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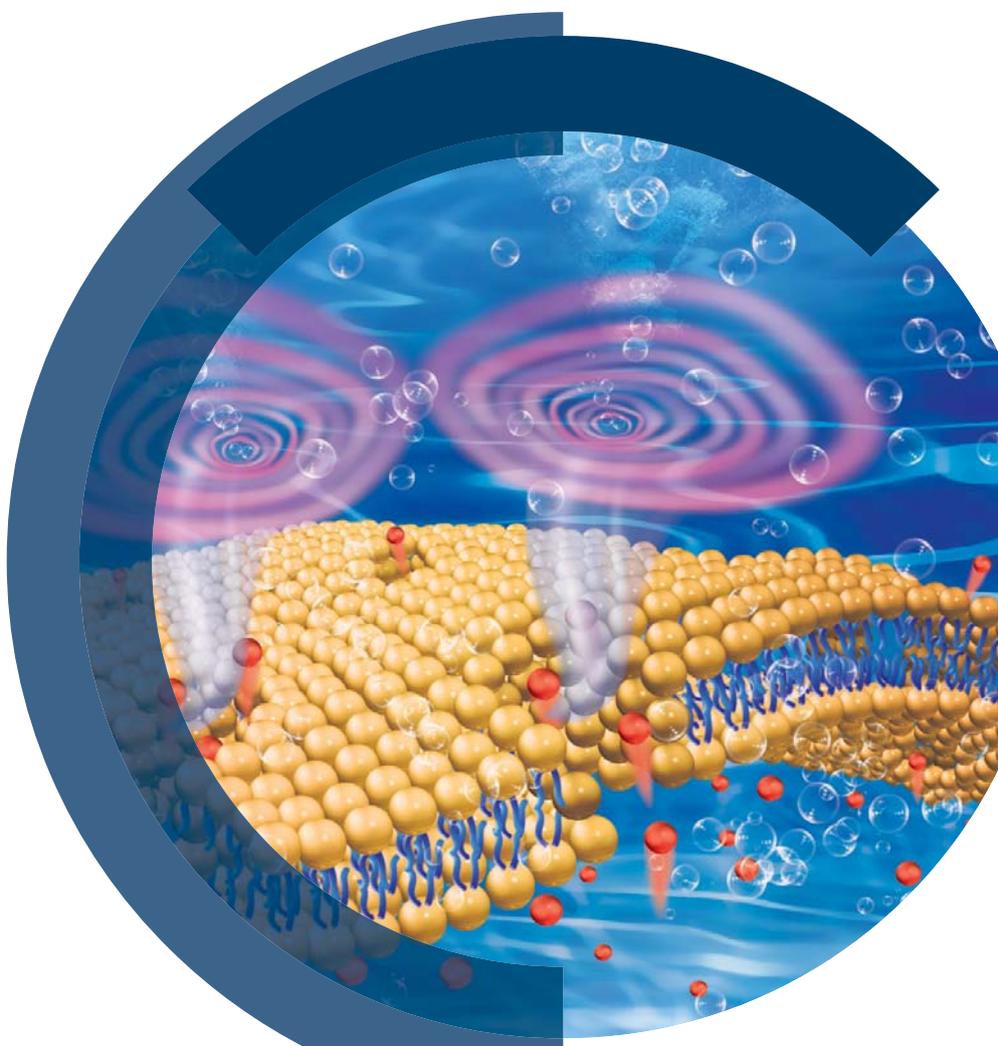
5 December 2019, Northwestern University - Evanston, United States

The 4th Materials Chemistry Frontiers International Symposium

Abstract
Book



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The 4th Materials Chemistry Frontiers International Symposium

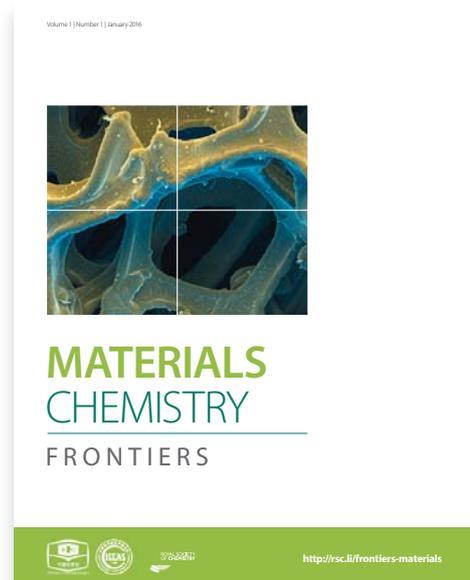
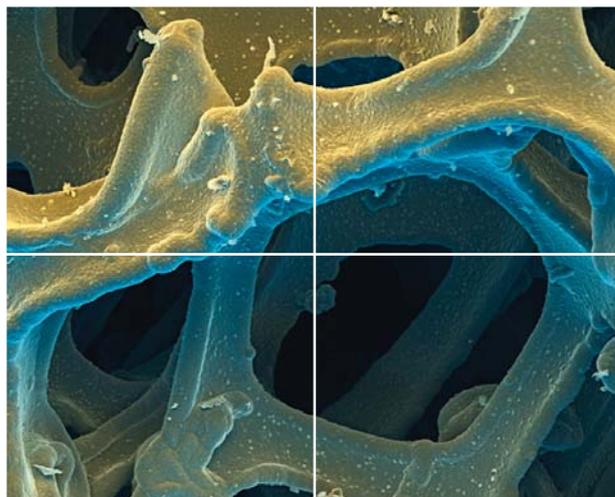
Hardin Hall, Rebecca Crown Center, Northwestern University—Evanston
05 December 2019

Time	Event	Session Chair
8:55	Opening remarks <i>Jiaxing Huang, Northwestern University</i>	
9:00	Integrated Electromagnetic Wave Spectroscopy Techniques: A Powerful Tool for Optoelectronic and Biochemical Materials <i>Shu Seki, Kyoto University</i>	Jiaxing Huang <i>Northwestern University</i>
9:30	Magnesium for Nanoplasmonics <i>Emilie Ringe, University of Cambridge</i>	
10:00	Chemistry for the Second Quantum Revolution <i>Danna Freedman, Northwestern University</i>	
10:30	AM Break	
11:00	Spherical Nucleic Acids with Cationic Backbone Modifications <i>Katherine Bujold, Northwestern University</i>	Shu Seki <i>Kyoto University</i>
11:30	Design for Stimuli-Responsive Luminescent Chromic Materials Based on Flexible Boron “Element-Blocks” <i>Kazuo Tanaka, Kyoto University</i>	
12:00	Reactivity-property Relationships in Photocontrolled Polymer Networks <i>Julia Kalow, Northwestern University</i>	
12:30	Lunch	
13:30	Crosslinked Organosilica BTBT Derivatives for Robust Transistors <i>Guillaume Wantz, University of Bordeaux</i>	Emilie Ringe <i>University of Cambridge</i>
14:00	Molecular Nanocarbons: Self-Assembly, Metal Binding, and Multi-Electron Charging <i>Marina A. Petrukhina, University at Albany at New York</i>	
14:30	Molecular Engineering of Two-Dimensional Organic-Inorganic Hybrid Perovskites <i>Letian Dou, Purdue University</i>	
15:00	PM Break	
15:30	Creating High-Performance ElectroCatalysts through Surface Engineering <i>Yu Huang, UCLA</i>	Jiaxing Huang <i>Northwestern University</i>
16:00	Dynamics of Surface Structures in Heterogeneous Catalysis and Electrocatalysis <i>Hong Yang, University of Illinois at Urbana-Champaign</i>	
16:30	Chemical and Structural Manipulation of Graphene and other 2D Nanomaterials for Electronics and Optoelectronics <i>Vikas Berry, University of Illinois at Chicago</i>	
17:00	Closing remarks <i>Jiaxing Huang, Northwestern University</i>	

MATERIALS CHEMISTRY

FRONTIERS

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Materials Chemistry Frontiers is the ideal home for studies of a significant nature that further the development of organic, inorganic, composite and nano-materials.

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Biography note of the Chair



Jiaxing Huang

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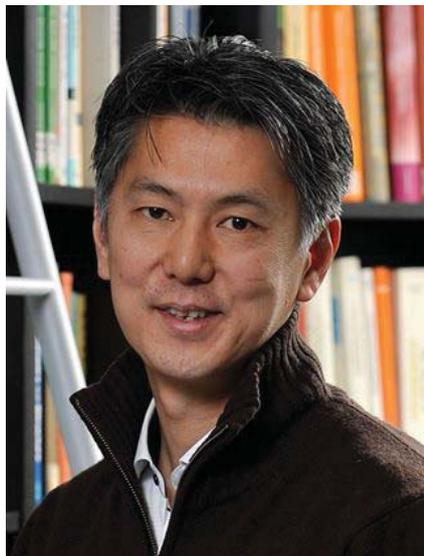
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Jiaxing Huang is a Professor of Materials Science and Engineering at Northwestern University. He received his B.S. degree in Chemical Physics from USTC, Ph.D. in Chemistry from UCLA, and became a Miller Fellow at UC Berkeley before joining Northwestern in 2007.

Prof. Huang enjoys integrating education and research to enhance learning experience for his students and himself. In research, his group uses chemical principles and tools to discover new materials, advance materials processing, and make materials innovations for better living. Some recent examples include carbon based nanomaterials, bulk nanostructure materials, and new forms of colloidal particles for solving problems in energy storage, water treatments and even personal care products. Through teaching, he aims to develop intuition, inspire creativity and bring the best out of students.

His work has been recognized by awards from the National Science Foundation, the Sloan Foundation, the Society of Manufacturing Engineers, the American Vacuum Society, and the International Aerosol Research Assembly. He is also a recipient of the Guggenheim Fellowship, the JSPS Fellowship from Japan and the Humboldt Research Award from Germany.

Biography notes of Speakers



Shu Seki

Kyoto University, Japan

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Shu Seki graduated from the University of Tokyo in 1993, and received his PhD degree in 2001 from Osaka University. He joined Argonne National Laboratory, USA in 1993, and Delft University of Technology in 2001. He was appointed as Professor of Applied Chemistry, Graduate School of Engineering, Osaka University in 2009. He was appointed as Professor of Molecular Engineering, Graduate School of Engineering, Kyoto University in 2015.

His research is primarily focused on the physical chemistry of condensed matters, functional organic materials, and nanomaterials.

Integrated Electromagnetic Wave Spectroscopy Techniques: A Powerful Tool for Optoelectronic and Biochemical Materials

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From radio-frequency to ionizing radiations, electromagnetic waves are the center of the spectroscopy techniques to assess electronic structures, optical/electronic/magnetic properties, reactivity, physical/chemical dynamics, etc. Particularly UV-vis-NIR probes have been the primary choices to trace the dynamics short-lived chemical intermediates/substances via transient spectroscopy for a long time, and microwaves in GHz regime have played a significant role in revealing dielectric/conductive properties of materials as well as in spin spectroscopies such as EPR. Integration of such spectroscopic techniques into a system leads to deduce a comprehensive set of information on electron driven properties of the materials in ps ~ ms time range. Herein, recent trends in the development of the integrated spectroscopy techniques are discussed in terms of electron mobility and reactions in 1) biological systems^{1,2}, 2) molecular electronics and their interfaces³, and supramolecular aggregates⁴.

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Biography notes of Speakers



Emilie Ringe

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Emilie Ringe earned her Ph.D. in chemistry and materials science from Northwestern University in 2012. She became the Gott Research Fellow at Trinity Hall as well as a Newton International Research Fellow (Royal Society) in the Electron Microscopy group in the Materials Science and Metallurgy Department at the University of Cambridge, UK. In 2014, she was hired as an assistant professor at Rice University, where she established the Electron Microscopy Center and her research in Earth-abundant and multi-metallic plasmonic nanoparticles. In 2018, she moved to the University of Cambridge as a lecturer, where she received an ERC Starting grant (1.6M Euros) to pursue her studies of Earth-abundant plasmonics. She has been elected fellow of Gonville & Caius College, and is an associate member of the Royal Society of Chemistry.

Magnesium for Nanoplasmonics

Emilie Ringe

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Most plasmonic metals studied to date are composed of either Cu, Ag, and Au. The former two can pose significant challenges related to oxidation, the latter is often perceived as cost-prohibitive, and all three are rare. Recently, much attention has been focused on earth-abundant Al, which is an excellent plasmonic in the UV. This talk will very briefly discuss colloidal Al nanoparticles as a plasmonic material, then report significant results on a new composition: magnesium. Colloidal Mg nanoparticles are remarkably active plasmonics across the UV, Vis and NIR, as shown optically and with STEM-EELS. Surprisingly, they are stable in air for weeks owing to a self-limiting oxide layer. Mg has potential on its own as a plasmonic structure, and can also be used as a scaffold for additional surface chemistry, sensing, and hybrid photocatalysts.

Biography notes of Speakers



Danna Freedman

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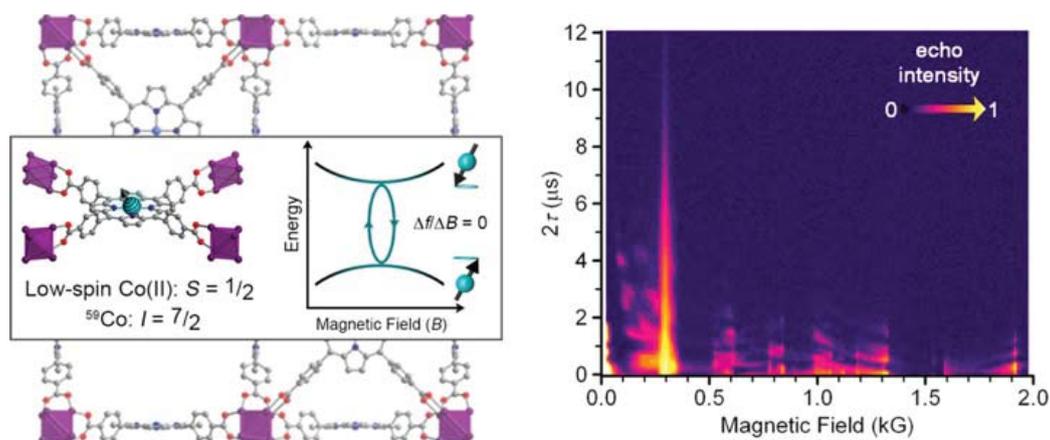
Danna Freedman received her BS from Harvard University in 2003 and the Ph.D. from the University of California, Berkeley in 2009, under supervision of in Prof. Jeffrey Long. She then joined in Prof. Daniel G. Nocera's laboratory at the Massachusetts Institute of Technology for post-doc research. Danna is now an Associate Professor of Northwestern University.

Research in Freedman laboratory focuses on applying inorganic chemistry to solve problems in physics.

Chemistry for the Second Quantum Revolution

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Chemistry offers a unique bottom up approach to the design of qubits, the smallest unit of a QIS system. We harness this angstrom scale precision to develop fundamental insight into the spin dynamics of electronic spin-based qubits. Results on increasing coherence time, constructing qubit arrays, and understanding the impact of nuclear spin on electronic spin coherence time will be presented.



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Biography notes of Speakers



Katherine Bujold

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Katherine Bujold is a Banting and International Institute for Nanotechnology Postdoctoral Fellow in Prof. Chad Mirkin's group at Northwestern University. She completed her PhD under the supervision of Prof. Hanadi Sleiman at McGill University where she developed stimuli-responsive DNA nanostructures towards biological applications as an NSERC and FRQNT awardee. Her principal research interests reside in oligonucleotide chemistry, DNA self-assembly and chemical biology. Her current work focuses on the synthesis of oligonucleotides and spherical nucleic acids with modified backbones to modulate their interactions with living systems.

Spherical Nucleic Acids with Cationic Backbone Modifications

Katherine E. Bujold,* Kacper Skakuj,* Caroline D. Kusmierz, John Cavaliere, Chad. A. Mirkin

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Oligonucleotide-based constructs are attractive materials because they can be synthesized in all shapes and sizes with unparalleled architectural control. However, their biological properties, namely cellular uptake and biological activity are limited the distinctive structure of DNA, which is densely negatively charged and hydrophilic. Recent progress in the synthesis of deoxynucleic guanidine (DNG) – oligonucleotides with a permanent cationic backbone – has enabled us to address these shortcomings and to study the impact of programmed surface charge modifications on the cellular uptake of nucleic acid-based constructs such as the spherical nucleic acid (SNA). We outline a new automated method for synthesizing deoxynucleic guanidine (DNG) oligonucleotides that is both mild and high yielding. Moreover, we demonstrate that increasing the number of DNG inserts on SNAs significantly increases their cellular uptake. This effect is mediated by interactions of DNGs with charged head groups at the cellular membrane level, which leads to further internalization. These findings open the door to the rational design of SNAs with controlled uptake mechanisms, thus expanding their therapeutic scope, and hold promise for cationic oligonucleotide drug design.

Biography notes of Speakers



Kazuo Tanaka

Kyoto University, Japan

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Kazuo Tanaka received his PhD degree in 2004 from Kyoto University, and worked at Stanford University, Kyoto University, and RIKEN as a postdoctoral fellow. In 2007, he moved to the Department of Polymer Chemistry, Graduate School of Engineering, Kyoto University, and in 2018, he was promoted to a Professor.

His research projects especially focus on design of new functional materials based on the heteroatom-containing polymers and organic–inorganic polymer hybrids for developing optoelectronic devices and bio-related materials.

Design for Stimuli-Responsive Luminescent Chromic Materials Based on Flexible Boron “Element-Blocks”

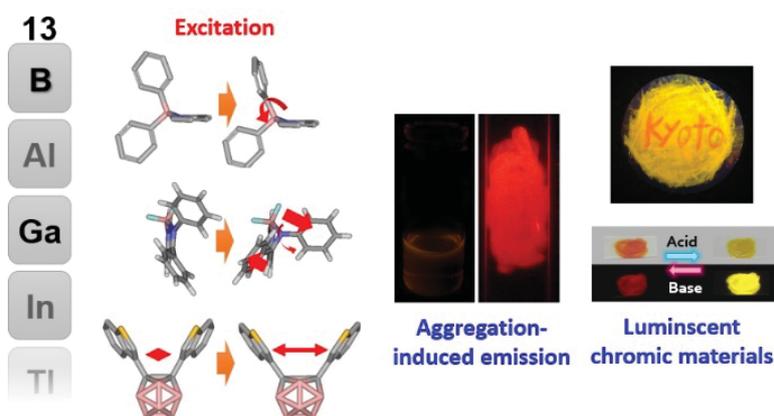
Kazuo Tanaka

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By the boron complexation, molecular rigidity and planarity can be improved. Owing to these structural features which are favorable for constructing robust conjugation system, many kinds of luminescent dyes have been developed based on boron complexes. Therefore, we regard boron complexes as a versatile luminescent “element-block”, which is defined as a minimum functional unit composed of heteroatoms.^{1,2} However, their emission properties in the solid state are generally spoiled by aggregation-caused quenching (ACQ). Therefore, there are difficulties in the applications of boron complexes as luminescent materials or devices.

Aggregation-induced emission (AIE) is a key phenomenon for overcoming the ACQ effect and obtaining highly-efficient light-emitting solid materials. We have found that ACQ-presenting boron complexes composed of the β -diketonate structure can be transformed to the AIE-active dyes by replacing the oxygen atoms in the β -diketonate ligand to nitrogen to form the ketoiminate or diiminate structures. According to quantum calculation, it was proposed that the nitrogen-replaced complexes should potentially show large degree of structural relaxation in the excited state. Based on this fact, we designed and synthesized similar “flexible” boron complexes and confirmed that they can work as an AIE-inducible “element-blocks”.³ In this presentation, development of the AIE-active conjugated materials including polymers based on AIE-inducible “element-blocks” will be demonstrated.

Moreover, it was found that AIE-active boron complexes showed luminescent chromism triggered by temperature changes, mechanical stresses and vapor fuming. The mechanisms and design strategies for obtaining stimuli-responsive luminescent chromic materials will be explained in the presentation.



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Biography notes of Speakers



Julia Kalow

Northwestern University, USA

Julia Kalow obtained her BA at Columbia University in 2008, where she studied chemistry and creative writing and performed research in the Leighton group. Following an internship in the medicinal chemistry department at Merck, she pursued graduate studies in the Doyle lab at Princeton University as a NSF predoctoral fellow. After completing her PhD in 2013, she joined the Swager lab at MIT as a Ruth L. Kirschstein NIH NRSA postdoctoral fellow. She started her independent career at Northwestern's Department of Chemistry in July 2016 and is now an Assistant Professor in Department of Chemistry.

The Kalow group engages in research at the interface of organic synthesis, polymer chemistry, and materials science through two distinct approaches: materials-inspired reaction discovery and reactivity-driven materials discovery.

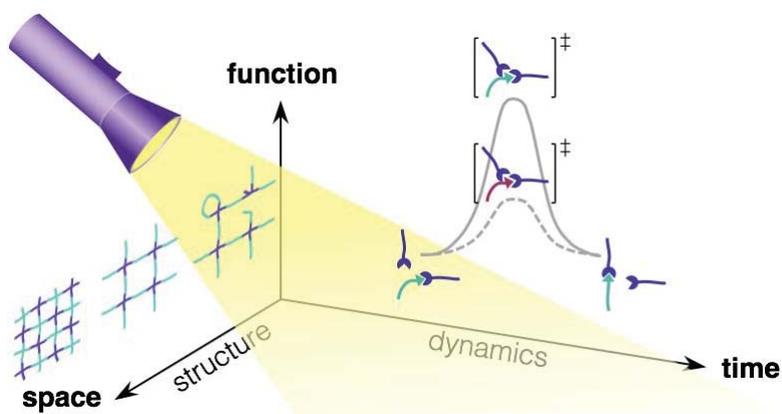
Reactivity-property relationships in photocontrolled polymer networks

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In polymer networks based on dynamic covalent bonds, changes in reactivity can be translated into macroscopic responses. Light offers precise, tunable, and noninvasive spatiotemporal control over molecular reactivity. In polymer networks based on dynamic covalent bonds, these changes in reactivity can be translated into macroscopic responses. The Kalow lab has designed crosslinks that allow us to tune the thermodynamics and kinetics of dynamic covalent bonds with light, including visible light, based on the conformation of an adjacent photoswitch. When incorporated into polymer networks, the stability or lifetime of these dynamic covalent bonds can be tuned with light. I will discuss our efforts to elucidate the molecular mechanism underlying these macroscopic changes, as well as mechanism-driven optimization of the photoswitch.



Biography notes of Speakers



Guillaume Wantz

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Guillaume Wantz obtained his Master degree from the Graduate School of Chemistry and Physics of Bordeaux (ENSCP) in 2001 including a thesis work at Philips Research (Eindhoven, NL) on ink-jet printing. He received his Ph.D. in Electronics Engineering from the University of Bordeaux in 2004 working on Polymer Light Emitting Diodes. He was Assistant Professor at the University of Bordeaux working on Organic Field Effect Transistors with research stays at Queen's University (Kingston, Canada). He has been appointed as tenure Associate Professor at the Bordeaux Institute of Technology (Bordeaux INP) since 2006. His research interest is on Organic Electronics and Photovoltaic. He was invited-professor at Queen's University (Kingston, Ontario, Canada) in Spring 2012 and at Univ. of Massachusetts (Amherst, USA) in Fall 2014. He is the head of the CNRS network on Organic and Hybrid photovoltaic since 2015. He has been appointed at the "Institut Universitaire de France" (Paris) in 2016.

Crosslinked organosilica BTBT derivatives for robust transistors

Gilles .H. Roche,^{1,2} Kazuo Takimiya³, Olivier J. Dautel,² **Guillaume Wantz**¹

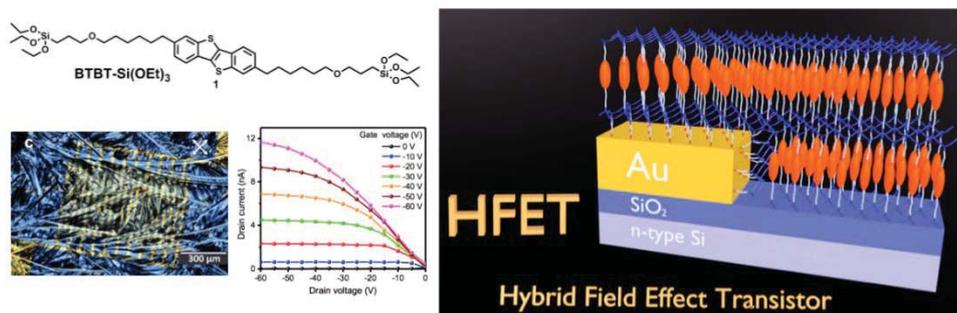
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This communication will display the use of novel organosilica materials embedding π -conjugated moieties¹ as semiconductors into field effect transistors. The π -conjugated core chosen is [1]benzothieno[3,2-b][1]benzothiophene (BTBT), first functionalized with hydroxyl groups³ and then modified with hydrolysable and cross-linkable triethoxysilyl moieties. After polycondensation, this compound forms a hybrid material found to be a semiconductor. Taking advantage of the sol-gel chemistry involved here, we built Hybrid Field Effect Transistors that are fully cross-linked with covalent bonds. Molecules are cross-linked to each other, covalently bonded to the silicon oxide dielectric and also covalently bonded to the gold electrode thanks to the use of an appropriate surface modifier in between. This is the first report of fully covalent transistors⁴. Those devices with low mobility ($10^{-5} \text{ cm}^2 \cdot \text{V}^{-1} \cdot \text{s}^{-1}$) show impressive resilience against polar, aliphatic and aromatics solvents (even under sonication). Our latest progress has enabled to better control the packing of molecules in Herringbone scheme, reaching now state-of-the-art mobility in the range of 0.1 to $1 \text{ cm}^2 \cdot \text{V}^{-1} \cdot \text{s}^{-1}$ but keeping their extraordinary robustness thanks to their hybrid crosslinked nature⁵.



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Biography notes of Speakers



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Marina A. Petrukhina is Professor at the Department of Chemistry, University at Albany, State University of New York. She received BS/MS (summa cum laude) and Ph.D. (Inorganic Chemistry) degrees from Moscow State University. Since joining the University at Albany in 2001, she has received the National Science Foundation CAREER Award in 2006, the President's Award for Excellence in Research and Creative Activities in 2013, and the SUNY Chancellor's Award for Excellence in Scholarship and Creative Activities in 2014. She was a Visiting Professor at the University of Bordeaux (2004), Max-Planck Institute for Chemical Physics of Solids in Dresden (2008), and University of Valencia (2016). In 2017, she was named the August-Wilhelm Scheer Visiting Professor and Honorary Fellow of TUM Institute for Advanced Study (Munich, Germany). She has published 195 original articles in refereed scientific journals, including 8 reviews, 2 book chapters, and 6 patents.

Her research interests span from synthetic and structural inorganic chemistry of transition metal clusters and main group elements to organometallic, supramolecular and materials chemistry of novel curved nanocarbon systems.

Molecular Nanocarbons: Self-Assembly, Metal Binding, and Multi-Electron Charging

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Molecular nanocarbons with defined molecular compositions and nonplanar frameworks with inherent strain attract significant current attention from the fundamental and applied viewpoints. The bowl-shaped fragments of fullerenes and end-caps of carbon nanotubes, that are often referred to as carbon bowls, represent a very interesting class of curved carbon π -scaffolds with unique structures and properties. Carbon bowls can serve as excellent reservoirs for multiple electrons.¹ Moreover, upon multi-electron charging they demonstrate remarkable supramolecular chemistry and record metal binding patterns unmatched by planar π -systems.^{2,3} Recently, various molecular nanocarbons with different core topologies and embedded curvature and twist have also become available, thus opening a new broad area of their organometallic and materials chemistry for investigation. A discussion of structure/property correlations, reduction limits and self-assembly patterns of novel nonplanar carbon frameworks will be provided. Supramolecular and host/guest chemistry of new nanocarbon materials such as carbon bowls,³ belts⁴ and wires,⁵ as well as fragments of nanographenes⁶ with controlled molecular compositions will also be discussed.

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Biography notes of Speakers



Letian Dou

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Letian Dou is currently an assistant professor of chemical engineering at Purdue University. He obtained his B.S. in Chemistry from Peking University in 2009. He then joined Prof. Yang Yang's group in the Department of Materials Science and Engineering at UCLA, and obtained his Ph.D. in 2014 (co-advised by Prof. Fred Wudl @UCSB in 2013). From 2014 to 2017, he was a postdoctoral fellow working with Prof. Peidong Yang at the Department of Chemistry, University of California-Berkeley and Materials Science Division, Lawrence Berkeley National Laboratory. His research interest includes the synthesis of organic-inorganic hybrid materials and low-dimensional materials, fundamental understanding of the optical and electronic properties of these new semiconductor materials, as well as device applications. He is a recipient of Office of Naval Research Young Investigator Award (2019), Highly Cited Researcher in Cross-Fields (2019), MIT Technology Review Innovators Under 35-China Award (2018), and MRS Graduate Student Award (2014). He has published over 50 research papers with more than 10000 citations.

Molecular Engineering of Two-Dimensional Organic-Inorganic Hybrid Perovskites

Letian Dou

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Two-dimensional halide perovskites are exciting new semiconductors that show great promising in low cost and high performance optoelectronics devices including solar cells, LEDs, photodetectors, transistors, etc. These materials show great structure and property tunability, not only in the perovskite layer, but also along the 2D crystal edges and surfaces. In the first part of this talk, I will introduce our recent discoveries about the origin and the unique optical and electronic properties of the edge states of the 2D perovskite single crystals. In the second part, I will present a molecular approach to the synthesis of high-quality organic-inorganic hybrid perovskite quantum wells through incorporating widely tunable organic semiconducting building blocks as the surface capping ligands. By introducing sterically tailored groups into the molecular motif, the strong self-aggregation of the conjugated organic molecules can be suppressed, and single crystalline organic-perovskite hybrid quantum wells and superlattices can be easily obtained via one-step solution-processing. Energy transfer and charge transfer between adjacent organic and inorganic layers are extremely fast and efficient, owing to the atomically-flat interface and ultra-small interlayer distance. Finally, I will briefly talk about the applications of these materials in high performance solar cells and field effect transistors.

Biography notes of Speakers



Yu Huang

University of California, Los Angeles, USA

Yu Huang is a professor in the Department of Materials Science and Engineering at University of California Los Angeles (UCLA). She received her B.S. in Chemistry from University of Science and Technology of China (USTC), and her Ph.D in physical chemistry and M.A in Chemistry from Harvard University. Before she embarked on her independent career at UCLA She was awarded the prestigious Lawrence Fellowship and held a joint postdoctoral position with Lawrence Livermore National Lab (LLNL) and Massachusetts Institute of Technology (MIT).

At UCLA Prof. Huang explores the unique technological opportunities that result from the structure and assembly of nanoscale building blocks. Her research focuses on mechanistic understanding of nanoscale phenomena and on exploiting the unique properties of nanoscale materials for various applications. Taking advantage of the unique roles of nanoscale surfaces and interfaces, Prof. Huang is creating methodologies to apply the latest developments in nanoscale materials and nanotechnology for probing nanoscale processes that can fundamentally impact a wide range of technologies including materials synthesis, catalysis, fuel cells, and devices applications. Prof. Huang's achievements have gained her international and national recognitions including the Materials Research Society (MRS) Fellow, the Royal Society of Chemistry (RSC) Fellow, the International Precious Metal Institute (IPMI) Carol Tyler Award, , the Presidential Early Career Award in Science and Engineering (PECASE), the National Institute of Health (NIH) Director's New Innovator Award, the Defense Advanced Research Projects Agency (DARPA) Young Faculty Award, the World's Top 100 Young Innovators award, the Sloan Fellowship, the International Union of Pure and Applied Chemistry (IUPAC) Young Chemist Award, and the Nano 50 Award.

Creating High-Performance ElectroCatalysts through Surface Engineering

Yu Huang

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Electrochemical processes play key roles in renewal energy scheme by converting intermittently produced electricity into fuels and value-added chemical feedstocks. Electrocatalysts are indispensable in these energy conversion processes. Great efforts have been placed on designing electrocatalyst that are highly active, selective and durable. Noble metal-based nanocrystals are often the desired catalyst due to their high activity and chemical stability. Owing to the large surface to volume ratio at nanoscale slight changes in the surface structure of catalytic materials can have large impacts on the catalytic stability and activity. The composition, facet, and strains in a nanocatalyst have profound impacts in its performance in catalytic reactions. In this presentation, I will share our recent efforts on designing the surface compositions, structures and the overall morphology of metal catalysts to improve both catalytic activity and stability of these catalytic materials.

Biography notes of Speakers



Hong Yang

University of Illinois at Urbana-Champaign

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Hong Yang is the Richard C. Alkire Endowed Chair Professor in Chemical Engineering at the University of Illinois at Urbana-Champaign (UIUC). He received his B.Sc. degree from Tsinghua University (1989), Ph.D. degree from University of Toronto (1998), and did his postdoctoral research at Harvard University. Among his awards and honors, Dr. Yang received one of the two NSERC Canada Doctoral Prizes in Science, was an NSERC Postdoctoral Fellow, a US National Science Foundation CAREER Award recipient, and an elected Fellow of American Association for the Advancement of Science (AAAS). He is a Section Editor on Nanotechnology for Current Opinion in Chemical Engineering and Subject Editor on Electrochemical Conversion for Frontiers in Energy, was a Guest Editor for Advanced Materials and Accounts of Chemical Research, respectively, and serves on several editorial boards, including Nano Today, ChemNanoMat, and Science China Materials. His research interests include nanocrystals, catalysis, electrocatalysis, and applications of nanomaterials for energy and sustainability. His group currently work in the areas of nanostructures for low-platinum group metal (PGM) and non-PGM catalysts for oxygen reduction, high valence electrode materials for rechargeable battery, electrochemical water splitting, and CO₂ utilization.

Dynamics of Surface Structures in Heterogeneous Catalysis and Electrocatalysis

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Catalysts made of nanoparticles have been used extensively in chemical conversion processes, ranging from chemical production to carbon dioxide utilization, and to hydrogen-powered fuel cells. Surface structures play crucial roles in achieving high activity or/and selectivity. In this presentation, I will present several recent studies on the understanding of dynamics of surface structures in the design of metal and metal oxide nanoparticles (*i.e.*, Pt, Cu, various alloys) for catalytic reactions involving oxygen both thermally and electrochemically. Local structure or reactive environment and catalytic property relationship will be discussed. Conditions that favor the dynamic control of surface compositions for optimal catalytic performance (activity or selectivity) under reactive conditions will be presented. Our results suggest that both thermodynamic and kinetic factors need to be taken into consideration in the design of catalysts.

Biography notes of Speakers



Vikas Berry

University of Illinois at Chicago

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Vikas Berry is a Chemical Engineering Professor and Department Head at University of Illinois at Chicago. Dr. Berry has made pioneering contributions in the fields of graphene quantum materials and Bionanotechnologies; and has received several honors, including the NSF-CAREER Award, Sigma Xi Outstanding Junior Scientist Award, Big 12 Fellowship, Prof. Rudolph Marcus Award, and William H. Honstead Professorship. Dr. Berry received his bachelor's degree from the Indian Institute of Technology-Delhi, India, in 1999, master's degree from the University of Kansas in 2003, and a doctorate degree from Virginia Polytechnic Institute and State University in 2006.

Chemical and Structural Manipulation of Graphene and other 2D Nanomaterials for Electronics and Optoelectronics

Vikas Berry

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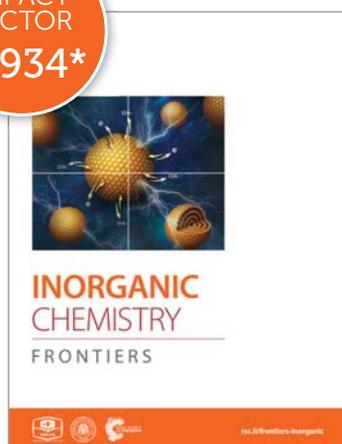
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The presentation will outline several chemical and structural manipulation techniques developed in our laboratory to control the properties of 2D nanomaterials. (a) Structural manipulation includes formation of wrinkles, nanoribbons and quantum dots, and (b) Chemical manipulation includes non-destructive functionalization, nanoparticle incorporation and biomolecular interfacing. The following topics will be discussed: (i) selective desiccation of bacterium under impermeable and flexible graphene *via* a flap-valve operation to produce axially-aligned graphene-wrinkles with anisotropic electrical properties; (ii) nanotomy process to cleave graphite nanoblocks and their exfoliation to produce graphene nanostructures (nanoribbons and quantum dots) with controlled electrical properties; (iii) wrinkling of MoS₂ to control photoluminescence; (iv) unique eta-6 organometallic approach to functionalize graphene in a vapor-phase process, while retaining its structural and electrical properties and offering chemical sites for nano-interfacing of plasmonic centers for enhanced photovoltaics; (v) biointerfacing of graphene and MoS₂ with cancer cells and bacteria for bionanotechnology and biomedical applications; and (vi) Photovoltaics via electronic coupling of graphene atop a bulk semiconductor to induce interfacial energy-band reorganization for light-sensitive junctions only one atom below the front surface.

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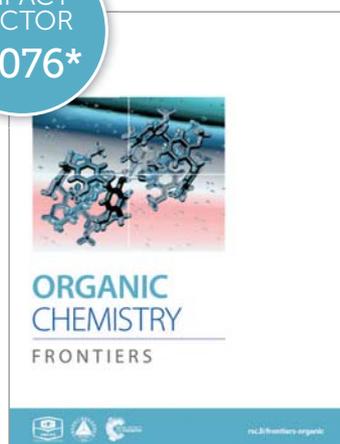


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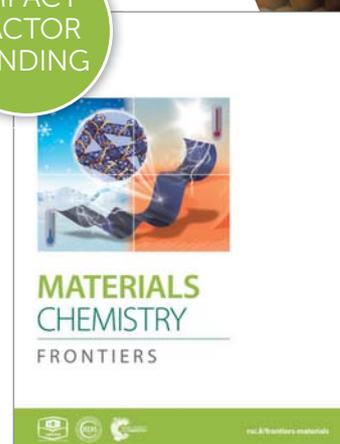


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