct. Mater.* **2020**, 30, 908704.
3. Guo, X.; Yuan, P.; Fan, J.; Qiao, X.; Yang, D.; Dai, Y.; Sun, Q.; Qin, A.; Tang, B. Z.; Ma, D. *Adv. Mater.* **2021**, 33, 2006953.
4. Lin, C.; Han, P.; Qu, F.; Xiao, S.; Li, Y.; Xie, D.; Qiao, X.; Yang, D.; Dai, Y.; Sun, Q.; Qin, A.; Tang, B. Z.; Ma, D. *Mater. Horizon* **2022**, : DOI: 10.1039/d2mh00627h.

Plenary Speaker

Prof. Henning SIRRINGHAUS

Hitachi Professor, Electron Device Physics
Royal Society Research Professor
Cavendish Laboratory, Department of Physics
University of Cambridge, United Kingdom

Prof. SIRRINGHAUS, FRS is the Hitachi Professor of Electron Device Physics and a Royal Society Research Professor at the Cavendish Laboratory, University of Cambridge. He works on the charge transport, photo- and device physics and thermoelectric properties of conjugated polymer and molecular semiconductors as well as hybrid organic-inorganic semiconductors. He is a cofounder of the technology company FlexEnable/Plastic Logic commercialising organic transistor technology for applications in flexible electronics.

Charge Transport Physics of Organic and Hybrid Perovskite Field Effect Transistors

Field-effect transistors based on organic and hybrid metal halide perovskite semiconductors provide a controlled means of studying the charge transport physics of these materials and are also of interest for a broad range of applications in electronics, optoelectronics or bioelectronics. In this talk we will provide a general overview of the structure-property relationships that determine the charge transport physics and performance of hybrid perovskite FETs and we will also discuss our current understanding of the factors that govern and limit the operational stability of conjugated polymer FETs for applications in large area electronics.

Keynote Speaker

Prof. Feng YAN

Professor
Department of Applied Physics
The Hong Kong Polytechnic University

Prof. YAN has research interests on organic electronics, 2D materials, solar cells, thin film transistors, biosensors and smart materials. He received his PhD degree in physics from Nanjing University in 1997 and then worked at the Department of Physics of Nanjing University as Associate Professor until Jan 2001. He joined the Engineering Department of Cambridge University in Feb 2001 as a Research Associate and joined National Physical Laboratory in UK in April 2006 as a Higher Research Scientist. He became an Assistant Professor at the Department of Applied Physics of The Hong Kong Polytechnic University in September 2006 and was promoted to Full Professor in 2016. He has published more than 280 papers in peer-reviewed journals including Advanced Materials, Nature Communications, Science Advances, Nano Letters, ACS Nano, Chemical Society Reviews, Energy & Environmental Science, Angewandte Chemie International Edition and Journal of the American Chemical Society, and given more than 70 invited talks in international conferences. The publications have received more than 20,000 citations with h-index of 79 in google scholar. He is a “highly cited researcher” selected by ClarivateTM in 2021, a fellow of the Royal Society of Chemistry and a Senior member of IEEE.

Flexible Organic Transistors for Sensing Applications

Flexible organic transistors have been successfully used in numerous sensing applications, such as biosensors, photodetectors and chemical sensors. Our group have been working on organic transistor – based sensors for many years. In this talk, I will introduce the following applications: (1) Biosensors based on organic transistors. By modifying the gate electrodes of organic transistors, we have realized the detection of various type of biomolecules, such as IgG antibody, protein biomarkers and RNA. In particular, portable and ultrasensitive COVID-19 IgG detection has been achieved with low-cost and flexible organic electrochemical transistors. (2) Transistors based on 2D metal-organic frameworks (MOF) Films. Flexible photodetectors based on MOF thin films exhibit reliable photo-responses at room temperature in a wavelength region from ultraviolet (UV) to mid-infrared (MIR). The photodetectors can show a typical synaptic behavior and excellent data recognition accuracy in artificial neural networks. Moreover, we have demonstrated high-performance organic electrochemical transistors based on highly oriented 2D c-MOFs and used for various sensing applications. These works indicate that organic transistors are excellent transducers for flexible/wearable electronics.

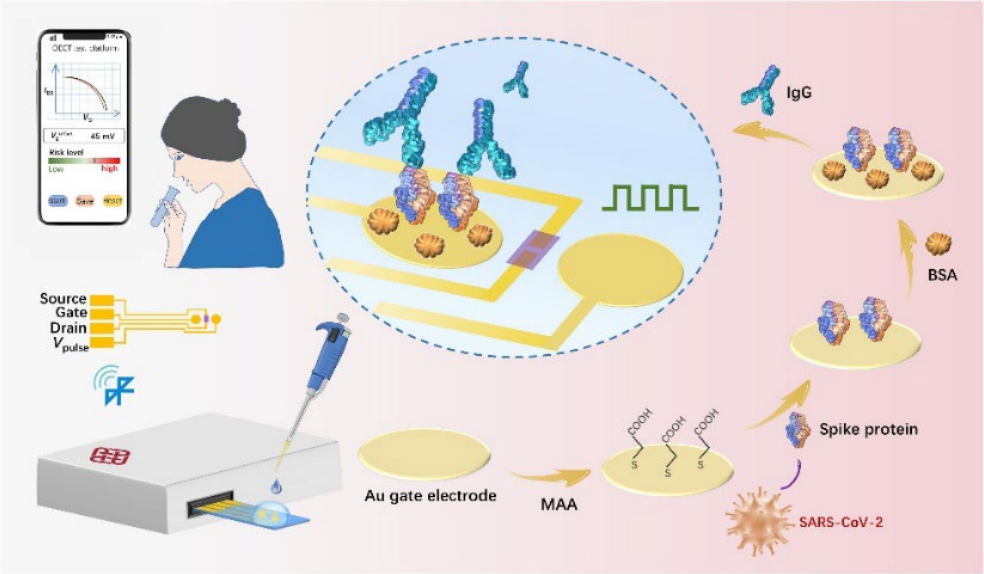


Figure 1: Scheme of the portable sensing system and the gate modification processes of the COVID-19 IgG sensor.

References

1. H. Liu, A. Yang, J. Song, N. X. Wang, P. Lam, Y. Li, H. K.-W. Law, F Yan*,Ultrafast, sensitive and portable detection of COVID-19 IgG using flexible organic electrochemical transistors, *Science Advances* **2021**, 7, eabg8387.
2. C.-K. Liu, V. Piradi, J. Song, Z. Wang, L.-W. Wong, E.-H.-L. Tan, J. Zhao, X. Zhu, F. Yan, 2D Metal-Organic Framework $Cu_3(HHTT)_2$ Films for Broadband Photodetectors from Ultraviolet to Mid-infrared, *Adv. Mater*. **2022**.