The 30th SYMPOSIUM ON CHEMISTRY POSTGRADUATE RESEARCH IN HONG KONG

6 April 2024

10:00AM - 4:15PM

City University of Hong Kong

Tin Ka Ping Lecture Theatre (LT-1), 4/F, Yeung Kin Man Academic Building
City University of Hong Kong, Tat Chee Avenue, Kowloon Tong

Organized by

CityU Department of Chemistry
香港城市大學
City University of Hong Kong

Participating Universities

Programme and Abstracts

The Thirtieth Symposium on

Chemistry Postgraduate Research in Hong Kong

City University of Hong Kong

6 April 2024 (Saturday)

Keynote Speaker	Professor Lutz Ackermann
	Institute for Organic and Biomolecular Chemistry
	Georg-August-University Göttingen
Organizers	Professor Kenneth Lo
	Professor K C Lau

Institutional Representatives

Institution	**Faculty**	**Postgraduate**
CityU	Professor Kenneth Lo	Eunice Mak
CUHK	Professor Zhifeng Huang	Tao Yao
HKBU	Dr Di Hu	Chin Wai Leung
HKU	Professor Junzhi Liu	Biao Xia
HKUST	Professor Yangjian Quan	Zixuan Zhang
PolyU	Dr Franco Leung	Ka Lung Hung

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Program

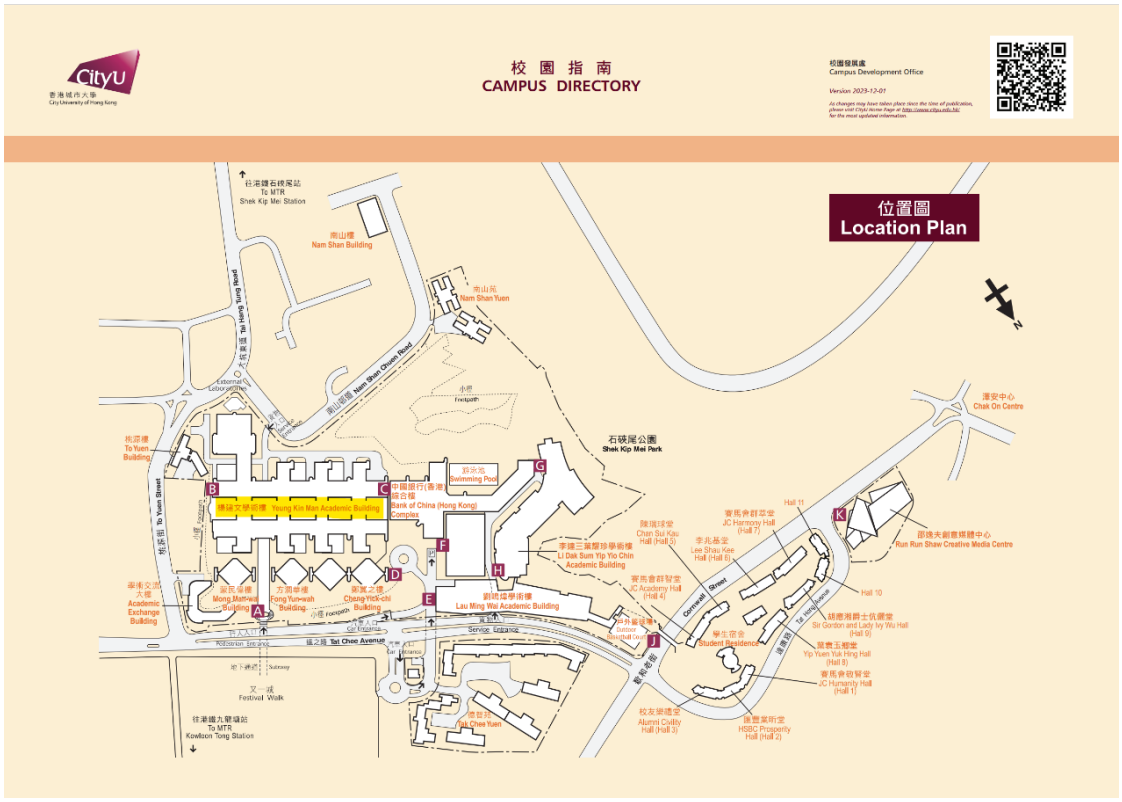
Time	Event
9:30 – 10:00 am	**Registration**
10:00 – 10:10 am	**Opening Ceremony** ***Welcoming Remarks*** **Professor K C Lau** Organizer & Associate Head Department of Chemistry City University of Hong Kong **Professor Denver Li** Associate Dean (Research and Postgraduate Education) College of Science City University of Hong Kong
10:10 – 10:20 am	**Group Photo-taking**
10:20 – 10:45 am	**Oral Presentation 1** **Phase engineering of noble metal-based alloys for highly efficient electrocatalysis** Biao Huang City University of Hong Kong
10:45 – 11:10 am	**Oral Presentation 2** **Negatively Curved Molecular Nanocarbons Containing Multiple Heptagons Are Enabled by the Scholl Reactions of Macrocyclic Precursors** Ka Man Cheung The Chinese University of Hong Kong
11:10 – 11:35 am	**Oral Presentation 3** **A Study of Emerging Disinfection Byproducts in Drinking Water** Weiyu Peng Hong Kong Baptist University

Time	Event
11:35 am – 12:00 nn	**Oral Presentation 4** **Dye-Sensitized Active Colloids: From Reversible Phototaxis to Optically Guided Dynamic Assemblies** Jingyuan Chen The University of Hong Kong
12:00 nn – 2:00 pm	**Lunch Break & Poster Session** *(for guests and faculty members)* *City Chinese Restaurant, 8/F, Bank of China (Hong Kong) Complex*
2:00 – 2:25 pm	**Oral Presentation 5** **A Photoactivatable Luminescent Motif through Ring-Flipping Isomerization for Multiple Photopatterning** Xin Li The Hong Kong University of Science and Technology
2:25 – 2:50 pm	**Oral Presentation 6** **Intramolecular Arene C(sp2)—H Amidation Enabled by Ferrocenium-Mediated Decomposition of 1,4,2-Dioxazol-5-ones as Amidyl Radical Precursorsg** Chi Ming AU The Hong Kong Polytechnic University
3:00 – 4:00 pm	**Keynote Lecture** **Catalyzed C–H Functionalization** Professor Lutz Ackermann Institute for Organic and Biomolecular Chemistry Georg-August-University Göttingen
4:00 – 4:15 pm	**Award Presentation & Closing Ceremony** **Professor Kenneth Lo** Organizer & Chair Professor Department of Chemistry City University of Hong Kong

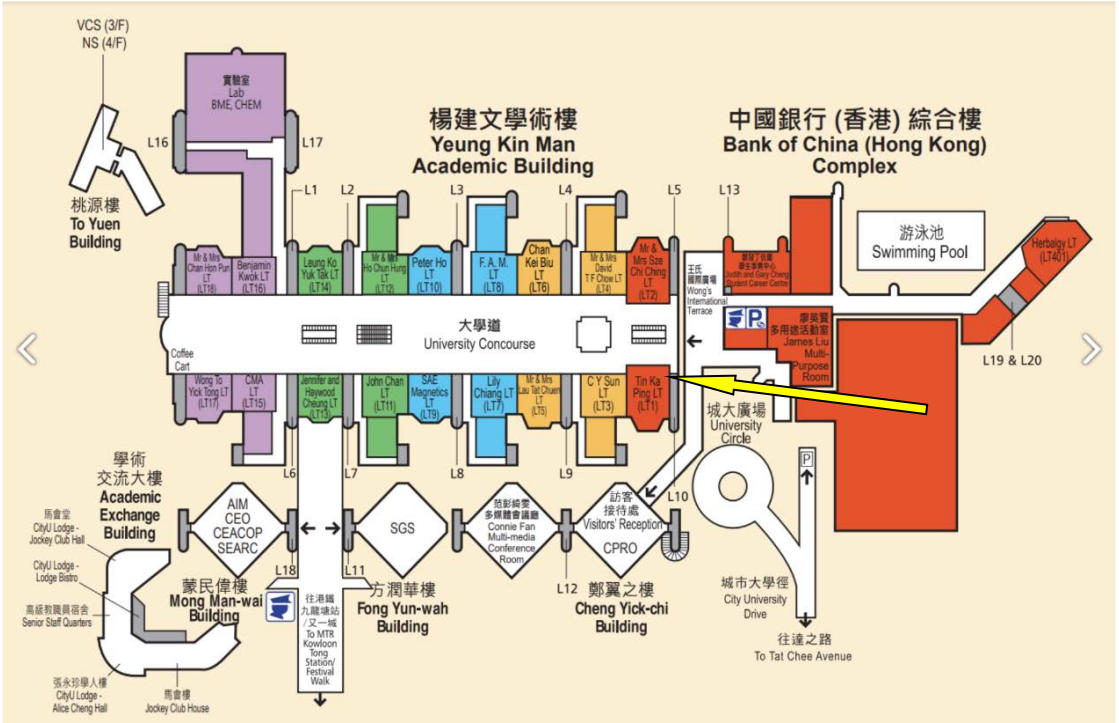
Campus Map

Routes for going to Yeung Kin Man Academic Building:

https://www.cityu.edu.hk/about/campus/map#code:YEUNG



Location of LT-1:



Keynote Speaker

Professor Lutz Ackermann studied Chemistry at the University Kiel (Germany) and performed his PhD with Professor Alois Fürstner at the Max-Planck Institut für Kohlenforschung (Mülheim/Ruhr, 2001). After a postdoctoral stay at UC Berkeley with Professor Robert G. Bergman, he started his independent research career in 2003 at the Ludwig Maximilians-University München. In 2007, he became Full Professor (W3) at the Georg-August-University Göttingen. His recent awards and distinctions include an AstraZeneca Excellence in Chemistry Award (2011), an ERC Consolidator Grant (2012), highly-cited researcher (2014 - 2023, Web of Science), a Gottfried Wilhelm Leibniz-Preis (2017), an ERC Advanced Grant (2021), a Werner Siemens-Stiftung (WSS) Research Award (2023), and the Otto Roelen-Medal (2024). His current research interests primarily focus on the development and application of novel concepts for sustainable catalysis, particularly in electrocatalysis, late-stage functionalization, and bond activation for benign molecular architecture with full selectivity control.

Keynote Lecture

Catalyzed C–H Functionalization

Lutz Ackermann

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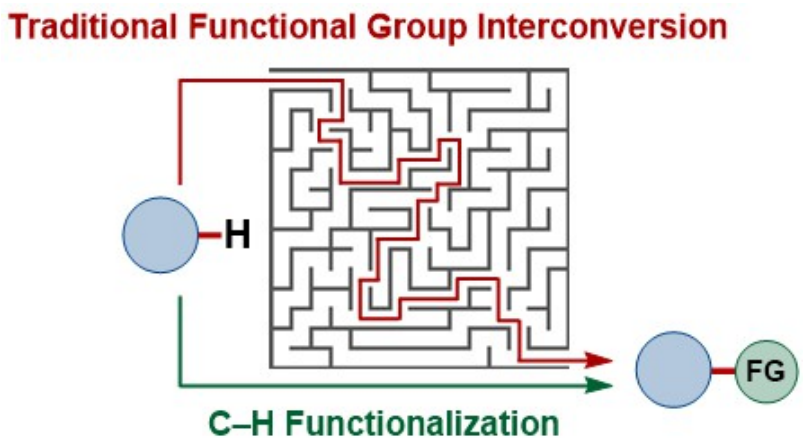
Keywords: C–H Activation, Late-Stage Functionalization, 3d Transition Metal Catalysis, Electrocatalysis, Molecular Machine Learning

Abstract:

C–H activation has surfaced as a powerful platform in molecular synthesis, with transformative applications to material sciences and drug discovery, among others.[1] In this context, we have introduced carboxylates, for position-selective C–H activation with versatile ruthenium(II) complexes. In light of limited resources, we developed Earth-abundant 3d metal catalysis based on detailed mechanistic insights.[2] Thus, we established *inter alia* benign iron-catalyzed C–H transformations.[3] Studies towards metallaelectrocatalytic C–H and C–C activation with a unique level of resource-economy,[4] late-stage functionalization,[5] data science,[6] and enantioselective catalysis[7] will be discussed, with a topical focus on sustainable base metals.



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Phase engineering of noble metal-based alloys for highly efficient electrocatalysis

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Abstract

Noble metal-based alloys have been investigated for various catalytic reactions due to the alloying effect of different elements. Nevertheless, the synthesis of noble metal-based alloys with unconventional phase is still challenging. Here, we have developed wet-chemical strategies to prepare a series of Pd-based alloys with unconventional phase for electrocatalysis. Specifically, a seeded method has been developed to prepare PdCu alloy nanoparticles with unconventional hexagonal close-packed (*hcp*, 2H type) phase, which deliver a higher mass activity towards oxygen reduction reaction than that of conventional face-centered cubic (*fcc*) PdCu counterpart.[1] Moreover, hollow PdSn intermetallic nanoparticles with two different unconventional intermetallic phases, *i.e.*, orthorhombic Pd_2Sn and monoclinic Pd_3Sn_2 have also been prepared using seeded method, and the hollow orthorhombic Pd_2Sn catalyst exhibits excellent electrocatalytic performances towards glycerol oxidation reaction, outperforming solid orthorhombic Pd_2Sn and hollow monoclinic Pd_3Sn_2.[2] Besides noble metal-based alloys with crystalline phase, we have also demonstrated the synthesis of various amorphous Pd-based alloys, including PdRu, PdRh, and PdRuRh.[3] Impressively, the as-synthesized amorphous PdRh nanocatalyst exhibits low overpotential and high turnover frequency values towards hydrogen evolution reaction, outperforming its crystalline *fcc* counterpart.

References

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Negatively Curved Molecular Nanocarbons Containing Multiple Heptagons Are Enabled by the Scholl Reactions of Macrocyclic Precursors

Ka Man Cheung, Yongming Xiong, Sai Ho Pun, Xingjian Zhuo, Qi Gong, Xingwei Zeng, Shilong Su, Qian Miao*

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Embedding heptagons in polycyclic aromatic frameworks gives rise to negatively curved molecular nanocarbons. These nanocarbons are vital building blocks in the long-awaited carbon schwarzites and also provide opportunities for further exploration of nanocarbon properties. This study demonstrates the Scholl reactions of macrocyclic precursors as a general approach to synthesizing negatively curved molecular nanocarbons with varying numbers of heptagons. Using density functional theory calculations and X-ray crystallography, it is clear that π-backbones containing multiple heptagons are significantly curved and rigid. Interestingly, these negatively curved π-backbones are interlocked through both face-to-face and edge-to-face π-π interactions in the crystals. These uncommon interactions have enabled the creation of a p-type organic semiconductor. However, the amorphous nature of the vacuum-deposited films has limited the hole mobility in the field effect transistors.

Fig. 1 Negatively curved polycyclic arenes **1**–**6**

A Study of Emerging Disinfection Byproducts in Drinking Water

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Abstract

Disinfection is critical for ensuring drinking water safety by eliminating harmful microorganisms, thereby mitigating water-borne diseases such as cholera and typhoid. During water disinfection, however, disinfectants can react with organic matter, chemicals and pollutants in the water to produce a variety of disinfection byproducts (DBPs) that can cause carcinogenic, teratogenic and mutagenic risks to human health. Although over 1400 DBPs have been identified, it was merely the tip of the iceberg, with a large portion of the emerging DBPs yet to be revealed. Therefore, a comprehensive investigation on these emerging DBPs, generated upon water disinfection is imperative to improve our understanding of these hazardous materials. In this study, two groups of emerging DBPs, namely 2-butene-1,4-dial and its analogues (BDAs) and the halonitriophenols (HNPs), were investigated. BDA is widely recognized as a toxic metabolite with genotoxic and carcinogenic properties, but little is known about the formation of itself and its analogues during water disinfection. HNPs are aromatic emerging DBPs that have raised great concern due to their high stability and high risk to human health.

The occurrence of BDA in the local drinking water was first studied: it was detected in almost all water samples with the detected concentrations ranging from 9.42 to 24.20 ng/L, which is comparable to other well-known emerging DBPs. Furthermore, four other BDA analogues were also identified upon suspect screening using high resolution mass spectrometry. Hence, follow-up studies were conducted to analyze the influential factors leading to the formation of these emerging DBPs, such as the type and dose of disinfectant, pH levels, and halides. Moreover, transformation pathways for the formation of these two emerging DBPs upon disinfection processes are further proposed. The findings of current study are useful in developing control strategies for emerging DBPs in disinfected water. It also highlights the need for further improvement of disinfection techniques to safeguard human health from the hazardous emerging DBPs.

Dye-Sensitized Active Colloids: From Reversible Phototaxis to Optically Guided Dynamic Assemblies

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Material properties are not only determined by their composition but also highly dependent on their precise arrangement of its constituent atoms within its crystal lattice. As a micrometer scale "atom" counterpart, synthetic colloidal particles are assembled into hierarchical nanostructures, recapitulating the essence of atoms formed into molecules and materials, which attracted broad interest for its profound impact on condensed matter physics and potential application in building new functional materials. Active colloids, on the other hand, which is dynamic and out-of-equilibrium, can also be assembled with light, leading to dynamic structure and material properties. For example, we have recently demonstrated the possibility of selectively tuning the pair potential between dye-sensitized TiO_2 colloids with incident light, where photochromism emanates from such spectrum-responsive active colloids[1].

In this work, we demonstrate photoactive colloidal particles with long-ranged tunable interaction, which provides a versatile route to guide the assembly on demand. To program the directionality during the assembly, we hereby suggest that a photonic nanojet effect on a photoactive spherical colloidal particle can create a highly localized hydrodynamic flow, resembling a directional molecular binding. By incorporating dye-sensitized spherical TiO_2 colloid with off-angle illumination, the photonic nanojet effect is induced by light with off-absorption peak wavelength, which leads to localized attraction at the focal point. By adjusting the illuminating condition, the tunable directional potential can be generated on spherical colloids, which can not only generate dynamic zigzag patterns, but also allows the polymorphic assembly to all 2D Bravais

lattices on demand. Such directional attraction/repulsion force is also measured under optical tweezers system. Finally, we reveal the rapid colloid phase transition, as controlled with light, can be used for living photonic devices to control the diffraction of the near-infrared laser.

Keywords: Self-assembly; Colloids; Photonic nanojet effect; Dye-sensitized TiO_2; Active matter

A Photoactivatable Luminescent Motif through Ring-Flipping Isomerization for Multiple Photopatterning

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Abstract

Photoactivatable luminescent materials have garnered enormous attention in the field of intelligent responsive materials, yet their design and applications remain challenging due to the limited variety of photoactivatable motifs. In the work described herein, we discovered a new photoactivatable luminescent motif that underwent ring-flipping isomerization under UV irradiation. The emission of this motif exhibited a rapid transformation from dark yellow to bright green, accompanied by a significant enhancement of quantum yield from 1.9% to 34.2%. Experimental and theoretical studies revealed that the effective intramolecular motion (EIM) was crucial to the distinct luminescence performance between two isomers. In addition, polymers containing this motif were achieved through a one-pot alkyne polymerization, exhibiting both photofluorochromic and photo-cross-linking properties. Furthermore, multiple types of photopatterning, including luminescent encryption, fluorescent grayscale imaging, and high-resolution photolithographic patterns, were realized. This work developed a new photoactivatable luminescent motif and demonstrated its potential applications in both small molecules and macromolecules, which will help in the future design of photoactivatable luminescent materials.[1]

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Intramolecular Arene C(sp^2)—H Amidation Enabled by Ferrocenium-Mediated Decomposition of 1,4,2-Dioxazol-5-ones as Amidyl Radical Precursors

Wenlong Sun[‡], Chi-Ming Au[‡], Ka-Wa Wong[‡], Ka Lok Chan, Cheuk Kit Ngai, Hung Kay Lee, Zhenyang Lin[*], and Wing-Yiu Yu[*]

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Direct arene C–H functionalization by amidyl radicals for arylamides synthesis has made significant advances.[1] While photocatalytic protocols can offer easy generation of amidyl radicals under mild conditions, designing catalysts involving earth-abundant Fe complexes for C–H amidation is an attractive approach to bring about ligand-enabled selectivity control.[2] However, due to preference for high-spin configuration, designing robust Fe catalysts for C–H amidation remains a substantial challenge. Taking the advantage of the strong Cp-Fe linkages, here we developed the 17-electron ferrocenium complexes as effective catalysts for facile intramolecular aryl C–H amidation with 1,4,2-dioxazol-5-one as amidyl radical precursors. The ferrocenium-catalyzed reaction affords 3,4-dihydroquinolin-2(1*H*)-ones in excellent yields and selectivity. Our experimental and computational studies revealed that the intramolecular arene amidation is brought about by electrophilic arene addition by reactive Fe(IV)-amidyl radical species. Consistent with the experimental findings, the regioselectivity (*ipso*- versus *ortho*-amidyl radical addition) is influenced by electronic factors. The *ipso* amidyl radical addition should form an azaspirocyclohexadienyl radical intermediate. Subsequent radical-polar crossover and 1,2-alkyl migration followed by rearomatization afforded the skeletal rearranged dihydroquinolinone lactams.

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DNA Origami as In Vivo Drug Delivery Vehicle using photocleave molecule to release TNA drugs for Cancer Therapy

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Abstract

α-L-Threose nucleic acid (TNA), which is an RNA-like polymer consisting of a four-carbon sugar group with a backbone repeat and phosphodiester bonds at the 2' and 3 'adjacent positions of the sugar ring. In recent years, the research progress and breakthrough of xeno nucleic acids (XNAs) have inspired us to explore TNA as a promising biomaterials. Using the DNA origami technique, we constructed a photon-activated DNA origami nanostructure to deliver multiple TNA-based therapeutic drugs to inhibit specific gene expression regulation and further modulate different signaling pathways related to triple negative breast cancer for effective treatment[1,2]. We expect that this DNA origami nanostructure can be linked to TNA drug by photocleavage molecules, that the photoresponsive DNA origami nanostructure can cleave TNA drug under the excitation of light, and that TNA drug can be released for gene therapy. Therefore, this clean and safe strategy for inducing the configuration change of DNA origami nanostructures will facilitate the remote control of DNA origami nanostruction-loaded drugs, either in solution or in a specific cellular environment, without disrupting the ordered biological system. Moreover, we expect that this novel engineered DNA origami nanostructure can exhibit enhanced enzymatic resistance and cellular uptake as well as lower cytotoxicity. Our study will provide a solid foundation for the creation of DNA-based nanostructures and their remote control in both time and space for drug release. We can expect that DNA nanotechnology will bring us another big step forward

in the realization of using nanomaterials in the human body to perform complex tasks with a high degree of specificity and precision.

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Theoretical Study of Water Affinity of Atmospheric $(H2SO4)_3$-$(NH3)_3$ Cluster

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Abstract

Aerosols have a great impact on global climate, air quality and human health. New particle formation (NPF) is a major source of atmospheric aerosols. Overall, NPF is mainly divided into three stages: the generation stage, nucleation stage and growth stage. In recent years, scientists have used field observations and smoke box simulation experiments to study new particle generation events around the world. However, restricted by experimental observations and characterization methods, the microscopic mechanism of the formation of new particles is still unclear. Quantum chemical calculations have obvious advantages in exploring chemical reaction mechanisms. Studying the nucleation mechanism of sulfuric acid-ammonia-water clusters in the atmosphere at the molecular level can provide valuable information for understanding the growth mechanism of water molecules on acid-base clusters and environmental management. In this work, we use quantum chemical calculation methods to study the mechanism of forming stable clusters in water molecules using small molecules of ammonia and sulfuric acid and explain how the sulfuric acid-ammonia cluster changes as the water molecules is increased.

References

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TNA-Mediated Antisense Strategy to Knockdown Akt Genes for Triple-Negative Breast Cancer Therapy

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Abstract

Triple negative breast cancer (TNBC) remains a significant challenge in terms of treatment.[1] In this study, we employed a threose nucleic acid (TNA)-mediated antisense approach to target therapeutic Akt genes for TNBC therapy. Specifically, we designed and synthesized two new TNA strands that specifically target Akt2 and Akt3 mRNAs. These TNAs exhibited exceptional enzymatic resistance, high specificity, enhanced binding affinity with their target RNA molecules compared to natural nucleic acids. In both 2D and 3D TNBC cell models, the TNAs effectively inhibited the expression of their target mRNA and protein, surpassing the effects of scrambled TNAs. Moreover, when administered to TNBC-bearing animals in combination with lipid nanoparticles, the targeted anti-Akt TNAs led to reduced tumor sizes and decreased target protein expression compared to control groups. This study introduces a novel approach to TNBC therapy utilizing TNA polymers as antisense materials and holds promise as a cost-effective and scalable platform for TNBC treatment.

Reference

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Reactivity of Sodium Chloride Clusters with Formic Acids in the Gas Phase by Theoretical Study

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Abstract

As increasingly facing the effects of global warming, it is important to identify and study the major climate drivers. Aerosols represent one of these major climate drivers and, thus, receive particular scientific and political attention. Aerosols contain organic and inorganic compounds that significantly affect radiative forcing. Sea salt aerosol is one of the most important aerosols in the earth's atmosphere and has important effects on the earth's climate. As the main component of sea salt aerosols, sodium chloride is involved in many atmospheric processes, such as cloud formation, photochemical reactions, and reactions with atmospheric trace gases. Gas clusters are ideal models for studying the basic physical and chemical properties of pure and doped salts. In previous experiment, gas-phase sodium chloride cluster ions are used to model chemical reactions in sea salt aerosols by A Fourier transform ion cyclotron resonance (FT-ICR) mass spectrometer and electrospray ionization (ESI). Formic acid is used as reaction gas. It recorded reaction kinetics and absolute rate coefficients. There are difference between different kinds of cluster. Because there are many kinds of structures for sodium chloride. To find reaction structures and explain experiment results, this study calculates reactivity of sodium chloride clusters with formic acids in the gas phase.

References

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Tau-targeting Manganese Dioxide Nanoflower with Enhanced MR Imaging for Alzheimer's Disease Diagnosis

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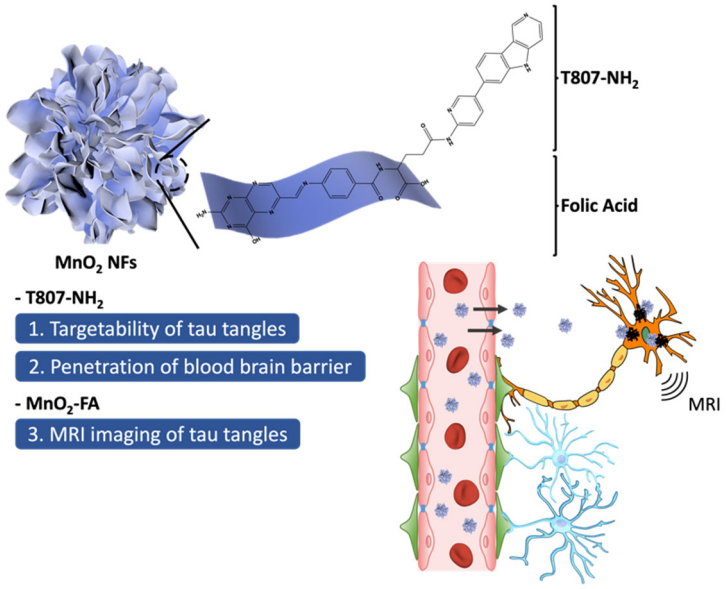
Abstract

Alzheimer's disease (AD) is the most prevalent neurological disorder among elderly but efficient and accurate diagnostic method for AD have not established yet. Widely used technique magnetic resonance imaging (MRI) only shows brain shrinkage of brain regions in later stages of AD. Tau deposition in the brain is one of the hallmarks of AD and thus serves as a crucial biomarker of AD that can be utilized in MRI for prognosis and diagnosis. However, significant challenges including limited blood-brain-barrier penetration (BBB), poor targeting of tau neurofibrillary tangles and unclear MR imaging still remain. Herein, tau-targeting T807-NH_2 covalently conjugated on folic acid-fabricated manganese dioxide nanoflower (MnO_2-FA) is developed. The results showed that NFs-T807 provides high binding affinity and targeting ability to tau, enhanced penetration of BBB and good T_1-weighted contrast effect for MRI. This platform is envisioned as a promising strategy for future AD diagnosis.



Enzymatic Interfacial Conversion of Acylglycerols in Pickering Emulsions Stabilized by Hydrogel Microparticles

Yongxu Han, Jiang Xia*

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Abstract

A critical challenge in the enzymatic conversion of acylglycerols is the limited exposure of the enzyme dissolved in the aqueous solution to the hydrophobic substrate in the oil phase. Positioning the enzyme in a microenvironment with balanced hydrophobicity and hydrophilicity in Pickering emulsion will facilitate the acylglycerol-catalyzing reactions at the interface between the oil and liquid phases. In this work, to overcome the challenge of biphasic catalysis, we report a method to immobilize enzymes in polyethylene glycol (PEG)-based hydrogel microparticles (HMPs) at the interface between the oil and water phases in Pickering emulsion to promote the enzymatic conversion of acylglycerols. 3 wt% of HMPs can stabilize the oil-in-water Pickering emulsion for at least 14 days and increase the viscosity of emulsions. Lipase-HMP conjugates showed significantly higher hydrolytic activity in Pickering emulsion; Co-immobilization of a lipase and a fatty acid photodecarboxylase from Chlorella variabilis (cvFAP) in Pickering emulsion enables light-driven cascade conversion of triacylglycerols to hydrocarbons, transforming waste oil to renewable biofuels in a green and sustainable approach. HMPs stabilize the Pickering emulsion and promote interfacial biocatalysis in converting acylglycerols to renewable biofuels.

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Lactone-to-Lactam Editing Alters the Pharmacology of Bilobalide

Xiaoding Jiang,[+[a]] Xu He,[+[a]] Jonathan Wong,[+[a]] Stephan Scheeff,[a] Sam Chun-Kit Hau,[b] Tak Hin Wong,[a] Yao Qin,[a] Chi Hang Fan,[a] Bowen Ma,[a] Ngai Lam Chung,[a,c] Junzhe Huang,[d] Jiajia Zhao,[a] Yu Yan,[a] Min Xiao,[a] Xueqin Song,[a] Tony K.C. Hui,[e] Zhong Zuo,[a] William Ka-Kei Wu,[f,g] Ho Ko,[d,g,h] Kim Hei-Man Chow,[i] and Billy Wai-Lung Ng*[a,g,h]

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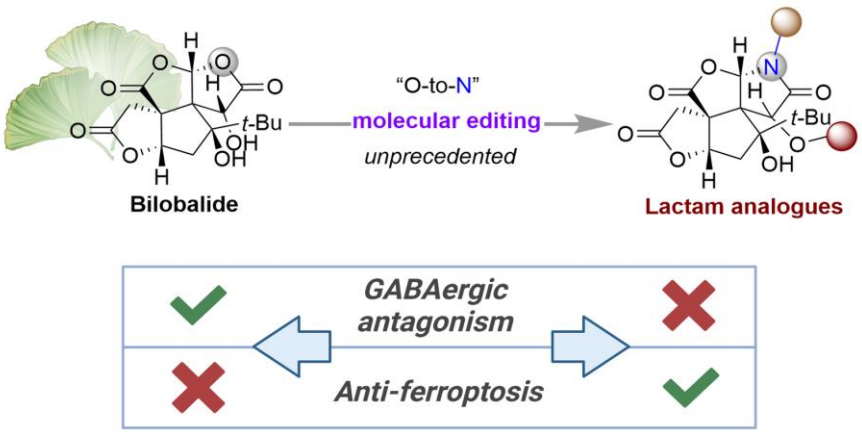
Abstract

Precise transformations of natural products (NPs) can fine-tune their physicochemical properties, while preserving inherently complex and evolutionarily optimized parent scaffolds. Here we report an unprecedented lactone-to-lactam transformation on bilobalide, thus improving its stability and paving the way for biological exploration of previously inaccessible chemical space that is highly representative of the parent structure. This late-stage molecular editing of bilobalide enables facile access to a unique library of lactam analogues with altered pharmacology. Through phenotypic screening, we identify **BB10** as a lead compound with unexpected inhibition of ferroptotic cell death. We further reveal that **BB10** suppresses ferroptosis by restoring the expression of glutathione peroxidase 4 (GPX4) in brain cells. This study highlights that even subtle changes on NP scaffolds can confer new pharmacological properties, inspiring the exploration of simple yet critical transformations on complex NPs.



Enzyme Assembly Based on Nucleoid Associated Proteins (NAPs) to Expand the Functions of *E.coli* nucleoid

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Abstract

In eukaryotic cells, various organelles, each with specific functions, are critical for complex life activities. Although prokaryotic cells lack membrane-bound organelles, the discovery of P granule in C. elegans has attracted focus to membraneless organelles.[1]

The primary mechanism for the formation of these organelles is liquid-liquid phase separation (LLPS). These organelles provide higher local concentrations of specific proteins while enabling material exchange with the cytoplasm. Our hypothesis is that constructing artificial membraneless organelles in prokaryotic cells and recruiting key catalytic enzymes into these organelles can optimize enzyme-catalyzed reactions, metabolic pathways, and increase yield.

We chose HUαβ as the platform for introducing the α-farnesene synthesis pathway into E. coli. The α-farnesene biosynthetic pathway has shown that assembling Idi and IspA, two rate-limiting enzymes in the pathway, could enhance α-farnesene production.[2] By fusing Idi and IspA with Huα and Huβ respectively, we aimed to form an enzyme complex that assembles with nucleoids in E. coli cells, potentially expanding the functions of the nucleoid into an organelle involved in terpene synthesis.

The main objectives were to overexpress HU proteins in E. coli, confirm their binding with nucleoids, and introduce the α-farnesene biosynthesis pathway by fusing key enzymes with HUαβ heterodimers. We aimed to modify nucleoids into α-farnesene-producing organelles and enhance α-farnesene production.

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Hybrid membrane-coated nanomotor for immunotherapy and chemotherapy of breast cancer

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Abstract

Cancer cells adhesion and extracellular matrix penetration are important for drug delivery in cancer treatment. However, it is reported that coating nanoparticle surface with tumor-recognizing ligands can only achieve 0.7% delivery to solid tumors in preclinical animal models. Here, we proposed a membrane coated NO driven mesoporous silica iron oxide drug carrier ([RM]-GDL-MSN@Fe_3O_4) for drug delivery. Red blood cells (RBCs) membrane coating can prevent the immune clearance of nanoparticles by expressing “don’t eat me” signal, thus prolonging the blood circulation time. Mesoporous silica iron oxide is loaded with Doxorubicin (DOX) and L-arginine(L-arg) for chemo/immunotherapy and starvation therapy. Through the conversion of L-arg to nitric oxide (NO) bubble in reactive oxygen species (ROS) overexpressed tumor microenvironment (TME), [RM]-GDL-MSN@Fe_3O_4 can be propelled by the generation of nitric oxide gas to penetrate the extracellular matrix. The release of nitric oxide is also reported to exhibit a promising antitumor effect at high concentration. Synergizing with immunotherapy, [RM]-GDL-MSN@Fe_3O_4 holds excellent potential to kill cancer without causing strong side effects.

Antibody Therapeutics (ImmuoRBC) for Cancer Based on Site-Selective Antibody Reaction

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Abstract

In this poster, we report the synthesis of antibody-lipid conjugates (ALCs) and develop antibody-functionalized red blood cells (immunoRBCs) for targeted drug delivery. A peptide-guided, proximal-induced reaction enables the site-specific transfer of an azidoacetyl group to the e-amino group of lysine precisely at Lys 248 of the Fc domain. Dibenzocyclooctyne (DBCO)-functionalized lipids were then conjugated to the azide-functionalized IgG through strain-promoted azide-alkyne cycloaddition to give ALCs, which were then inserted into the membrane of RBCs to enable the construction of immunoRBCs. Trastuzumab-functionalized immunoRBCs loaded with a photosensitizer, Zinc phthalocyanine (ZnPc), bound selectively to HER2-overexpressing cells, released ZnPc into cancer cells upon photolysis and effectively killed the cells, 2-fold decrease of the cell viability compared to the positive group (adding ZnPc directly).

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AuNPs-locked CeO_2 Doped UCNP@$mSiO_2$ Nanoparticles for Dual ROS- and Light-triggered Synergistic Tumor Therapy

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Abstract

Limitations and side effects of conventional tumor therapies imperatively entail novel yet more efficacious methods against tumor. PTT, PDT and CDT have recently emerged as potent tumor therapeutic alternatives. By achieving tumor-ablation high temperature or generating highly cytotoxic ROS, these novel methods efficiently kill tumor cells while minimizing side effects, courtesy of controlled on-site functioning. Nanomaterials, which can be engineered to interact with biological systems at cellular and molecular levels, enable targeted and precise interventions. Mesoporous SiO_2 ($mSiO_2$) coated upconversion nanoparticles (UCNPs), which convert lower-energy photons into higher-energy photons, are able to sufficiently house CDT agents CeO_2 that was *in situ* oxidized inside mesopores.[1] Meanwhile, functionalized $mSiO_2$ surface enables the conjugation of TK-CUR-TPP for PDT. Finally, AuNPs that were modified by light-triggered click chemistry compounds tetrazole and alkene were attached to the surface via electrostatic force to lock CeO_2.[2] After internalization by tumor cells, overexpressed ROS cleaves TK to release TPP-CUR, which resumes the negatively charged surface, causing the detachment of AuNPs and thus the release of CeO_2. Upon UV light emitted by UCNP, AuNPs aggregate for remarkably enhanced PTT. Synergistically, ROS generated by CUR expedites the cleavage of TK, bolstering the more complete detachment of AuNPs and further the release of CeO_2, which then generates more ROS for positive feedback and O_2 for elevated PDT, forming a mutually facilitating circle. Hence, the devised UCNP@$mSiO_2$@CeO_2/AuNPs with three intertwined moieties exhibit great promises in tumor treatment in a synergistic fashion.

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Detection of Biomarker Based on Enzyme-free Cascade Signal Amplification Strategies

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Disease-associated biomarkers circulate throughout the body and exist in different body fluids, such as blood, urine, and saliva. They are closely related to diverse kinds of diseases. Thus, detecting such biomarkers in body fluids is promising for early disease diagnosis. Nucleic acids (such as DNA, mRNA, and microRNA (miRNA)) are the most common types of biomarkers used in disease diagnostics. Recently, isothermal, enzyme-free amplification techniques, such as the hybridization chain reaction (HCR) and catalytic hairpin assembly (CHA), have gained increasing attention for nucleic acid detection. However, current methodological challenges, including slow kinetics, and low amplification efficiency, need to be addressed. Here, we report a novel amplification cascade of FRET-based two-layer nonenzymatic nucleic acid circuits, HCR-CHA circuit, in which the target DNA as the input initiates the first HCR amplification circuit, generating HCR products containing numerous trigger sequences as a mediator to trigger the second CHA amplification circuit to induce repeated hybridization, allowing real-time monitoring of the self-assembly process by FRET signal. We explored the amplification potential of the cascade HCR-CHA circuit and compared it with individual amplification circuits. We found that the kinetics of the combined HCR-CHA amplification method is faster than that of HCR amplification method, and the detection limit of the combined HCR-CHA circuit is low to pM level, demonstrating the promising application in bioanalysis and early disease diagnosis.

Targeted Protein O-GlcNAcylation in Living Cells

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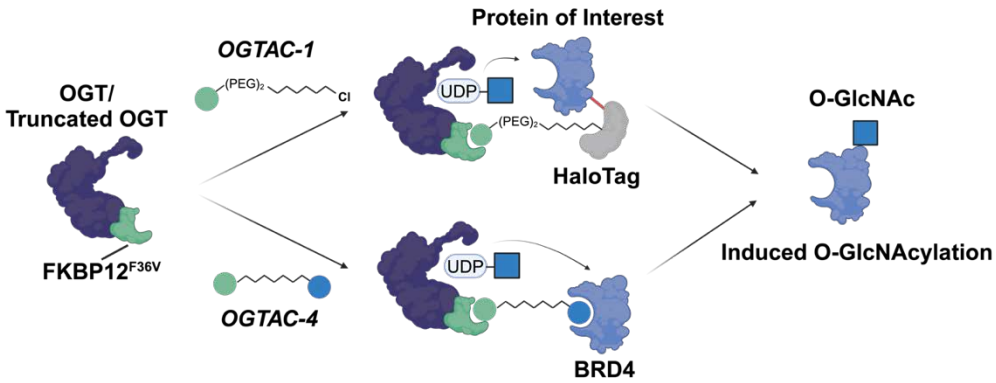
Abstract

Protein O-linked β-*N*-acetylglucosamine modification (O-GlcNAcylation) plays a crucial role in regulating essential cellular processes. The disruption of O-GlcNAcylation homeostasis has been linked to various human diseases, including cancer, diabetes, and neurodegeneration. However, there are limited chemical tools for protein- and site-specific O-GlcNAc modification, rendering the precise study of O-GlcNAcylation challenging. To address this, we have developed heterobifunctional small molecules, named O-GlcNAcylation TArgeting Chimeras (OGTACs), which enable protein-specific O-GlcNAcylation in living cells. OGTACs promote O-GlcNAcylation of proteins such as BRD4, CK2α, and EZH2 *in cellulo* by recruiting $FKBP12^{F36V}$-fused O-GlcNAc transferase (OGT), with temporal, magnitude, and reversible control. Overall, OGTACs represent a promising approach for inducing protein-specific O-GlcNAcylation, thus enabling functional dissection and offering new directions for O-GlcNAc-targeting therapeutic development.



Ultrasensitive Direct Detection of Neurofilament Light Chain in Circulatory Body Fluids for Neurodegenerative Diseases Diagnosis

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Abstract

Neurodegenerative diseases (NDs) are getting more prevalent in most countries because of the increasing life expectancy and are posing considerable burden to the society and economy. The most common form of NDs includes Alzheimer's disease (AD) and Parkinson's disease (PD). However, there is still no treatment that can cure most of these diseases. Early diagnosis and intervention are the best approach to alleviate the symptoms and delay the NDs progression. Therefore, we here develop an ultra-sensitive and direct assay to detect one emerging biomarker, neurofilament light chain (NfL) protein, in body fluids for early diagnosis of NDs. We employ capture antibody modified magnetic nanoparticles to specifically capture the target and a tailor-made protein turn-on fluorophore to label the immunocomplex, showing a remarkably fluorescence enhancement upon binding. The magnetic nanoparticles served as preconcentration and purification platform. Our immunoassay-based method consumes only minute sample and simplifies the detection process by skipping the use of detection antibody as compared to commercial ELISA Kit. The detection limit of our assay can reach fM level. This assay used for real sample analysis and differentiated the AD patients and healthy people by determination of the serum NfL, which shows the potential for NDs screening in clinics.

Peptide-based Phase Separation System for Intracellular Nucleic Acids Delivery

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Abstract

Nucleic acids are promising therapeutic biomacromolecular which could not pass through the cell membrane spontaneously. Various vehicles have been devised to deliver nucleic acids across the plasma membrane but limited by the bio-compatibility or delivery efficiency. Here we design a new peptide-based phase separation system, which could recruit a wide range of nucleic acids in a high packaging rate, enter the cytoplasma spontaneously, and release the cargos by response to the natural reductant in the mammalian cells. It could deliver siRNA, different size of plasmids and also mRNA. This new system shows even a better delivery efficiency compare to the common used commerial transfection reagents in vitro. The possible mechanism of coacervates entering cells might depend on F-actin participated pathway and traffic to early endosome.

Visible light induced proximity labeling based on antibody-photocatalyst conjugate

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The interactions of biomolecules are the base of cellular processes, so understanding them can help people find more strategies to treat diseases. Protein–protein interactions (PPIs), in particular, play a vital role within this arena, providing the basis for the majority of cellular signaling pathways. Despite their great importance, methods to detect information about PPIs have been limited. Nowadays, a novel method called proximity labeling has been developed to detect protein-protein interactions. One key parameter of proximity labeling is the radius of the active reagents with the biotin marker, which results in the amounts of the proteins you labeled around the target protein. Here, we report a novel method for proximity labeling based on the site-selective antibody-catalyst conjugate. Our group has developed a site-selective antibody modification on the Fc domain. Based on this method, we conjugated the Ir catalyst to the antibody on the Fc domain. We utilized the special function and structure of the antibody in the immune process to achieve the proximity labeling around the immune cell's surface.

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Xanthine-derived reactive oxygen species exacerbates adipose tissue disorders in male *db*/*db* mice induced by real-ambient PM2.5 exposure.

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Abstract

Epidemiological and experimental data have associated exposure to fine particulate matter (PM2.5) with various metabolic dysfunctions and diseases, including overweight and type 2 diabetes. Adipose tissue is an energy pool for storing lipids, a necessary regulator of glucose homeostasis, and an active endocrine organ, playing an essential role in developing various related diseases such as diabetes and obesity. However, the molecular mechanisms underlying PM2.5-impaired functions in adipose tissue have rarely been explored. In this work, metabolomics based on liquid chromatography-mass spectrometry was performed to study the adverse impacts of PM2.5 exposure on brown adipose tissue (BAT) and white adipose tissue (WAT) in the diabetic mouse model. We found the effects of PM2.5 exposure by comparing the different metabolites in both adipose tissues of male *db/db* mice using real-ambient PM2.5 exposure. The results showed that PM2.5 exposure changed the purine metabolism in mice, especially the dramatic increase of xanthine content in both WAT and BAT. These changes led to significant oxidative stress. Then the results from real-time quantitative polymerase chain reaction showed that PM2.5 exposure could cause the production of inflammatory factors in both adipose tissues. Moreover, the increased reactive oxygen species (ROS) promoted triglyceride accumulation in WAT and inhibited its decomposition, causing increased WAT content in *db/db* mice. In addition, PM2.5 exposure significantly suppressed thermogenesis and affected energy metabolism in the BAT of male *db/db* mice, which may deteriorate insulin sensitivity and blood glucose regulation. This research demonstrated the impact of PM2.5 on the adipose tissue of male *db/db* mice, which may be necessary for public health.

Early diagnosis of nasopharyngeal carcinoma based on machine learning modelling and plasma metallomics analysis

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Abstract

Current diagnosis of nasopharyngeal carcinoma (NPC) mainly relies on detection of plasma Epstein-Barr virus DNA or nasal endoscopy. However, trace metals or other elements may have critical roles in the pathophysiology of NPC. In this study, plasma samples from 93 NPC patients and 30 healthy control were used for metallomics analysis. Plasma was prepared by alkali dilution method, and the concentrations of elements were detected and measured by inductively coupled plasma-mass spectrometry. We then built six machine learning (ML) algorithms based on the elemental contents and evaluated the predictive performance of algorithms by the area under the receiver operating characteristic curve (AUC). Shapley Addictive exPlanations (SHAP) was employed to interpret the prediction results and explain the contribution of each variable to the model. The levels of Be, Sn and Bi were significantly higher in plasma of the NPC group compared to the healthy control group (p<0.01), while the levels of Ni, Fe, P, Mg, Mn, Co, Zn, Sr, Mo, Sb, Ba, Tl and Pb were significantly lower in the NPC group compared to the healthy control group (p<0.05). Among the ML models, the bagging model demonstrated the most promising performance in predicting the risk for NPC with AUC of 0.999 in testing sets. We further recruited 30 patients with other types of cancer and disease and used them as blind testing samples. The model can successfully identify NPC patients from those samples with AUC and accuracy of 0.965 and 0.934, respectively. In summary, the present study highlights the use of metallomics analysis combined with ML in NPC identification, especially in early-stage cancer prediction.

Metabolomics and Lipidomics with Mass Spectrometry Imaging Reveal Mechanistic Insights into Di-butyl Phthalate-Promoted Proliferation of Breast Cancer Cell Spheroids

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Abstract

Di-butyl phthalate (DBP), extensively used as a plasticizer, has endocrine-disrupting properties that may increase the risk of breast cancer at low concentrations. However, previous studies on the effects of DBP on breast cancer mainly focused on the activation of typical intracellular receptors, and the downstream mechanisms at the metabolic level have not been well elucidated. Therefore, our study applied metabolomics, lipidomics, and mass spectrometry imaging (MSI) techniques to investigate the metabolic responses of MCF-7 breast cancer cell spheroid (CCS) to DBP exposure. The omics results showed that DBP exposure resulted in increased glucose and glutamine uptake and catabolism in breast CCS which supported the production of nucleotides, glycerophospholipids, and amino acids, providing sufficient energy and building blocks for the synthesis of DNA/RNA and cytomembrane necessary for cell proliferation. These results were further corroborated by the MSI data, showing enhanced abundances of ATP, GMP, UDP, lyso-phosphatidylcholines, phosphatidylcholines, and phosphatidylethanolamines in CCS treated with DBP. Interestingly, most of these biomolecules were predominantly distributed in the proliferative region. Our result indicated that the enhanced supply of energy and biosynthetic substrates in the peripheral area facilitated the proliferation of breast CCS, shedding new light on the metabolic mechanisms of DBP-promoted breast cancer development.

Imaging inorganic minerals and metabolites simultaneously by MALDI-MS on rigid biological samples

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ABSTRACT

Mass spectrometry imaging (MSI) is a developing technique that spatially resolves the molecular composition of samples in a label-free manner. Matrix-assisted laser desorption/ionization technique is one of the most investigated ionization techniques in MSI. However, due to challenging sample preparation, rigid samples, such as teeth, bones, and plants, usually cannot be easily analysed. The development of cryo-film, which maintains adhesion even at low temperatures, enables a section of the rigid sample without decalcification[1]. However, reported studies are still limited in coverage of the metabolome. In this work, we reported an optimized workflow for mass spectrometry imaging of fresh, frozen, rigid biological samples. We prepared a fresh frozen section of rat joint samples using a cryofilm-assisted method. Simultaneous detection of various types of endogenous molecular classes, including phosphoglycerolipids, polar metabolites, as well as inorganic metal salts, was achieved. Compared with the existing studies, our method has a higher coverage of the metabolome with comparable lateral resolution[2]. The current method can detect more metal ions simultaneously, which MALDI-MS cannot easily detect in negative mode. For the first time, in rigid samples, small metabolites and inorganic metal ions are imaged simultaneously.

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Nasal epithelial cells collection in vitro and transformed into adult stem cells by recompilation and cultured in 2D differentiation to culture respiratory organoids

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Abstract

Recent advances in regenerative medicine and tissue engineering have paved the way for the development of complex organoid systems that mimic the structure and function of native tissues. In this study, we report a novel approach for the efficient collection of somatic cells and their subsequent reprogramming into induced adult stem cells (ASCs). This allows us to harvest mature nasal epithelial cells in vitro without the need for invasive surgery to obtain respiratory tissue, reducing the difficulty of obtaining access. Through a meticulous process of 2D differentiation and culture, we have successfully generated lung organoid structures characterized by the presence of functional cilia, mirroring the epithelial architecture of the respiratory tract. Immunofluorescence staining revealed the organoids comprised a diverse cellular composition, including ciliated cells, goblet cells, club cells, and basal cells, each contributing to the organoid's functionality and structural integrity. Our findings demonstrate a significant step forward in organoid technology, offering potential applications in toxicology analysis by environmental pollutants.

Urinary exposure marker discovery for QACs using ultra-high pressure liquid chromatography coupled with TOF high resolution mass spectrometry

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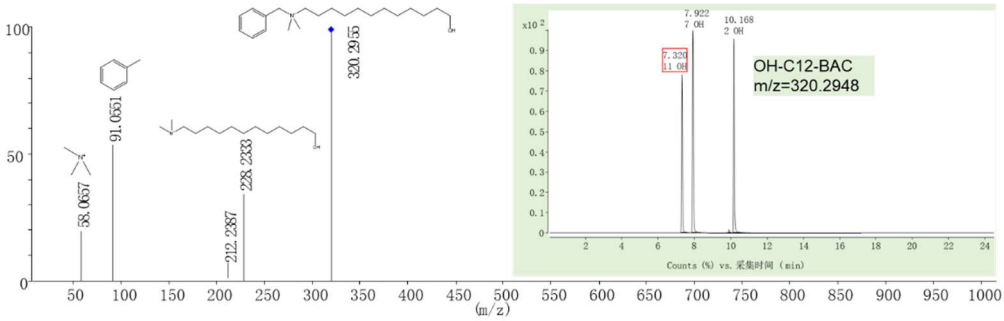
Abstract

Quaternary ammonium compounds (QACs) have been widely employed as a predominant class of biocides, disinfectants, and sanitizers since the late 1940s. Humans can be exposed to QACs through various pathways, however, the understanding of the absorption, distribution, metabolism, and excretion of QACs in humans remains limited. Appropriate biomarkers are essential for assessing the extent of human exposure and potential adverse health effects associated with concerning chemicals. In this study, high-resolution mass spectrometry (TOF) was utilized to achieve precise measurements of metabolite signals. We investigated the hydroxy metabolite signals of C12-BAC to identify potential exposure markers in in vitro C12-BAC human liver microsomes incubation samples. Through target standard analysis, we successfully identified the ω-hydroxy metabolite of C12-BAC. Subsequently, the ω-hydroxy metabolite signal of C12-BAC was confirmed as a reliable exposure marker in human urinary samples.



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Evaluation of nanoplastic toxicity in the soil nematode *Caenorhabditis elegans* by quantitative proteomics

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In recent years, plastic pollution has emerged as a significant threat to both terrestrial and aquatic ecosystems. The degradation of large plastic objects can lead to the formation of microplastics and nanoplastics, which are tiny plastic fragments[1]. In this study, we utilized the soil nematode *Caenorhabditis elegans* as an in vivo model to investigate the dynamic changes in the proteome in response to 100 nm polystyrene nanoplastics, employing iTARQ-based quantitative proteomics. Following a 48-hour exposure to nanoplastics at concentrations of 0.1, 1, and 10 mg/L, we observed differential expression of 136 out of 1684 proteins, with 108 proteins showing up-regulation. The proteomic data revealed a hyper-activation of ribosome biogenesis, translation, and proteolysis, along with an up-regulation of key enzymes involved in energy metabolism pathways. These findings highlight the disturbance of proteome homeostasis as a biological consequence of nanoplastics deposition and offer valuable insights into the molecular mechanisms underlying the toxic effects of nanoplastics on terrestrial organisms.

Environmental Fate of Quaternary Ammonium Compounds upon the UV/NH_2Cl Process: Kinetics, Transformation Pathways and the Formation of N-nitrosamines

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Abstract

Quaternary ammonium compounds (QACs) are extensively found in aquatic environment due to their broad use in numerous antibacterial products throughout the pandemic. In the current study, UV/monochloramine (UV/NH_2Cl) was utilized to degrade three representative QACs, including benzalkonium compounds (BACs), alkyl trimethyl ammonium compounds (ATMACs), and dialkyl dimethyl ammonium compounds (DADMACs). High removal efficiency was achieved for homocyclic QACs (BACs) upon the UV/NH_2Cl process. The transformation products resulting from the UV/NH_2Cl treatment of QACs were identified and analysed using a high-resolution mass spectrometer, and the corresponding transformation pathways were proposed. The formation of N-nitrosamines, including N-nitroso-n-methyl-n-alkylamines (NMAs) and N-nitrosodimethylamine (NDMA) were observed during the degradation of QACs. The ecotoxicity of these NMAs and their corresponding QACs was further predicted using ECOSAR software. An increase in toxicity levels could be ascribed to the formation of NMAs with longer alkyl chains, which exhibited an increase in toxicity by an order of magnitude when compared to their respective QACs. This study provides valuable insights into the knowledge gap concerning the formation of N-nitrosamines derived from various types of QACs during the UV/NH_2Cl process.

A simple signal enhancement strategy for Rapid Matrix-Assisted Laser Desorption/Ionization Mass Spectrometry Imaging

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Abstract

Matrix-assisted laser desorption/ionization (MALDI) is the most utilized technique in mass spectrometry imaging (MSI). While powerful in mapping molecules of interest such as drugs, metabolites, lipids, and proteins with high spatial resolution (sub 10 μm), MALDI-MSI requires a complex and time-intensive sample preparation process, necessitating well-trained professionals to achieve quality MS imaging. Researchers have proposed a matrix pre-coated approach to reduce the time and cost of MS imaging. However, this method has limitations due to suboptimal tissue-matrix co-crystallization and extraction, leading to low ionization yields and poor image quality. This study presents a one-step, rapid method as a signal enhancement strategy for the MALDI workflow, taking approximately 30 seconds. The process involves spraying a small amount of water or 70% methanol (MeOH) onto a tissue section mounted on a pre-coated ITO slide for 15 seconds, followed by a 4-second microwave treatment. This approach yielded a 3.8- to 4-fold signal increase in the lipid region (600–1000 m/z) and enhanced the signal-to-noise ratio in both 2,4-Dihydroxybenzoic acid (DHB) pre-coated slides in positive mode and N-(1-Naphthyl)ethylenediamine dihydrochloride (NEDC) pre-coated slides in negative mode after treatment. In conclusion, our rapid enhancement strategy significantly increases ion yield in the lipid region, resulting in improved MS image quality with only an additional 30 seconds of sample preparation time.

Characteristics and source apportionment of water-soluble organic nitrogen (WSON) in $PM_{2.5}$ in Hong Kong: With focus on amines, urea, and nitroaromatic compounds

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Abstract:

Water-soluble organic nitrogen (WSON) is ubiquitous in fine particulate matter (PM2.5) and poses health and environmental risks.[1,2] However, there is limited knowledge regarding its comprehensive speciation and source-specific contributions. Here, we conducted chemical characterization and source apportionment of WSON in 65 PM2.5 samples collected in Hong Kong during a 1-yr period. Using various mass-spectrometry-based techniques, we quantified 22 nitrogen-containing organic compounds (NOCs), including 17 nitroaromatics (NACs), four amines, and urea. The most abundant amine and NACs were dimethylamine and 4-nitrocatechol, respectively. Two secondary (i.e., secondary formation and secondary nitrate) and five primary sources (i.e., sea salt, fugitive dust, marine vessels, vehicle exhaust, and biomass burning) of WSON and these three categories of NOCs were identified. Throughout the year, secondary sources dominated WSON formation (69.0%), while primary emissions had significant contributions to NACs (77.1%), amines (75.9%), and urea (83.7%). Fugitive dust was the leading source of amines and urea, while biomass burning was the main source of NACs. Our multi-linear regression analysis revealed the significant role of sulfate, NO_3, nitrate, liquid water content, and particle pH on WSON formation, highlighting the importance of nighttime NO_3 processing and heterogeneous and aqueous-phase formation of NOCs in the Hong Kong atmosphere.

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A turn-off chemosensor for selective detection of palladium (II) ion

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Abstract

Due to the excellent physical and chemical properties, palladium has been used in various materials, such as catalysis, dental crowns, jewelry and fuel cells[1]. However, the increasing use of palladium can also lead to contamination of environment and living organisms. In order to prevent the health hazards caused by palladium, this residual heavy metal in products are strictly limited by relevant regulatory. Although some traditional methods have been used for the detection such as atomic absorption spectroscopy(AAS), there are limitations like the requirements of expensive instruments.

Since palladium is a heavy metal, which means a higher affinity to sulfur based on hard and soft, acids and bases theroy (HSAB)[2]. Herein, we describe a novel fluorescent sensing system, which can selectively detect palladium(ll) from a series of metal species. A nitrobenzofurazan based sulfur derivative is found to detect palladium(ll) selectively at room temperature and shows a turn-off type fluorescent response. With the addition of Pd^{2+}, a significant emission decline can be observed through fluorescence spectrometry.

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Machine learning-assisted cultivate food-grade *Spirulina* in seawater-based media

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Abstract

The shortage of food and freshwater sources threatens human health and environmental sustainability. *Spirulina* grown in seawater-based media as a healthy food is promising and environmentally friendly. This study used three machine learning techniques to identify important cultivation parameters and their hidden interrelationships and optimize the biomass yield of *Spirulina* grown in seawater-based media. Through optimization of hyperparameters and features, eXtreme Gradient Boosting, along with the recursive feature elimination model demonstrated optimal performance and identified 28 important features. Among them, illumination intensity and initial pH value were critical determinants of biomass, which impacted other features. Specifically, high initial pH values (> 9.0) mainly increased biomass but also increased nutrient sedimentation and ammonia losses. Both batch and continuous additions could decrease nutrient losses by increasing their availability in the seawater-based media. When illumination intensity exceeded 200 μmol photons/m^2/s, it amplified the growth of *Spirulina* by mitigating the light attenuation caused by a high initial inoculum level and counteracted the negative effect of low temperature (<25 °C). These findings reveal the interactive influence of cultivation parameters on biomass yield and help us determine the optimal cultivation conditions for large-scale cultivation of *Spirulina*-based seawater system based on a developed graphical user interface website.

Keywords: Machine learning; Biomass yield; Cultivation parameters; Large-scale cultivation; Graphical user interface

Seasonal variation in molecular-level characteristics of root exudates from typical tree species in tropical forest

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Abstract

Root exudates are the main form of organic carbon input into soil by the underground parts of plants during the growing period, and these carbon compounds disturb the original soil carbon pool [1]. However, the effect of root exudates on soil organic matter formation has been seriously underestimated [2]. Forest ecosystems are the most important part of the terrestrial carbon sink, while the specific composition characteristics of organic carbon inputs from forest root systems, including variations among different tree species and across different seasons, are not yet well understood [3,4]. Applied with a set of in-situ sampler [5], we collected root exudates from four typical tress (non-N/N fixing) species of a tropical forest in Xishuangbanna at different seasons and analyzed their chemical profiling and specific fluorescence signal. We found that the total organic matter and molecular characteristics of forest root exudates were different between N fixing and non-N fixing tree species and between different seasons. Exudates of the two N fixing species performed higher C exudation rate, lower aromatic compounds content and lower humification than that of the non-N fixing species in growing season. Root exudation rate of carbon both negatively correlated with a conservative trait (root tissue density) and the humification index. Next, fourier transform ion cyclotron resonance (FT–ICR) mass spectrometry is expected to applied for this study to obtain “complex” wholeness molecules information of root exudates and predict the functional effects of exudates molecules on microbial activity and changes in soil carbon pools.

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Neuroprotective Compounds isolated from marine derived Streptomyces-longispororuber (MCCC1A01629)

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Abstract

The ocean occupied 70% of the earth surface which contained abundant microorganism resources, and with the special environmental conditions like low temperature, high pressure, no light and so on. Those conditional parameters change the metabolic mechanisms to the marine microorganisms. The marine microorganisms are the main sources of multiple structure and different bio-activity marine natural products. Marine microorganisms are identified that it can produce massive bio-active compounds in the past several decades. Currently, bio-active compounds from marine microorganisms are used to treat diseases, and as an important member of the marine microorganisms, marine bacteria are also an important source of new active compounds. Streptomyces-Longispororuber (MCCC1A01629), “SL-1629” or “1629” in a short words, a marine-derived bacteria which belongs to genus of streptomyces, is an interesting strain in marine bacteria group. In this research, the secondary metabolites from SL-1629 were isolated and figured out the raw structure of those compounds. 6 natural compounds were gained from the fermentation extract mixture broth via HPLC and reversed phase C_{18} silica gel column (YMC) chromatography, 2 of natural products showed good neuroprotective activity, and 1 compounds was a mid-material in synthesis of 4-Hydroxy-2-aminocyclohexanecarboxylic Acids. Meanwhile, 3 compounds were identified as diketopiperazines derivative. All natural products were first time reported in streptomyces-longispororuber.

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Feasibility of PAA-RVG29 as a nanocarrier to deliver Rhodamine B into Neuro2a and NSC34 Cells

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Abstract:

Objectives: Poly(amido amine)s (PAAs), featuring amine and amide functional chemical groups, are extensively applied in drug delivery and gene transfection. Utilizing RVG29, a 29-amino acid peptide from rabies virus glycoprotein, we aim to enhance intra-neuronal transport of cargo-loaded PAA-RVG29 polymers[1]. We investigate the capability of PAA-RVG29 in delivering rhodamine B and plasmid (EGFP-N1) into the neuronal cell (specifically Neuro2a and NSC34 cells), for gene transfection as well as imaging.

Methods: The PAA polymers are synthesized using N,N' -cystamine diacrylamide and N-(2-aminoethyl) piperazine. RVG29 is used to functionalize PAA-surface to achieve neuronal targeting. Cytotoxicity is assessed in Neuro2a and NSC34 cells using MTT assays. Cargo-loading capabilities are evaluated through HPLC and agarose gel electrophoresis. Cellular uptake and gene transfection are examined using fluorescent and confocal imaging techniques.

Results: The characterization by MTT assay, HPLC, and agarose gel indicates that PAA-RVG29 exhibits both excellent biocompatibility and cargo-loading capabilities. Dye-loaded PAA-RVG29 can be taken up by neurons, which are also consequently confirmed by confocal imaging. On the other hand, despite the potential of PAA-RVG29 to carry negatively charged plasmids, PAA-RVG29 failed to achieve successful transfection.

Conclusion: This study highlights the intra-neuronal cargo delivery capabilities of RVG29-modified nano-carriers, which could partially address the challenges of gene transfection and optimization of gene delivery.

Keywords: Drug delivery, neuron, polymers, rabies virus glycoprotein 29

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The Regulation Of The Pro-inflammatory Cytokine Interleukin 6 (IL6) By Epstein-Barr Virus (EBV)

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Abstract

Epstein–Barr virus (EBV) is a human herpesvirus and is closely related to many malignancies of lymphocyte and epithelial origins, such as gastric cancer, Burkitt's lymphoma, and nasopharyngeal carcinoma (NPC). NPC is a malignant epithelial tumor which is 100% associated with EBV latent infection. To our knowledge, overexpression of pro-inflammatory cytokines may result in a loss of balance of the immune system and cause damage to human bodies. Interleukin-6 (IL6) is a pro-inflammatory cytokine which plays an important role in tumor progression[1]. In addition, gene expression is regulated by both transcriptional and post-transcriptional pathways. AU-rich element binding factor 1 (AUF1)/heterogeneous nuclear RNP D (hnRNP D) is known for its function in destabilizing mRNAs, including cytokines and cell cycle regulators. In this project, our aim is to determine the role played by hnRNP D in EBV-infected cells and how our anti-EBV agents can affect the function of hnRNP D. The results of this study will provide a new insight into how the pro-inflammatory cytokine expression can be regulated by EBV.

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Systematic analysis of microplastics in Hong Kong marine sediments: abundance, characteristics, polymer compositions, and spatial pattern

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Abstract

Microplastics (MP) have been a growing concern in environmental research due to their persistence and potential ecological impacts. In 2022, the Ministry of Ecology and Environment officially classified microplastics as persistent organic compounds, highlighting the need for comprehensive studies on their occurrence and distribution. Marine sediments have been considered as sinks and the repositories of riverine input microplastics. To assess the state of microplastic pollution in the marine environment of Hong Kong, a systematic analysis was conducted, focusing on the abundance, characteristics, spatial distribution, and potential sources of microplastics in marine sediments. Marine sediment samples were collected from the 20 sites distributed in the coastal region of Hong Kong for polymer observation by Fourier Transform infrared spectroscopy (FTIR). Friedman test was used to investigate the differences in the microplastic abundance of different characteristics (colors, shapes, sizes, and polymer compositions). Based on the obtained results from field sampling, the Kiring process was further utilized to reasonably predict the spatial pattern of microplastics in Hong Kong marine sediments. The results of the analysis revealed that microplastic concentrations in Hong Kong marine sediments varied between 402.12 and 1507.96 items//kg, with an average concentration of 874.62±342.24 items//kg (dry weight). The most commonly observed polymers were polypropylene (PP), polyethylene (PE), and chlorinated polyethylene (CPE). Additionally, fragments and fibers were found to be the dominant shapes of microplastics in the sediments.

Developing a dual-site fluorescent probe for simultaneously discrimination of GSH, Cys, and SO_2 Derivatives

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Abstract

Reactive sulfur species (RSS), including GSH (glutathione) and sulfur dioxide (SO_2), play critically important roles in biological systems. [1,2] To clarify their complex correlations, fluorescent probes to simultaneously detect GSH, Cys, and SO_2 derivatives are highly desirable. Herein, we develop a fluorescent probe to simultaneously discriminate GSH, Cys, and SO_2 derivatives. The probe is non-fluorescent due to intramolecular charge transfer (ICT) from cage moiety. Upon substitution reaction by nucleophilic bio-thiols, the fluorophore will be released and give rise to an emission at near infrared region. In the presence of GSH, the probe system will exhibit the emission of the fluorophore, while the resultant GSH adduct is nonfluorescent due to strong quenching ability of the sulfur ether moiety in the molecular structure. While Cys would induce an intramolecular rearrangement cascade reaction, thus the emission of cage moiety can also be observed at visible region. In the presence of sulfite, the nucleophilic addition of SO_3^{2-} toward probe interrupts the conjugation of probe to yield adduct with the emission of a part of the probe can also be observed at visible region. The different spectral properties of these adduct provide a chance to simultaneously detect GSH, Cys, and SO_2 derivatives.

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Application of Machine Learning-Based Metabolomics to Early Liver Cancer Diagnosis: A Proof-of-Concepts Study in Mice

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Abstract

Cancer is the leading cause of death worldwide, accounting for nearly 10 million deaths in 2020.[1] Approximately one in six deaths is due to cancer. In 2020, liver cancer was ranked 7th of the most common new cases of cancer, yet it was one of the most common causes of cancer death- 830,180 deaths.[2] It is predicted that liver cancer will be one of the top cancer killers in 2030.[3] Many cancers can be cured if detected early and treated effectively. However, there are no widely recommended screening tests for those who are at average risk.[4] Hence, this disease is usually diagnosed in the middle or late stage. A method for early liver cancer diagnosis is therefore demanded.

Early liver cancer detection is critical to control disease progression. Abdominal ultrasound-guided fine-needle aspiration biopsy assessment is a test for confirming the type of the tumor cells and examining whether they are benign or malignant by histological analysis. This test requires ensuring the needle is inserted at the precise position of an observable tumor for valid sampling. However, in this work, we hope to detect hepatocellular carcinoma (HCC, the most common type of liver cancer) before tumor occurrence through random sampling.

As a proof-of-concept study, a mouse liver cancer model is used. Twelve microsections of the left liver are analyzed for each disease progression stage by imaging mass spectrometry (IMS) to acquire spatial data on the distribution of metabolites *in situ*. After signal denoising by spatial integrity, each pixel within the liver image region is treated as one sample entry in a dataframe. The rows are for the pixelized point samples, yet the columns are for the molecular features. Discriminative molecular features are further shortlisted upon sensitivity test by 5-fold cross-validation. An XGBoost model is trained and validated by the 5:5 internally split training and validation datasets. The attained model is therefore validated by an external independent IMS pixel dataset. To mimic the real-life application of the developed method, IMS data are acquired from the glass smears of fine-needle aspirates that are sampled at the random position of the mouse's right liver.

The predictive model is eventually attained by retaining 16 discriminative features. It resulted in an accuracy of 66.52% for an external independent IMS dataset, demonstrating great predictive power. Model deployment for the data from the glass smears of needle aspirates showed an accuracy of 68.96%, implying the feasibility of translating the integration of machine learning with IMS to neoadjuvant. We believe a similar strategy that uses clinical samples for the predictive model construction could facilitate public health surveillance and achieve the goal of good health and well-being.

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Study on the potential toxicity mechanism of Liquid Crystal Monomers (LCMs)

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Abstract

Liquid crystal monomers (LCMs) generally have a diphenyl backbone structure and where phenyl ring hydrogen atoms are replaced by various functional groups, that is, cyano, fluorine, chlorine, or bromine. High concentrations of LCMs were detected in a variety of environmental samples, including dust, sediment, leachate, and soil samples. Fluorinated-LCMs (FBAs) are the main LCMs compounds detected in the environment and human serum. The log K_{OA} of FBAs mostly ranged form 7 to 10, which have a higher emission rate, and three FBAs were predicted to be carcinogenic by two models. Hence, the understanding of the toxicity mechanism of LCMs is urgently needed. In our study, mice experiments were conducted to explore the toxicity of LCMs with different types and exposed concentrations. Our findings showed that high levels of LCM were detected in mouse brains, indicating that LCM can cross the blood-brain barrier. Besides, LCM exposure may be associated with obesity and oxidative stress due to the significant up-regulation of serum triglycerides content and dysregulation of glutathione metabolism.

High-Resolution 3D Spatial Distribution of Complex Microbial Colonies Revealed by Mass Spectrometry Imaging

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Abstract

Bacterial living states and the distribution of microbial colony signaling molecules are widely studied using mass spectrometry imaging (MSI).[1] However, current approaches often treat 3D colonies as flat 2D disks, inadvertently omitting valuable details.[2] The challenge of achieving 3D MSI in biofilms persists due to the unique properties of microbial samples.[3] This work developed the moisture-assisted cryo-section (MACS) method, enabling embedding-free sectioning parallel to the growth plane. MACS secures intact sections by controlling ambient humidity and slice thickness, preventing molecular delocalization. Combined with matrix-assisted laser desorption ionization mass spectrometry (MALDI)-MSI, MACS provides high-resolution insights into endogenic and exogenous molecule distributions, including isomeric pairs. Moreover, analyzed colonies are revived into 3D models, vividly depicting molecular distribution from inner to outer layers. These results unveil complex cell activities within biofilm colonies, offering insights into microbe communities. MACS method is universally applicable to loosely packed microorganism colonies, overcoming the limitations of reported MSI methods and making it a valuable tool in microbiological research.

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An approach to convert fragile hydrogel-based microfluidic chips into cartridges easy and reliable to use

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Abstract

Hydrogel plays a crucial role in constructing microfluidic chips and holds immense potential for diverse applications in the field of biology due to its ability to modify its chemical and mechanical properties, effectively mimicking the in vivo conditions of the human body. The notable biocompatibility and biodegradability of hydrogel make it a commonly utilized material for antibiotic susceptibility testing (AST). However, hydrogel is fragile and challenging to handle. Traditionally, hydrogel chips are connected using needle insertion or press-fitting with a fixture, which can easily damage the hydrogel and necessitate skilled personnel for operation. In this study, we present a cost-efficient and highly scalable solution based on a hybrid hydrogel-plastic device and a contactless connection strategy. This innovative approach transforms the hydrogel device into a standardized cartridge, offering ease of use and reliability even for non-experts.

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Rab23 Deficiency in the Central Nervous System Alters Appetite Control and Induces Obesity

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Abstract

RAB23, a causative gene in Carpenter Syndrome (CS), a rare genetic disorder characterized by obesity, craniofacial malformations, and polydactyly, remains poorly understood in its role in obesity pathogenesis. In this study, we aim to investigate the roles of *Rab23* in the development of obesity. Given its important involvement in growth factor signaling pathways during central nervous system (CNS) development, we hypothesize that *Rab23* acts as a critical regulator in maintaining energy homeostasis in the CNS. To test the hypothesis, we utilized a conditional knock-out mutant of *Rab23* by using *Nestin*-cre to specifically delete the gene in neural progenitor cells. Our findings demonstrate that mice with a CNS deficiency in *Rab23* develop obesity, exhibiting clinical features similar to individuals with CS. Excessive food intake was identified as the primary driver of this obesity phenotype. Additionally, the mutant mice exhibited impaired response to leptin signaling, as evidenced by diminished leptin-induced activation of p-STAT3 in the hypothalamus, and decreased expression level of *Mc4r* in the same region. Collectively, these results highlight the significance of *Rab23* in the modulation of satiety signaling in the hypothalamus, potentially by modulating the leptin-melanocortin pathway. These findings contribute to our understanding of the underlying mechanisms contributing to CS-related obesity and shed light on the pathophysiology of the disorder.

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MS-based metabolomics and lipidomics for studying F53B induced metabolic disorders associated with Parkinson's disease in primary dopaminergic neurons

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PFOS (perfluorooctane sulphonate) has several toxic effects in rodent studies, including hepatotoxicity, neurotoxicity, and reproductive toxicity, and disrupts thyroid function[1]. Due to its toxicity and potential carcinogenicity, 6:2 chlorinated polyfluorinated ether sulfonate (6:2 Cl-PFAES) has been used as an alternative[2]. Potassium 6:2 Cl-PFAES is the major component of the commercial goods F-53B (trade name). The stability and bioaccumulation of F53B allow it to remain in the environment and the body tissue for extended periods, increasing the likelihood of human exposure and the risk of nerve damage[3].

Parkinson's Disease ranks as the world's second-most prevalent neurodegenerative disorder, with its incidence and associated disability witnessing a notable rise in recent years. This condition stems from the gradual loss of dopaminergic neurons within the substantia nigra. In this study, we established a model using α-synuclein preformed fibrils (α-syn PFF) to induce primary dopaminergic neurons (PDNs), thereby replicating the neuropathological state of PD. Our aim was to explore the potential of F-53B exposure to provoke metabolic dysfunctions akin to those observed in PD and to decode the fundamental mechanisms of such disturbances. This study could give us novel perspectives on the link between F53B exposure and the progression of Parkinson's disease.

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The process and application of cell-SELEX

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Abstract

Aptamers are RNA or DNA sequences that consist of a single strand. Through a process called systematic evolution of ligands by exponential enrichment (SELEX), artificial aptamers can be created in vitro. Using screening technology, it is possible to identify and select aptamers that bind to target molecules with high specificity and affinity. In vitro SELEX has been widely used to identify a diverse range of targets, including small molecules, large proteins, and complex targets[1, 2]. Aptamers are small molecules that possess unique biochemical properties which make them ideal for detection, diagnosis and treatment of diseases. A new strategy for selecting aptamers, called cell-SELEX, has been developed to avoid the disadvantages of choosing aptamers against non-native protein conformations[3]. Unlike protein-SELEX, cell-SELEX doesn't require any prior knowledge of protein conformation, and there's no need to purify the target protein through processes that may disrupt its native conformation. In this method, whole living cells are used as targets for aptamer selection. All cell surface molecules will remain in their natural environment, retaining their native folding structures and incorporating possible post-translational modifications throughout the selection process. Therefore, aptamers selected using intact living cells will be able to bind to the native folded conformation of the target on the cell. This approach has great potential in biomedical research and the development of cell-specific diagnostics and therapeutics.

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From rubber antioxidants to toxins: elucidating the acute toxicity and mechanisms of emerging PPD-Qs on aquatic bacterium

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Substituted *para*-phenylenediamines (PPDs) are synthetic chemicals used globally for rubber antioxidation, with their quinone derivatives (PPD-Qs) raising particular environmental concerns due to their severe toxicity to aquatic organisms reported by *Science*. Emerging research has identified a variety of novel PPD-Qs ubiquitously detected in the environment, yet experimental proof for the toxicity of PPD-Qs has not been forthcoming due to the unavailability of bulk standards, leaving substantial gaps in the prioritization and mechanistic investigation of such novel pollutants. Here, we first studied the acute toxicity of 18 PPD-Qs and PPDs to the aquatic bacterium *V. fischeri* using synthesized chemical standards and investigated the underlying mechanisms through *in vitro* biological response assays and *in silico* simulations. Bioluminescence inhibition EC_{50} of PPD-Qs ranged from 1.76-15.6 mg/L, and PPDs exhibited pronounced hazards with the EC_{50} ranging from 0.02-7.07 mg/L. Biological response assays revealed that PPDs and PPD-Qs can reduce the esterase activity, cause cell membrane damage, and induce intracellular oxidative stress. Molecular docking unveiled multiple interactions of PPD-Qs with the luciferase in *V. fischeri*, suggesting their potential functional impacts on proteins through competitive binding. Our results provided crucial toxicity benchmarks for PPD-Qs, prioritized these novel pollutants, and shed light on the potential toxicological mechanisms. The broad toxicity of novel PPD-Qs is unveiled, and the toxicological mechanisms can help comprehend their toxicities to other species.

$PM_{2.5}$-bound Organophosphate Flame Retardants in Hong Kong: Occurrence, Origins, and Source-Specific Health Risk

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Abstract:

Organophosphate flame retardants (OPFRs) are emerging organic pollutants in $PM_{2.5}$, which have caused significant public health concerns in recent years, given their potential carcinogenic and neurotoxic effects.[1,2] However, studies on the sources, occurrence, and health risk assessment of $PM_{2.5}$-bound OPFRs in Hong Kong are lacking. To address this knowledge gap, we characterized thirteen OPFRs in one-year $PM_{2.5}$ samples using gas chromatography-atmospheric pressure chemical ionization tandem mass spectrometry. Our findings showed that OPFRs were present at a median concentration of 4978 pg m^{-3} (range from 1924 pg m^{-3} to 8481 pg m^{-3}), with chlorinated-OPFRs dominating and accounting for 82.7% of the total OPFRs. Using characteristic source markers and positive matrix factorization, we identified one secondary formation and five primary sources of OPFRs. Over 94.0% of $PM_{2.5}$-bound OPFRs in Hong Kong were primarily emitted, with plastic processing and waste disposal being the leading source (61.0%), followed by marine vessels (14.1%). The contributions of these two sources to OPFRs were more pronounced on days influenced by local pollution emissions (91.9%) than on days affected by regional pollution (44.2%). Our assessment of health risks associated with human exposure to $PM_{2.5}$-bound OPFRs indicated a low-risk level. However, further source-specific health risk assessment revealed relatively high noncarcinogenic and carcinogenic risks from chlorinated-OPFRs emitted from plastic processing and waste recycling, suggesting a need for more stringent emission control of OPFRs from these sources in Hong Kong.

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Determination of Multiclass Pharmaceuticals in Environmental Samples by Liquid Chromatography-Tandem Mass Spectrometry

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Abstract

Pharmaceuticals (PhACs) that are closely related to human life have become an emerging contaminant in the environment with their rapid growth of production and usage. The source, occurrence, and transformation of antibiotic compounds in the environment and potential health hazards have become hot environmental issues of global concern.

However, most previous studies mainly focused on analyzing very few compounds (mostly < 20) at a time. This study aims to develop an analytical method for identifying and quantifying 114 PhACs, including 98 antibiotic compounds and 16 other drugs in different environmental samples.

An instrumental analytical method was established through UHPLC-MS/MS for 114 pharmaceuticals that could be separated within 10 minutes. A cross-class screening method was developed for the analysis of low-ng/L(ng/g) of 101, 76, and 80 PhACs in surface/groundwater, sewage, and sediment samples, respectively, using solid phase extraction (combined with QuEChERS for sediment) and UHPLC-MS/MS.

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Differentiation and Visualization of Chiral Amino Acids Using Ion Mobility Mass Spectrometry

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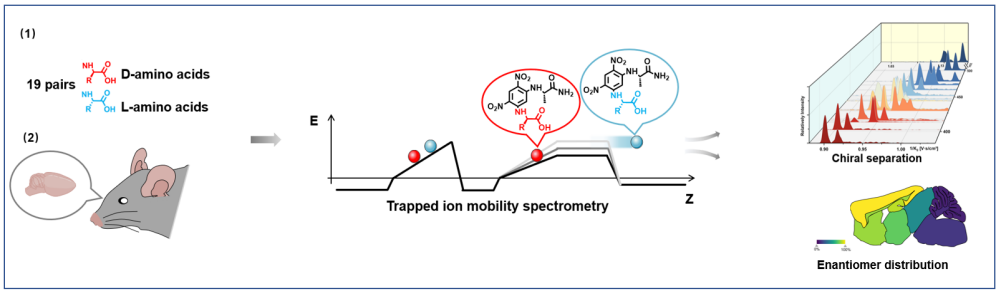
Absract

The roles of chiral molecules in living organisms have obtained increasing attention since the discovery of the critical functions of endogenous D-form amino acids (AAs) and their connection to several neurological diseases with great concern.[1,2] We first achieved a simultaneous chiral separation of all encoded proteinogenic amino acids in a single trapped ion mobility mass spectrometry (TIMS-MS) run using N_a-(2,4-dinitro-5-fluorophenyl)-L-alaninamide (FDAA) derivatization[3]. In addition, endogenous chiral AAs were identified in mouse brain extracts and the enantiomeric ratio (*er*) can be determined as well. Based on the proven separation and detection ability, the spatial information of endogenous chiral metabolites was quantitively obtained by laser microdissection (LMD) and TIMS-MS.



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Amyloid-β Guided Responsive Theranostic Fluorescent Probe for Imaging of Endogenous Hydrogen Peroxide in Alzheimer Disease

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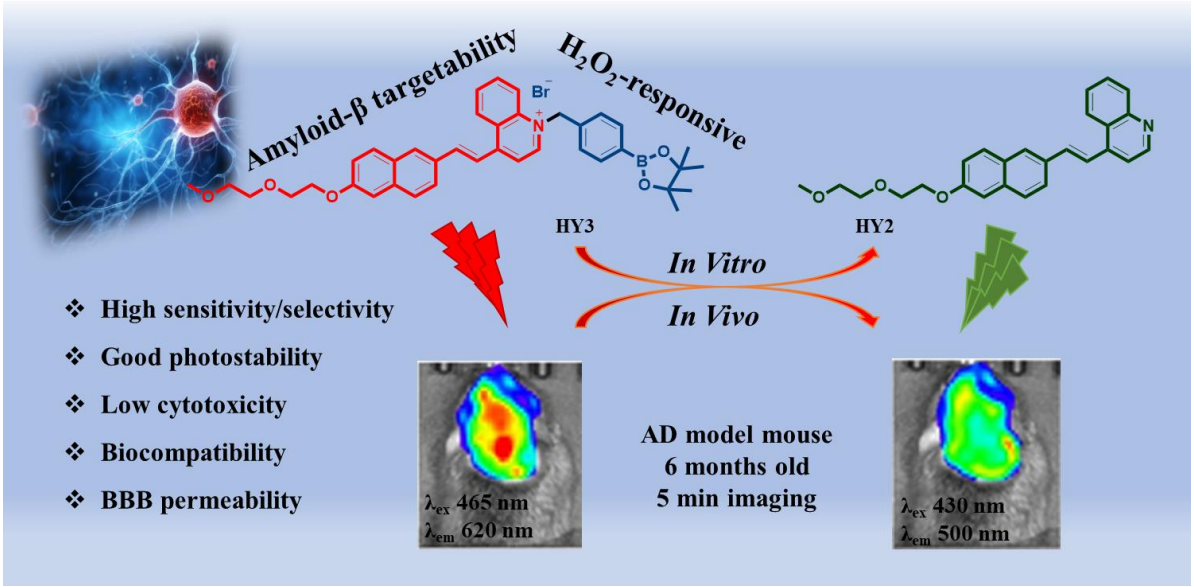
Abstract

Alzheimer disease (AD) is a severe neurodegenerative disorder marked with a series of pathological changes. Among them, deposition of amyloid-β (Aβ) plaque is the most well-known hallmarks of AD, which is formed from the aggregation of misfolded Aβ peptides leading to neuroinflammatory, neuronal dysfunction, cell death and ultimately dementia. Meanwhile, oxidative stress is widely observed in AD brain due to the overproduction of reactive oxygen species (ROS) such as hydrogen peroxide (H_2O_2), leading to the peroxidation of lipids, proteins, and DNA, exacerbating lesions of brain. Currently, magnetic resonance imaging (MRI) and positron emission tomography (PET) are the primary imaging technique applied in the clinical diagnosis of AD. Due to their inherent limitation, optical imaging utilizing fluorescent dye as a label for the visualization of pathological changes is potentially promising to be an alternative diagnostic technique clinically. However, effective fluorescent probes for diagnosis of AD are still lacking.

Aβ and H_2O_2 are the widely used biomarkers in developing probes and drugs for the detection, diagnosis, and therapy of AD. Herein, we report the design and development of a dual-target fluorescent probe (HY3) constructed by the D-π-A structural based fluorophore and H_2O_2-responsive moiety for detection of Aβ and H_2O_2 in AD cell and mouse models. HY3 exhibits a large emission wavelength shift of ~130 nm upon reacting with H_2O_2 and ~180 nm in the presence of Aβ, concomitant with a strong fluorescence enhancement. HY3 shows outstanding sensitivity and selectivity towards Aβ and H_2O_2 compared with other biologically related proteins and ions. This biocompatible and nontoxic sensing probe is able to detect exogenous/endogenous H_2O_2 and differentiate N2a and N2aSw cells. *In-vivo* imaging studies also show that HY3 is BBB-permeable and can successfully transform to its oxidative product (HY2) in the brain giving rise to dual emission. The remarkable difference

in fluorescence intensity between the wild-type and transgenic mice of different age groups suggests that HY3 is a highly sensitive probe to detect and monitor Aβ plaque and H_2O_2 in the brain of AD mouse model. Thus, HY3 is promising to be a useful tool in the detection and diagnosis of AD.



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Stable Isotope-Assisted Mass Spectrometry Reveals *In Vivo* Distribution, Metabolism, and Excretion of Tire Rubber-Derived 6PPD-Quinone in Mice

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ABSTRACT

N-1,3-dimethylbutyl-*N*'-phenyl-*p*-phenylenediamine quinone (6PPD-Q), has been identified as a ubiquitous environmental contaminant in our surrounding locality including air particles, roadside soils, dust, and water, which may enter the human body via various exposure routes. Recently, the prevalence of 6PPD-Q in human urine has accentuated the urgency for investigating its biological fate and health implications. To address this, we conduct a comprehensive investigation using stable isotope-assisted high-resolution mass spectrometry (HRMS) to uncover the distribution, metabolism, excretion, and toxicokinetic properties of this contaminant in a mouse model. In this study, we first detected the levels of 6PPD-Q in human serum samples with concentrations ranging from 0.11-0.43 ng/mL, and mice were fed with deuterated 6PPD-Q-d_5 at human-relevant exposure levels. Our findings revealed rapid assimilation and distribution of 6PPD-Q into the bloodstream and major organs of mice, with concentrations peaking under 1 h following administration. In addition, 6PPD-Q was determined to be more likely to accumulate in adipose, lung, kidney, testis, and spleen. Moreover, our measurement demonstrated that 6PPD-Q can penetrate the blood-brain barrier of mice within 30 minutes. The half-lives ($t_{1/2}$) of 6PPD-Q in serum, lung, kidney, and spleen were measured at 12.7 ± 0.3, 20.7 ± 1.4, 21.6 ± 5.3 and 20.6 ± 2.8 h, respectively, while a relatively shorter $t_{1/2}$ of 6.7 ± 0.6 h was observed in the liver. Using HRMS combined with isotope tracing techniques, two novel hydroxy-metabolites of 6PPD-Q in mice liver were identified for the first time, which provides new insights into its rapid elimination *in vivo*. Furthermore, we determined fecal excretion to be the primary pathway for eliminating 6PPD-Q and its hydroxylated metabolites. Collectively, our findings extend the current knowledge on the biological fate and exposure status of 6PPD-Q in a mouse model, which has the potential to be extrapolated to humans.

Dissecting the mechanism of action for metformin with thermal proteome and co-aggregation analysis

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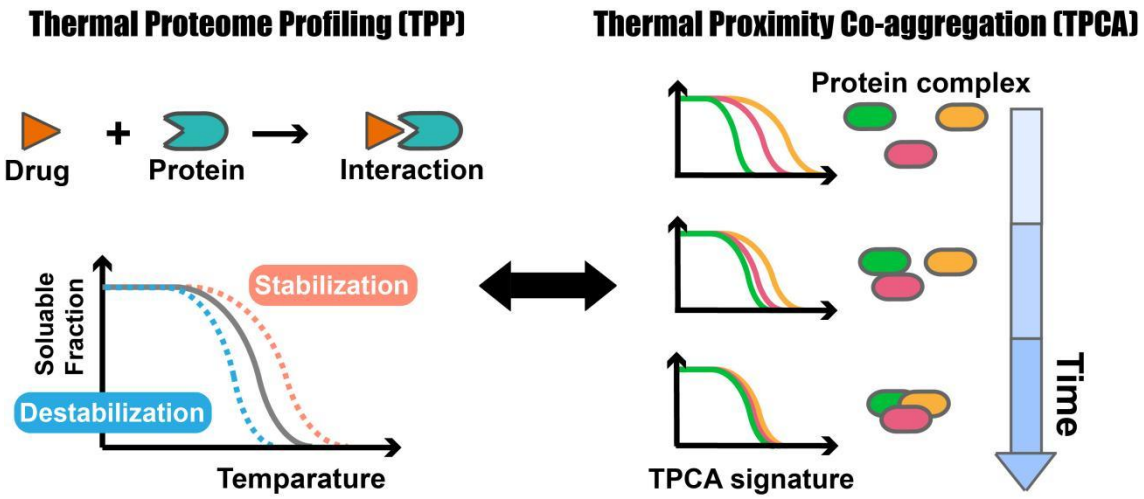
Abstract

Metformin, a first-line drug for type 2 diabetes mellitus, exhibits diverse therapeutic effects in addition to its established role in glucose metabolism. Due to the increasing body of evidence suggesting additional effects of metformin, such as anti-aging, anti-inflammatory, and anticancer properties[1], the underlying mechanisms of metformin's actions may be complex and multifaceted. Here, we employed both thermal proteome profiling (TPP)[2] and thermal proximity co-aggregation (TPCA)[3] analysis, to identify direct protein targets of metformin and characterize downstream protein complexes perturbed under different duration of metformin treatment. A total of 66 protein targets were discerned, which mainly associating functions of cellular metabolic process and post-transcriptional regulation of gene expression. Excluding the naive changes induced by cell growth, we identified many perturbed protein complexes as well as several which formation are induced by metformin that are involved cell homeostasis, immune response, and cancer deveplopment. We observed the dynamic remodeling of many protein complexes such as v-ATPase-Regulator-AXIN/LKB1-AMPK complex[4], where two separate subcomplexes were detected at multiple time points. Together, integrating stabilized or destabilized

protein targets identified by mass spectrometry-coupled cellular thermal shift assay (MS-CETSA) with the TPCA signatures of protein complexes, these findings revealed metformin-induced dynamic alterations at the cellular protein level.



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Improve the potential of CO_2 sequestration and biomass production of Cyanobacteria in open pond cultivation systems through the introduction of key channel proteins and metabolic pathway remodeling.

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Abstract

Microalgae represent an appealing option as substrates to produce valuable commodities, owing to their nutrient-rich composition and rapid growth kinetics. They exhibit considerable promise in alleviating escalating carbon emissions by sequestering carbon through photosynthesis. However, their utilization at the commercial scale is presently hindered by the elevated expenses associated with producing sought-after microalgae-derived goods. Open pond cultivation methodologies offer a potential avenue for reducing the cost of microalgae cultivation. Nonetheless, maintaining a consistent growth environment in open ponds proves challenging due to contamination by other microalgae species and grazers. Genetic modification of microalgae to enhance their adaptability to high pH conditions is pivotal for successful outdoor cultivation. Furthermore, inducing microalgae to grow in the absence of light holds significant potential for enhancing productivity. This study integrated a cation proton antiporter (Mrp) from Bacillus pseudoformal OF4 into the genome of *Synechococcus elongatus*, thereby augmenting the cyanobacteria's capacity to thrive in alkaliphilic environments. Simultaneously, a glucose transporter (Galp) was introduced into the genome, enabling the cyanobacteria to flourish in darkness when provided with glucose as a carbon source. The findings indicate that the incorporation of these two proteins not only enhances microalgae productivity over time but also yields specific metabolites containing biologically active functional fragments when cultured under high pH conditions.

Application of Zein in the Encapsulation of Probiotics to Improve Bioavailability and Anti-inflammatory Effect

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Abstract

This study explores the potential of zein, a naturally occurring protein with amphiphilic properties, as a carrier for encapsulating probiotics. Specifically, Lactobacillus Plantarum (LP) is microencapsulated using zein to protect it from gastric acid and bile, enhancing its survival and efficacy. According to the findings, the microencapsulated L. Plantarum (MLP) exhibited a diameter of 4um and carried a negative charge. The survival rate of MLP in gastric acid was observed to increase by 2.7 times compared to non-encapsulated LP. Additionally, the microencapsulation demonstrated controlled release behavior in simulated intestinal fluid, suggesting the potential to enhance the bioavailability of L. Plantarum. These results indicate that the microencapsulation process effectively protected and improved the survival of L. Plantarum in harsh gastrointestinal conditions, while also facilitating controlled release in the intestinal environment.

The study also investigates the efficacy and mechanism of MLP in treating depression disorders using a chronic restraint stress (CRS) model in mice. Results demonstrate that MLP significantly modulated intestinal microbiota. The study examines the expression of pro-inflammatory factors in the intestine and hippocampus, revealing that MLP reverses inflammation in these regions. This research highlights the dual potential of zein as a carrier for probiotics and microencapsulated L. Plantarum as a promising therapeutic intervention for depression disorders, emphasizing the importance of innovative delivery systems for enhancing the efficacy of functional ingredients.

Mass spectrometry proteomics reveals PLEK as a biomarker for the early phase of severe COVID-19

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Abstract

SARS-CoV-2 infection, responsible for the ongoing COVID-19 pandemic, presents a wide range of clinical manifestations[1]. Understanding the factors contributing to disease severity is critical to developing effective therapeutic strategies. Identifying biomarkers associated with disease severity may aid in early detection and risk stratification. This study applied mass spectrometry-based proteomics as the primary analytical method to the sera of COVID-19 patients infected with wild-type and omicron variants to find the potential protein biomarkers, revealing pleckstrin (PLEK) in sera of severe COVID-19 patients was significantly upregulated during the first ten days of infection. Experimental studies in golden hamsters confirmed that PLEK was significantly upregulated in early severe infections. Using intranasal administration of exogenous PLEK in hamsters, increased PLEK expression was shown to exacerbate COVID-19 lung injury. PLEK expression is significantly correlated with levels of interleukin-6 (IL-6), interleukin-8 (IL-8), and monocyte chemoattractant protein-1 (MCP-1) in both patient sera and Calu-3. The observed correlation suggests a potential regulatory role for PLEK in modulating the inflammatory response during SARS-CoV-2 infection. Mechanistic studies show that PLEK upregulation enhances virus-mediated inflammation by activating the ERK1/2 signaling pathway. This mechanism provides insight into the potential role of PLEK in promoting the inflammatory response associated with severe COVID-19.

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Visualizing Lead(II) Proteomes in Cells with NIR Fluorescence

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Lead (Pb), as one of the most serious toxicants for public health, has been revealed to exert a concerning effect on vital organs like the liver, kidney, and central nervous system where it causes significant neurophysiological and neurophysiological deficits.[1-2] Hence, mapping out the lead-associated proteomes can possibly provide an answer on the molecular mechanism of the toxicity of lead(II). In this regard, fluorescent imaging has emerged as a powerful tool for in situ visualization of metalloproteins. It not only can localize the proteins of interest but also monitors and quantifies the protein expression in real time. Despite the achievements of existing protein-labeling probes,[3,4] there is still great demand for developing NIR fluorescent probes that provide deeper penetration depth for animal studies, and increased signal-to-noise ratio imaging results.

To this end, fluorescence probe QM-NH_2 was designed and synthesized. QM-NH_2 exhibits weak fluorescence around 650–730 nm, which diminishes upon coordination with Pb(II). However, after incubating with the albumin and exposure to UV light, the fluorescence was able to restore and enhance by 10-fold. Subsequent SDS-PAGE analysis confirmed that the probe can label proteins selectively. Further, QM-Pb (coordination product between QM-NH_2 and Pb) exhibited rapid cell permeability of 15 min, and reached saturation in 30 min. Importantly, after UV photoactivation, QM-Pb shows fluorescence enhancement in cellular environment. Therefore, it can be used to visualize Pb(II)-binding proteins in cells and tissues. Overall, our work has demonstrated great potential in understanding how lead inserts its toxicity in the brain and kidney and may also offer a powerful tool for metalloproteome in vivo.

We thank the Research Grants Council (RGC) of Hong Kong SAR (SRFS2122-7S04, C7034-20E, 17306323), and the University of Hong Kong (URC and Norman & Cecilia Yip Foundation) for support.

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An Unexpected Fe-S Cluster in Nsp14 of SARS-CoV-2: A New Target of Antivirals

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Abstract

Proteins with Fe-S clusters always favor cysteine and histidine ligands, which is very similar to zinc-fingers.[1] Due to the susceptibility to destabilization and degradation of Fe-S clusters, zinc can replace Fe-S cofactors under aerobic environment, perhaps explaining why some annotated zinc-finger proteins were found to be Fe-S co-factored proteins.[2] SARS-CoV-2 nsp14 functions both as an N-terminal 3' to 5' exoribonuclease stimulated and a C-terminal N7-methyltransferase in the virus life cycle. Crystallography studies show that SARS-CoV-2 nsp14 also possesses three important zinc-fingers, which are critical to the enzyme activity as well as architecture integrity.[3] Herein, we surprisingly found that SARS-CoV-2 nsp14 ligates an Fe-S cluster in the sites annotated as a zinc finger under anaerobic environment. Besides, Bi(III)-based compounds, which target at nsp14 in SARS-CoV-2-infected mammalian cells,[4] were also found to significantly inhibit both the MTase and ExoN activity of nsp14 regardless in the Fe-S cluster or zinc-binding forms. This study illustrates a more authentic mechanism of action of the Bi(III)-based SARS-CoV-2 nsp14 inhibitors and highlights the potential of a labile Fe-S cluster of nsp14 as an important target for the development of anti-SARS-CoV-2 agents.

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Identification of eEF1A methylation “readers” in living cells

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Abstract

eEF1A1 is involved in delivering aminoacyl-tRNAs during mRNA translation. Lysine methylation occurs at 5 sites (K36, K55, K79, K165, and K318) on eEF1A1, mediated by specific lysine methyltransferases (KMTs). These KMTs are dedicated to methylating eEF1A1 exclusively. Methylation events on eEF1A1 have been linked to the regulation of protein synthesis elongation. However, the precise molecular mechanisms and implications in cellular processes and disease remain unknown. To gain insights, we aim to identify the "readers" of eEF1A1 methylation. To capture the transient and weak interactions in living cells, we have developed two strategies: SILAC-based TurboID and iCLASPI (in vivo crosslinking-assisted and stable isotope labeling by amino acids in cell culture [SILAC]-based protein identification). Once we have identified the "readers" of eEF1A1 methylation, we will proceed to verify and characterize the interaction through Co-IP, FPLC, and ITC assays. Additionally, we aim to understand the binding mechanisms using crystallography or Cyro-EM techniques. Finally, we will explore the biological significance of eEF1A methylation.

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YEATS2-specific inhibitor attacks ATAC-related histone transferases in non-small cell lung cancer

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Abstract

YEATS2 is a histone reader that recognises crotonylation, acetylation, propionylation and butyrylation. It can bind with H3K27ac and recruit the ATAC complex, which allows the chromatin to maintain an open structure for gene expression and leads the histone transferases in the ATAC complex to modify the related histone site. The overexpression of YEATS2 may upregulate cell proliferation, cell survival, cancer migration and invasion. Moreover, patients with non-small cell lung cancer (NSCLC) were diagnosed with a significant increase in YEATS2 expression [1]. Until now, there have been no known YEATS2-targeting inhibitors published yet.

In our lab, we have designed a YEATS2-specific inhibitor, LS-170, which can competitively bind to the YEATS2 YEATS domain and suppress the cancer cell survival. In this study, we are focused on the evaluation of inhibitory efficiency on YEATS2 protein and ATAC-dependent histone modifications *in vivo*.

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Bismuth Drug and Hinokitiol Combination Therapy for Overcoming Methicillin Resistance S. aureus (MRSA)

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Bismuth has been used in medicine for over two centuries with effectiveness against gastrointestinal disorders[1]. Bismuth drugs are among the few metallodrugs in clinical use for the treatment of *H. pylori* infection. Although bismuth has been successful in medicine, a bismuth drug alone shows only moderate antibacterial activity against a limited number of prevalent human pathogens. Therefore, bismuth drugs need to be used in combination with antibiotics[2]. Recently, hinokitiol (β-thujaplicin), a metal chelator has shown potential in restoring site- and direction-selective transmembrane iron transport[3]. It remains unknown whether hinokitiol could enhance the antimicrobial efficacy of bismuth drugs.

This study conducted a screening of a range of metal-chelating ligands, and hinokitiol was identified as the most promising ligand that significantly enhances the antibacterial activity of bismuth drugs against a wide array of Gram-positive and Gram-negative bacteria (Fig 1). This enhanced activity can be attributed to increased bismuth uptake and decreased levels of intracellular iron. Additionally, the combination of bismuth drugs with hinokitiol demonstrated anti-biofilm activity. Importantly, the *in vitro* antimicrobial activity observed from the combination of bismuth drugs and hinokitiol was successfully translated into *in vivo* efficacy.

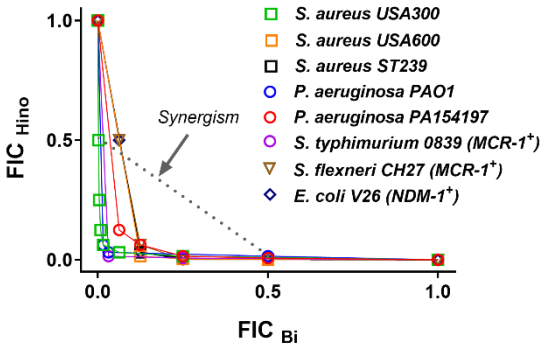

Fig. 1. Isobologram of the combination of CBS and hinokitiol against different bacterial strains.

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Vangl2 C-terminal binding protein identification and its regulation by phosphorylation

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Abstract:

Planar cell polarity (PCP) is formed during the life cycle of the many living creatures. However, the establishment process of PCP is yet to be elucidated. Vangl2 is known to be a key protein during the process of the establishment of PCP and we found its C terminal PDZ binding motif is vital for its function. But the proteins that interact with its C terminal is unknown. So we applied the chemical proteomic methods to identified the C terminal binders of Vangl2 and explored how the interaction between the Vangl2 C terminal and the binder is regulated by the phosphorylation on serine 520. We found that ZO-2 can be enriched by the Vangl2 C terminal and even further enriched after the phosphorylation. We validate the interaction by western blotting and photo-crosslinking experiments

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Discovery of X as potential reader of H3P16oh

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Abstract

Oxygen is essential for the survival of all living organisms. The regulation of oxygen perception in mammalian cells consists of two categories of proteins: early-stage oxygen sensors such as prolyl hydroxylases, which are accountable for modifying substrates including hypoxia-inducible factor; and the subsequent von Hippel-Lindau E3 ligase complex. Since the discovery of hydroxylation of histone H3 at proline 16, which explored the new feature of histone post-translational modifications. To date, even though KDM5A was supposed to be the potential binder of H3P16oh in the presence of H3K4me3, the real binding protein of H3P16oh was still unknown. In this study, we discovered X as the potential reader of H3P16oh using the CLASPI experiment. In vitro experiments were also performed to validate the reality of the MS data. Protein X showed quite strong binding affinity with H3P16oh and showed relatively good selective to the site of H3P16oh. Further research will be carried out to explore the related biological functions of this protein X recognizes the H3P16oh.

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Development of Inhibitors targeting YEATS2 as a Novel Strategy against Non-small Cell Lung Cancer

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Abstract

Epigenetic proteins that regulate the 'writing', 'erasing' and 'reading' of histone and DNA modifications are emerging drug targets, given their essential roles in normal physiology and disease pathogenesis. YEATS domain represents a new class 'reader' protein that recognize histone acyl modifications such as acetylation, crotonylation and benzoylation. The human YEATS domain-containing proteins (i.e., ENL, AF9, YEATS2 and GAS41) are involved in a variety of molecular functions in transcription elongation, histone modification, chromatin remodelling and histone variant deposition. Dysregulation of YEATS domains is often implicated in different types of cancers including acute myeloid leukemia (AML) and non-small cell lung cancer (NSCLC). Considering their therapeutic potential, chemical inhibitors for ENL, AF9 and GAS41 have been developed. However, to date, there is no inhibitor developed targeting YEATS2 despite its crucial role in the ADA Two A-Containing (ATAC) histone acetyltransferase complex for transcription regulation and tumorigenesis of NSCLC.

To fill this knowledge gap, we have developed first-in-class inhibitors targeting the YEATS domain of human YEATS2. Guided by the structural analysis of the YEATS2 YEATS-H3K27cr complex, we synthesized peptide-derived inhibitors by replacing the crotonyl group with expanded π systems or changing the surrounding residues against the surface contacts outside the Kcr-binding pocket. The subsequent structure-activity relationship study has led to the discovery of a potent inhibitor with 89 nM dissociation constant (Kd) toward YEATS2 in vitro. The further optimization of drug-like properties resulted in a potent, selective, and cell-permeable inhibitor named LS-170, which engaged with endogenous YEATS2 in cells, and selectively reduced the chromatin occupancy of YEATS2 but not other YEATS-containing proteins. The TMT-based quantitative proteomics analysis demonstrated the high specificity of LS-170 targeting YEATS2 in whole-cell proteomes. Armed with this powerful chemical tool, we detailed the biological response of NSCLC cells to pharmacological YEATS2 disruption. Notably, we discovered that YEATS2 YEATS inhibition is sufficient to selectively suppress YEATS2 target genes, including MCMs, E2F2, TK1, and GINS1, a subset of cell cycle and DNA replication-related genes that are essential for the growth of NSCLC. In a xenograft mouse model, LS-170 significantly suppressed the NSCLC tumor growth without apparent toxicity. Collectively, this study provided the first thoroughly

characterized inhibitors for the YEATS2 YEATS domain and established the YEATS2 YEATS domain inhibition as a feasible strategy to impair the pathogenic function of YEATS2 in NSCLC.

Semi-synthesis of trifunctional histone H4K20me2 and H3K36me3

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Key words: H4K20me2, H3K36me3, Ligation

Abstract: H4K20me2 and H3K36me3 are two important histone modifications, playing key roles in various cell process. H4K20me2 is crucial for the maintenance of whole genome integrity.[1] H3K36me3 is highly related to transcription initiation, elongation and alternative splicing.[2] Great efforts have been put to investigate these histone modifications, including the discovery of H4K20me2 / H3K36me3 effector proteins. Given that traditional methods of PTM effector proteins identification are limited owning to their lack of whole chromatin context or the low binding affinity between binders and modified histone, significant information could be lost. To solvent that, a trifunctional nucleosome-based probe has been developed, which has the whole context of nucleosome and can convert weak interaction into covalent bond upon UV irradiation. To prepare a nucleosome probe, the trifunctional histones need to be synthesized. Here we report the synthesis strategies of H4K20me2 and H3K36me3.

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Genomic and metabolic analyses reveal antagonistic lanthipeptides in archaea

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Keywords: Archaea, secondary metabolites, antibiotics, lanthipeptide

Abstract:

Microbes produce diverse secondary metabolites (SMs) such as signaling molecules and antimicrobials that mediate microbe-microbe interaction. Archaea, the third domain of life, are a large and diverse group of microbes that not only exist in extreme environments but are abundantly distributed throughout nature. However, our understanding of archaeal SMs lags far behind our knowledge of those in bacteria and eukarya. Guided by genomic and metabolic analysis of archaeal SMs, we discovered two new lanthipeptides with distinct ring topologies from a halophilic archaeon of class Haloarchaea. Of these two lanthipeptides, archalan α exhibited anti-archaeal activities against halophilic archaea, potentially mediating the archaeal antagonistic interactions in the halophilic niche. To our best knowledge, archalan α represents the first lantibiotic and the first anti-archaeal SM from the archaea domain. Our study investigates the biosynthetic potential of lanthipeptides in archaea, linking lanthipeptides to antagonistic interaction via genomic and metabolic analyses and bioassay. The discovery of these archaeal lanthipeptides is expected to stimulate the experimental study of poorly characterized archaeal chemical biology and highlight the potential of archaea as a new source of bioactive SMs.

Mechanistic Insights into Bismuth (III) Inhibition of SARS-CoV-2 Helicase

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The COVID-19 pandemic remains a global public health crisis. An effective way is a vaccine plus a drug (via oral administration). Identification of proteins that is critical for virus replication will provide guidance for searching drugs quickly.[1] SARS-CoV-2 genome encodes 16 non-structural proteins with multiple enzymatic functions. Among them, metalloenzymes are crucial for virus and the potential targets. Helicase (i.e. nsp13) is considering as a promising target due to its unique structure and function.[2,3]

Historically, metal compounds have been used as antimicrobial agents, but their antiviral activities have rarely been explored. Previously, we found bismuth-based complexes exhibited inhibition towards SARS-CoV-2 nsp13 activities, highlighting nsp13, a perfect target for anti-coronavirus drugs and the clinical potential of metallodrugs for COVID-19 treatment[4]. Here, we report potent inhibitors targeting SARS-CoV-2 nsp13 among a battery of metallodrugs. We subsequently examined inhibition modes, validated nsp13 is an authentic target *in cellulo*. We aim to develop more effective antiviral drugs to combat COVID-19 and relevant coronavirus based on nsp13 and explore the understanding molecular mechanisms.

We thank the Research Grants Council (RGC) of Hong Kong SAR (SRFS2122-7S04, C7034-20E, 17306323), and the University of Hong Kong (URC and Norman & Cecilia Yip Foundation) for support.

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A systematically biosynthetic investigation of lactic acid bacteria reveals diverse antagonistic bacteriocins that potentially shape the human microbiome

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Abstract:

Lactic acid bacteria (LAB) produce various bioactive secondary metabolites (SMs), which endow LAB with a protective role for the host. However, the biosynthetic potentials of LAB-derived SMs remain elusive, particularly in their diversity, abundance, and distribution in the human microbiome. Here, we systematically investigate the biosynthetic potential of LAB from 31,977 LAB genomes, identifying 130,051 secondary metabolite biosynthetic gene clusters (BGCs) of 2,849 gene cluster families (GCFs). Analyzing 748 human-associated metagenomes, we gain an insight into the profile of LAB BGCs, which are highly diverse and niche-specific in the human microbiome. We discover that most LAB BGCs may encode bacteriocins with pervasive antagonistic activities predicted by machine learning models, potentially playing protective roles in the human microbiome. Class II bacteriocins, one of the most abundant and diverse LAB SMs, are particularly enriched and predominant in the vaginal microbiome. We utilize metagenomic and metatranscriptomic analyses to guide our discovery of functional class II bacteriocins. Our study systematically investigates LAB biosynthetic potential and their profiles in the human microbiome, linking them to the antagonistic contributions to microbiome homeostasis via omics analysis. These discoveries of the diverse and prevalent antagonistic SMs are expected to stimulate the mechanism study of LAB's protective roles for the microbiome and host, highlighting the potential of LAB and their bacteriocins as therapeutic alternatives.

Oncohistone H3K27M mutation excludes a tumor suppressor PHF6 from chromatin

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Abstract

Histone play a significant role in regulation and remodeling of chromatin based on several kinds of post-translational modifications[1], which may be disrupted by mutation on histones, regarded as a kind of oncogenic driver. H3K27M is a reported typical oncogenic mutation which leads to a global decrease of H3K27me3, a known repressive mark[2-3]. We found that H3K27M mutation causes the loss of PHF6 from chromatin, a conserved protein functions as a transcription factor and tumor suppressor in diverse species[4], which provide a possible mechanism for revealing H3K27M oncogenic pathway.

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Arsenic-based Fluorescent Probe for Mining Intracellular Arsenic-proteome

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Arsenic trioxide (ATO) is a potential therapeutic agent for treating ALK-positive anaplastic large cell lymphoma (ALCL) [1]. Although enormous efforts have been made, the underlying mechanism of action of ATO remains unclear. Due to the complexity of arsenic-protein interactions in cells, tracking arsenic-binding proteins, particularly live cells, is a considerable challenge. Previously, we designed a series of fluorescent probes that have been successfully utilized to track metal-related proteins in different cells [2-4]. Nevertheless, the applications are limited due to low quantum yield due to low fluorescence enhancement after activation.

Herein, we report a novel fluorescent probe NI-As, enabling the arsenic-binding proteins to be anchored upon photoactivation and subsequently identified through high-throughput proteomics. Our approach enables weakly, even transiently arsenic-binding proteins to be identified. Moreover, NI-As shows excellent selectivity of arsenic-binding proteins and exhibits 20-fold fluorescence enhancement after UV irradiation within 15 min. The study provides an approach to understand the biological and pathological mechanisms of ATO at the cellular level. We also anticipate to mine and edit intracellular arsenic proteome.

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Development of Peptide-based Photoaffinity Probes to Identify Readers of H4K12acme

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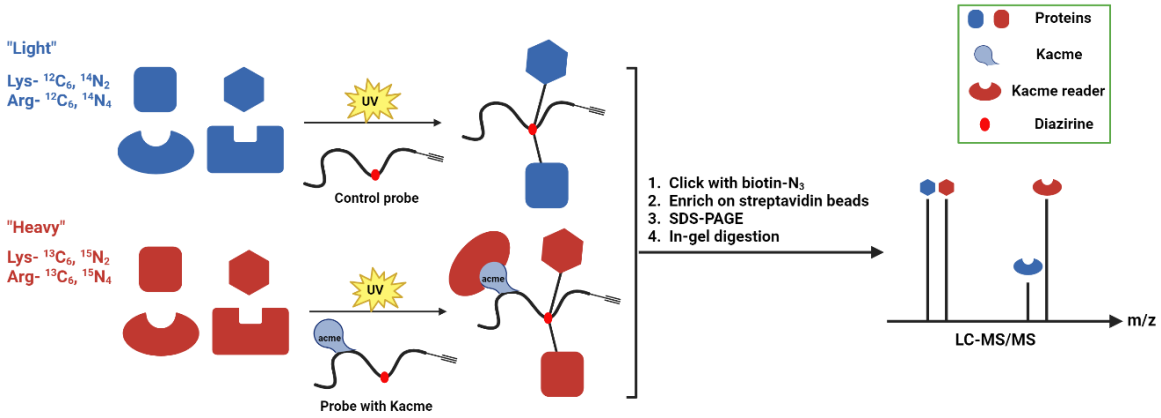
Abstract

Histone lysine post-translational modifications (PTMs) play crucial roles in various cellular processes. Recently, the Kacme modification where lysine is mono-methylated and acetylated on the same side chain was found on histone H4 K5 and K12 in human cells.[1] While it binds to BRD2 protein as Kac does, its specific reader proteins remain uncharacterized. In this work, we developed a peptide-based photoaffinity probe to identify the specific reader proteins of H4K12acme *via* Cross-Linking-Assisted and SILAC-Based Protein Identification (CLASPI) strategy. Strong candidates are yet to be identified at this stage, but with this robust strategy and modifying the probes, we envision the discovery of the specific reader proteins of H4K12acme and validating the candidates in future studies.



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Water stable co-block polymer coated $Cs_2AgIn_{0.9}Bi_{0.1}Cl_6$ lead-free double perovskite nanocrystals as luminescent probes

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Abstract

Lead halide perovskite nanocrystals are being heavily studied due to their excellent optical properties but lead toxicity is still a major issue. They have been utilized in various domains so far such as photovoltaic devices, solar cells, LEDs, and biosensors. Recently, double perovskite nanocrystals (PNCs) have emerged as a promising alternative. In this work, lead-free double perovskite nanocrystals were synthesized using the ligand-assisted reprecipitation (LARP) method. The synthesis of $Cs_2AgIn_{0.9}Bi_{0.1}Cl_6$ PNCs was performed at room temperature and the resulting NCs have a bright orange emission when excited at 375 nm. They feature two emission peaks, a violet emission that is due to free excitons and self-trapped emissions (STEs) that lead to orange emission. The orange emission peak has a maximum of 630 nm.

In this study, polystyrene-b-polyacrylic acid (PS-b-PAA) was used to transform these PNCs into water stable ones and enhanced the photoluminescence quantum yield (PLQY) upto 55%. After coating, they showed exceptional stability in various polar solvents such as water, Dimethyl sulfoxide (DMSO), and various biological mediums. They were successfully used as luminescent probes in HeLa and Hep G2 cells. Cell toxicity studies were performed to confirm the biocompatibility of the lead-free double PNCs. Even at high concentrations the cells were compatible with double PNCs. Without the lead toxicity, these water stable double PNCs can be used for various analytical applications such as luminescent probes for bioimaging of various cell lines. They can be also integrated with microfluidic chips for various biosensing applications in the future.

Thiamine diphosphate (ThDP) liganded gold(I) for the construction of artificial metalloenzyme

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Abstract

Artificial metalloenzymes (ArMs) result from the incorporation of a catalytically competent metallocofactor into a protein scaffold. ThDP-dependent enzymes possess the unique ability to generate a carbene within their active site. Therefore, the construction of ThDP enzymes with transition metals could represent a novel platform for ArMs with novel catalytic substrates and mechanisms. In addition, gold catalysis has proven to be an important breakthrough for organic synthesis. In this study, we sought to utilize this carbene to produce an Au(I) N-heterocyclic complex directly in the active site of ThDP enzyme, which is MenD ((1*R*,2*S*,5*S*,6*S*)-2-succinyl-5-enolpyruvyl-6-hydroxy-cyclohex-3-ene-1-carboxylate (SEPHCHC) synthase). To this end, ThDP=AuCl was prepared and characterized by nuclear magnetic resonance (NMR) and high-resolution mass spectrometry (HR-MS). ThDP=AuCl also showed good activity in the hydrofunctionalization of alkynes in water. The investigation of catalytic activity investigation by ThDP=AuCl-MenD system is still in progress.

Acknowledgement

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A Cyclodepsipeptide Nature Product from Saccharothrix syringae targets DNA in its mode of action

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Saccharothrix syringae (DSM 43886) is one famous strain for its main nature product Nocamycin with excellent antibacterial ability. Along with Nocamycin I, many analogues were also found during the isolation and showed great antibacterial activity. In our research, we found one novel nature product from *Saccharothrix syringae* fermentation that structurally different from those found in the same strain that have been reported which was a cyclodepsipeptide and found that it targets DNA in its mode of action. Through the experiments with several kinds of DNA, we found that this peptide can only bind to DNA in double strand. Moreover, after denaturing cyclodepsipeptide-binding DNA by heating, we isolated the compound from DNA which was found to be the cyclodepsipeptide through the LC-MS analysis. It convinced us of the non-covalent interaction between this nature product and DNA. In vivo experiments, cyclodepsipeptide could successfully induced sos-response of *B. Subtilis* and also confirmed that RecA was the responsible for sos-response. However, different from common DNA-binding compound such as mitomycin C, cyclodepsipeptide would not induce the release of spβ prophage and it was still under exploration how it was to induce the self-protection of bacteria.

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Digital microfluidics-engaged automated synthesis of helical silica@gold nanoparticles

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Abstract

Chiral gold nanoparticles (AuNPs) have found wide interest as functional and structural building blocks for three-dimensional nanostructures. The chirality is completely derived from the chiral organic moiety, whose chiral stability cannot be guaranteed in complex ambient surroundings. Helical silica, as inorganic chiral templates, have emerged as a promising alternative. Herein, the synthesis of AuNPs on helical silica is achieved with digital microfluidic system (DMF). Moreover, Right-handed and left-handed helical silica-AuNPs hybrid shows respectively positive and negative circular dichroism signals. Generally, AuNPs are produced by the reduction of chloroauric acid with a reducing agent. Various reducing agents such as sodium borohydride and tannic acid and stabilizing agents such as citrate and tannic acid were used in order to tune the size of AuNPs as well as their surface reactivity. For a higher affinity towards AuNPs, helical silica was modified with amino group.

CD spectroscopy was employed to examine the optical activity of these AuNPs-helical silica hybrids. Right-handed hybrids exhibit positive signals, while opposite spectra are observed for the left-handed ones, with a sign reversal in the vicinity of the plasmon resonance frequency of AuNPs (~550 nm). And with the increase of AuNPs diameters, the amplitude of the CD signals increased and red-shifted.

Such tunable and robust chiral hybrids with strong CD response can be developed for applications of metamaterials in visible range based on the importance of the SPR effect. And we are trying to integrate DMF chips with the synthesis of this hybrid and are currently studying their use for chiral separation of enantiomers in microchannels.

Exploring the functional significance of heterologous dimerization in lasso peptide synthases

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Lasso peptides are a class of ribosomally-synthesized and post-translationally modified peptides (RiPPs), characterized by their unique 1-rotaxane structure. Their unique structure allows for sequence customization, making them excellent candidates for protein engineering. Furthermore, they can serve as molecular scaffolds for drug carriers or molecular probes, exhibiting capabilities such as half-life extension and delivery of cytotoxic payloads. The versatility of lasso peptides makes them an exciting prospect for the development of innovative therapeutic and molecular tools. Despite the relative simplicity of their biosynthetic gene cluster, our understanding of the lasso peptides biosynthesis is very limited, and most of the intermediates are still not able to be trapped and structurally analyzed.

Here, we use microcin J25 (MccJ25) as our project model, in which McjB and McjC proteins are the maturation enzymes working on the precursor peptide. We successfully expressed and purified MBP-tagged McjB protein and His-tagged McjC protein with different *E. coli* strains. MccJ25 was readily formed from a reconstitution assay using chemically synthesized McjA, MBP-McjB and His-McjC, proving that both the maturation proteins are active. More activity assays were performed to characterize the maturation reaction. Binding interaction between McjA, McjB and McjC are tested using isothermal titration calorimetry (ITC), suggesting maturation enzymes can bind each other at a nanomolar affinity.

Acknowledgement

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Composite Thin Films with Embedded Polymer Coated Lead-free Double Perovskite Nanocrystals Integrated in Digital Microfluidic Chips as Sensing Layer

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Abstract

Lead-free double perovskite nanocrystals (PNCs) have attracted significant attention due to their high luminescence and low toxicity. On the other hand, digital microfluidic (DMF) chip can manipulate microliter volume of liquids through the electrowetting effect and have potential in biological, environmental, and analytical applications.

In this work, lead-free double PNCs ($Cs_2AgIn_{0.9}Bi_{0.1}Cl_6$) were integrated into the DMF chip. First, lead-free double PNCs were synthesized at room temperature using the ligand-assisted reprecipitation (LARP) method and their surface was coated with Poly (methyl methacrylate) (PMMA). The coated NCs exhibited a bright orange emission when excited at 365 nm. PLQY is 61% with good shelf life upto 18 months.

Composite thin film of PMMA-coated NCs were fabricated by spin coating, achieving a thickness of approximately 100 nm. The coated PNCs exhibited exceptional photostability properties and retained over 90% PL intensity when constantly irradiated by UV (365 nm). These composite films were photostable for 120 minutes in water and 60 minutes in BRB buffer. This film served as the luminescent sensing layer as a top plate and the DMF chip as the bottom plate. The photostability and water stability of the composite thin film makes it suitable for applications such as sensing layers in aqueous mediums. By integrating water-stable PNC sensing film into dedicated microfluidic chips, real-time monitoring of various chemical and biological reactions can be performed quickly. The integrated chips can be further used for their application for the multiplex detection of biological analytes in DMF chips.

Daptomycin forms a stable complex with Phosphatidylglycerol for selective uptake to bacterial membrane

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Abstract

Daptomycin is a lipopeptide active against a range of gram positive bacteria. Since its discovery in the early 1980s, its mode of action has been highly debated. In a recent review, Pokorny et al argue that daptomycin kills bacteria by membrane reorganization and that understanding the early events of the binding holds key to the mode of action of the drug[1].

Here we use stopped-flow to study the first binding of daptomycin to anionic lipids. Further, we follow the confirmational changes of daptomycin as it binds to the lipid surface using circular dichroism. The evidence from stopped-flow, fluorescence, and CD points towards a reversible and irreversible change in daptomycin's confirmation as it binds with PG (phosphatidylglycerol). While daptomycin binds to cardiolipin very quickly in milliseconds, the change is reversible in nature. On the other hand, daptomycin's interaction with PG is in minutes in a ratio of 1:2 as evident from fluorometric titration. To further substantiate a complex formation between daptomycin and PG, the complex was reconstituted in-vitro as well as isolated from *Bacillus subtilis*[2].

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Microfluidic Platform for Operating *C. elegans* Eggs as Tool Development for Drug Screening with the Species

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Abstract

Caenorhabditis elegans as a nematode species is frequently adopted for drug screening due to its maintenance ease, well-studied structure and biology, and the presence of homolog genes related to human diseases. As a work responding to such research needs by providing further effective strain maintenance and screening preparation, a microfluidic device for single species trapping and releasing *C. elegans* eggs and its fabrication are presented. Soft lithography of polydimethylsiloxane (PDMS) over photoresist masters prepared from photolithography and the incorporation of multiple PDMS layers are adopted for preparing the device that contains pressurized control over solution flow. Achieved functionality in separating, trapping, and releasing the nematode eggs of the devices is shown by working with aqueous-based egg suspension.

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High Throughput Drug Screening based on Factor Combinations Chip

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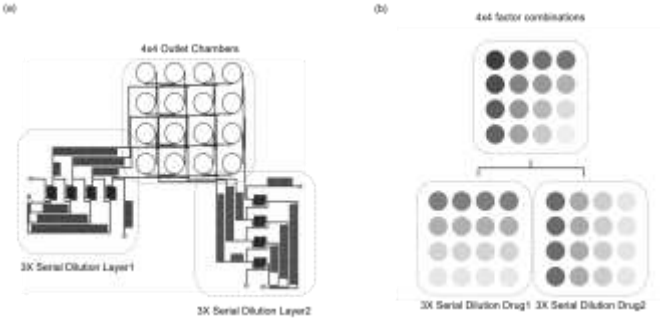
Abstract

The concentration range provided by traditional microfluidic linear gradient generators is limited, significantly restricting the application of microfluidics in drug screening[1]. Generating logarithmic drug concentration gradients by adjusting the channel ratio in the chip is confined to single-drug dilution chips[2]. We presented a microfluidic chip featuring continuous dilution capabilities, which generates logarithmic stepwise drug concentration gradients. We have devised a "mathematical-circuit-chip" model for designing the chips and fabricated a device capable of providing 16 distinct drug concentration combinations for two types of drugs. The chip is composed of two structurally identical orthogonally arranged layers, each containing a dilution capable of forming a 3-fold gradient. Drug and culture medium delivery to the open culture chamber array is driven by a pressure pump. This device facilitates high-throughput drug screening for tumor cells, representing a significant stride toward the realization of precision medicine.



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Development of bacterial transcription antitermination inhibitors as novel antimicrobial agents

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Abstract:

The upsurging antibiotic resistance urges the development of novel antibiotic candidates and bacterial transcription could be a promising drug target for the development of novel antibiotics. The protein-protein interaction (PPI) between N-utilization substance proteins B and E (Nus B and E) complex could be a potential target site, since the NusB-NusE PPI is essential for assembling the antitermination complex, which is responsible for ribosomal RNA (rRNA) transcription. This PPI is highly conserved and exclusively exists in bacteria. Based on the *in-silico* screening using a pharmacophore model designed based on the structure of NusB, we identified a hit compound, MC4 (1), as a potential NusB-NusE PPI inhibitor. Through the structure-activity relationship study, several MC4 compounds which demonstrated broad-spectrum antibacterial activity against methicillin- and vancomycin-resistance *Staphylococcus aureus*, good inhibitory activity against NusB-NusE PPI, and *in vivo* efficacy were synthesized.

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Kinetics and Conformational Dynamics Study of SARS-CoV-2 Main Protease and Its Interactions with Inhibitors

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Abstract

The main protease (M^{pro}), an essential enzyme for the replication of SARS-CoV-2 and highly conserved in structures among coronaviruses, is an appealing target for the development of broad-spectrum antiviral drugs. SARS-CoV-2 M^{pro} is in an equilibrium between the active dimer and inactive monomer in solution. In this study, the dissociation rate constant of the SARS-CoV-2 M^{pro} dimer for the first time was measured via subunit exchange between SARS-CoV-2 M^{pro} and ^{13}C-labeled M^{pro} monitored by native mass spectrometry, and a value of 0.0025±0.0001 min^{-1} and a half-life ($t_{1/2}$) of 277 minutes were obtained, indicating that the rate-limiting step was the dimer dissociation and M^{pro} had higher tendency to form the dimer. Hydrogen/deuterium exchange mass spectrometry (HDX-MS) was also employed to investigate the conformational dynamics of M^{pro} and its interactions with four inhibitors (i.e., PF-07321332, boceprevir, carmofur, and ebselen). Consistent with the X-ray crystallography results, residues containing active site amino acids exhibited significant decreases in deuterium uptakes and thus reduced flexibility upon the binding. It was newly discovered that the N-terminal region, C-terminal region and the long-loop region (residues 185-200), which were not directly involved in the interactions with the inhibitors, showed significant allosteric effects upon the binding. These results allowed us to gain new knowledge in kinetics and conformational dynamics of SARS-CoV-2 M^{pro} and its interactions with inhibitors and revealed the allosteric sites as new potential targets for drug design. This work was supported by RGC GRF (Grant Nos. 5308923 and 15304022).

Discovery of antimicrobials targeting RNA polymerase-sigma factor interaction

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Abstract

Bacterial transcription is a series of sequential processes catalyzed by bacterial RNA polymerase (RNAP). As one of the essential stages in gene expression, bacterial transcription is considered as an attractive and promising target for antibacterial agents. Interfering the contacts between RNAP and transcription factors related to transcription regulation (such as the house-keeping sigma factors) can significantly inhibit RNA synthesis and subsequent protein synthesis, thus impede the growth and proliferation of bacteria.

In the previous study, based on the key residues found in the β' clamp-helix (CH) region of RNAP, a pharmacophore model was established [1]. Compounds with antimicrobial properties that can disrupt the essential RNAP-σ interactions were identified, including **C3**. Subsequent studies were focused on the exploration of structure-activity relationships and structural optimizations of **C3**. The antimicrobial activity against *Streptococcus pneumoniae* were significantly enhanced from 256 to 1 μg/mL through this process [2, 3]. Further evaluation of the optimized compounds containing antimicrobial activity assessment, transcription inhibition, *in vitro* pharmacological profiling, cytotoxicity testing, and in vivo efficacy collectively indicated their potential for future development.

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Development of a search algorithm for rapid and accurate classification of edible oils by MALDI-MS

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Abstract

Market prices of different edible oils vary extensively because of their different compositions and nutritional values. Therefore, expensive edible oils were frequently counterfeited using cheaper oils for the tremendous profit, negatively impacting the industry. Conventional methods for edible oil analysis are difficult for high-throughput analysis of massive samples because of the sample pretreatment and chromatographic separation requirements. We have previously established a protocol for rapid analysis of edible oils by MALDI-MS and a corresponding spectral database. In this study, an automatic classification system was developed for the authentication of the edible oils including blended oils. The peaks in the raw spectral data were aligned and normalized, and unknown samples were compared against reference samples using a combination of the Gaussian Mixture Model and decision tree in an expanded database. Finally, oil types matching the samples were displayed according to the descending order of calculated similarity scores. The performance of this authentication system was evaluated by a testing dataset (n>600) and a training dataset (n>1000). The results showed that the authentication system could correctly classify 97.2% of the edible oil samples in total and process 60 spectra within 35 seconds, demonstrating its ability to rapidly and accurately classify unknown edible oil samples.

Chemical Modification of Cytochrome C for Acid-Responsive Intracellular Apoptotic Protein Delivery for Cancer Eradication

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Abstract:

Delivering bioactive proteins into cells without carriers presents significant challenges in biomedical applications due to limited cell membrane permeability and the need for targeted delivery. Here, we introduce a novel carrier-free method that addresses these challenges by chemically modifying proteins with an acid-responsive cell-penetrating peptide (CPP) for selective intracellular delivery within tumors. Cytochrome C, a protein known for inducing apoptosis, served as a model for intracellular delivery of therapeutic proteins for cancer treatment. The CPP was protected with 2,3-dimethyl maleic anhydride (DMA) and chemically conjugated onto the protein surface, creating an acid-responsive protein delivery system. In the acidic tumor microenvironment, DMA deprotects and exposes the positively charged CPP, enabling membrane penetration. Both in vitro and in vivo assays validated the pH-dependent shielding mechanism, demonstrating the modified cytochrome C could induce apoptosis in cancer cells in a pH-selective manner. These findings provide a promising new approach for carrier-free and tumor-targeted intracellular delivery of therapeutic proteins for a wide range of potential applications.

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Gene doping control analysis of human erythropoietin transgene in equine plasma by PCR-liquid chromatography high resolution tandem mass spectrometry

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Abstract

Gene doping involves the misuse of genetic materials to alter athlete's performance, which is banned at all times in both human and equine sports. Quantitative polymerase chain reaction (qPCR) assays have been used to control the misuse of transgenes in equine sports. Our laboratory recently developed and implemented duplex as well as multiplex qPCR assays for transgenes detection. To further advance gene doping control, we have developed for the first time a sensitive and definitive PCR-liquid chromatography high resolution tandem mass spectrometry (PCR-LC-HRMS/MS) method for transgene detection, with an estimated limit of detection of below 100 copies/mL for the human erythropoietin (hEPO) transgene in equine plasma.[1] The applicability of this method has been demonstrated by the successful detection of hEPO transgene in a blood sample collected from a gelding (castrated male horse) that had been administered the transgene. This novel approach not only serves as a complementary method for transgene detection, but also paves the way to developing a generic PCR-LC-HRMS/MS method for the detection of multiple transgenes.

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Design, and Synthesis of Functionalized Two-Photon Caging Platforms

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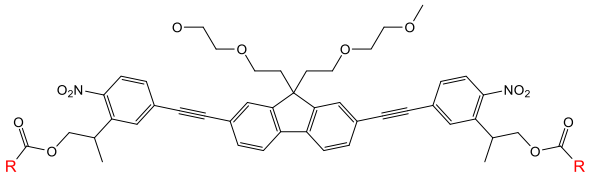
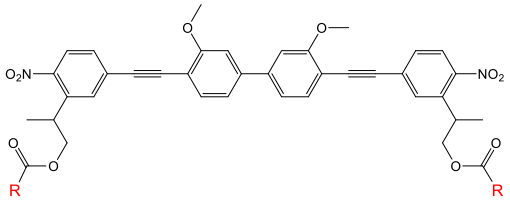
Abstract

Two-photon absorption (TPA) has become popular for biological applications, owing to its advantageous property of being able to achieve photophysical reactivities at long wavelengths in the near infrared region, it minimizes photodamage to materials and biological samples. Furthermore, deep tissue penetration and lower scattering can be achieved with long wavelengths. TPA photocleavable molecules are able to act as protecting groups for biological systems, creating caged compounds. An example of these types of biological cages in the literature are caged neurotransmitters, glutamate. Molecules that exhibit good TPA cross section are BNSF-Glu and BNSMB-Glu.[1] This experiment aims to replace the double bond linking the chromophore with the photolabile units in BNSF and BNSMB with a triple bond through Sonogashira coupling to discern the effect of this change to their photocleavage properties. This modification was made in hopes of increasing the photocleavage properties of BNSF and BNSMB by increasing the number of electrons in the conjugated system. We report the synthesis of triple bond versions of BNSMB and BNSF, serving as cages for R = phenylalanine, glutamic acid or γ-aminobutyric acid for photocleavage experiments.



Triple bond BNSF



Triple bond BNSMB

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Photofunctional Cyclometalated Iridium(III) Polypyridine Methylsulfone Complexes as Sulfhydryl-Specific Reagents for Bioconjugation, Bioimaging, and Photocytotoxic Applications

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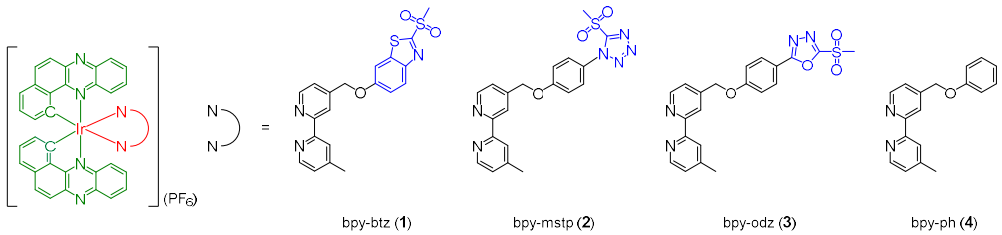
Heteroaromatic methylsulfones have emerged as a new class of electrophiles for selective sulfhydryl modification *via* the formation of a heteroaryl–thiol linkage in proteins. In this work, we designed a new class of iridium(III) methylsulfone complexes for the labeling of cysteine-containing peptides and proteins. Upon photoexcitation, all the complexes exhibited moderately intense NIR emission in solutions and in low-temperature alcohol glass. One of the complexes was selected to conjugate with L-cysteine and cysteine-containing peptides or proteins to afford conjugates. The resultant conjugates displayed interesting photophysical and photochemical properties, cellular uptake, localization properties, and (photo)cytotoxic activity. Importantly, all the conjugates showed higher cellular uptake and (photo)cytotoxicity toward cancer cells than normal cells.



We thank the Hong Kong Research Grants Council (Project Nos. CityU 11301121, CityU 11317022, CityU 11309423, C6014-20W, and C7075-21GF) and the Hong Kong Research Grants Council, National Natural Science Foundation of China (Project No. N_CityU104/21) for financial support.

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Huang, L.; Leung, P. K.-K.; Lee, L. C.-C.; Xu, G.-X.; Lam, Y.-W.; Lo, K. K.-W. *Chem. Commun.* **2022**, *58*, 10162 – 10165.

Strategic Establishment of Rhodamine-Decorated Rhodium(III) Complexes as Bioimaging Reagents and Controllable ROS Photosensitizers for Photodynamic Therapy

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[b]*Department of Chemistry, Southern University of Science and Technology, 1088 Xueyuan Blvd., Shenzhen 518055, P. R. China.*

In this work, a series of rhodamine-containing rhodium(III) complexes exhibited moderate rhodamine fluorescence in solutions under ambient conditions and sensitized a considerable amount of singlet oxygen ($^1O_2$) upon photoexcitation. Time-resolved transient absorption (TA) spectroscopic results suggested a long-lived dark rhodamine triplet state as a result of the incorporation of the rhodium(III) center, and this lowest-lying state is responsible for the enhanced reactive oxygen species (ROS) photogeneration ability. An energy cascade pathway from rhodamine S_1 to a rhodium-based triplet (T_1'), and subsequently to the lowest rhodamine T_1 was proposed. Interestingly, live-cell studies revealed that the complexes were localized in the mitochondria, and the photogeneration of ROS triggered a loss of mitochondrial membrane potential, leading to cell death. The complexes exhibited promising photocytotoxicity toward MCF-7 cells, via a combination of type I and type II ROS photosensitization mechanisms. This hybrid rhodamine–rhodium(III) system is anticipated to function as innovative theragnostic agents for both imaging and PDT properties.

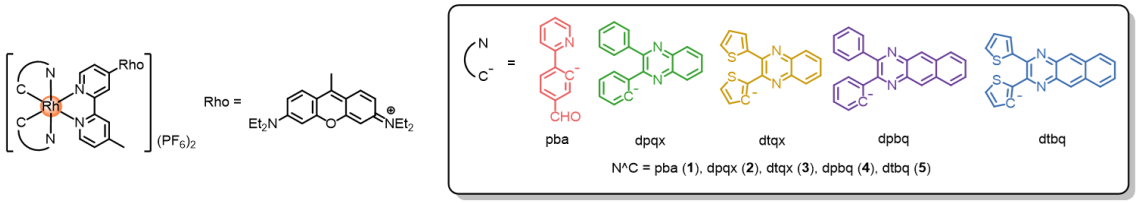

Fig 1. The molecular structures of complexes **1**–**5**.

We thank the Hong Kong Research Grants Council (Project Nos. CityU 11301121, CityU 11317022, C6014-20W, C7075-21GF, and N_CityU104/21).

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Photofunctional Cyclometalated Iridium(III) Polypyridine Complexes Bearing a Perfluorobiphenyl Moiety for Bioconjugation, Bioimaging, and Phototherapeutic Applications

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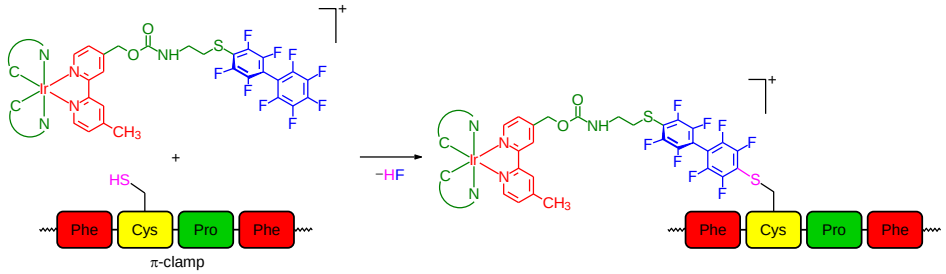
Chemoselective reactions are useful for the covalent attachment of functional entities to biomolecules to create novel constructs for biological applications. In this work, we modified cyclometalated iridium(III) polypyridine complexes with a perfluorobiphenyl (PFBP) moiety to afford novel reagents for bioconjugation, bioimaging, and phototherapeutic applications. Reactions of the PFBP complexes with peptides containing an FCPF (π-clamp) sequence via the selective cysteine conjugation yielded luminescent peptide conjugates that displayed rich photophysical and photochemical properties. Importantly, the conjugation of complexes to organelle-targeting peptides was found to modulate their intracellular localization behavior, which was further shown to be important to their photosensitization properties and photocytotoxicity.



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Luminescent Rhenium(I) Perfluorobiphenyl Complexes as Site-specific Labels for Peptides to Afford Photofunctional Bioconjugates

Peter Kam-Keung Leung,[ab] Lawrence Cho-Cheung Lee,[a] Tiffany Ka-Yan Ip,[a] Hua-Wei Liu,[a] Shek-Man Yiu,[a] Nikki P. Lee,[c] and Kenneth Kam-Wing Lo*[ab]

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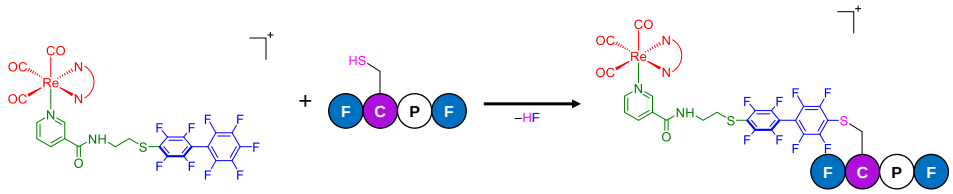
[c]*Department of Surgery, The University of Hong Kong, Hong Kong*

A four amino-acid sequence (FCPF, termed as "π-clamp") has been developed for the site-specific cysteine labeling of peptides and proteins in aqueous media. This short sequence undergoes selective and rapid cysteine arylation with perfluorobiphenyl (PFBP) derivatives without the need for catalysts. Given the rich photophysical and photochemical properties of rhenium(I) polypyridine complexes, for example, their long-lived triplet emission and efficient singlet oxygen generation, these complexes have been widely exploited for biological applications. Herein, we report rhenium(I) PFBP complexes that specifically label the cysteine residue of the π-clamp sequence. The complexes were conjugated to π-clamp-modified peptides to afford novel conjugates that selectively stained the lysosomes and mitochondria of KYSE-510 cells. Also, the photocytotoxicity activity of the conjugates toward the cells was investigated. Additionally, a phosphorogenic substrate for caspase-3/7 was developed to monitor the activity of these enzymes in live cells.



We thank the funding support from the Hong Kong Research Grants Council (Project no. CityU 11301121, CityU 11317022, C6014-20W, C7075-21GF, and N_CityU104/21).

Reference

Leung, P. K.-K.; Lee, L. C.-C.; Ip, T. K.-Y.; Liu, H.-W.; Yiu, S.-M.; Lee, N. P.; Lo, K. K.-W. *Chem. Commun.*, **2021**, *57*, 11256 – 11259.

Iridium(III) *bis*-Nitrone Complexes as Innovative Phosphorogenic Reagents for Bioimaging and Phototherapeutics

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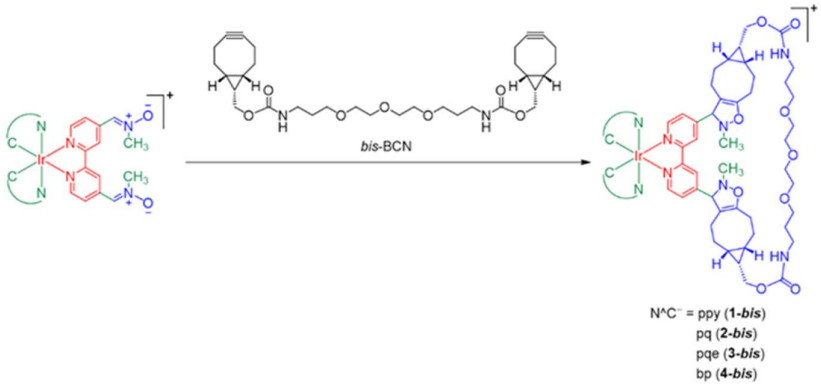
Nitrones are a relatively new bioorthogonal system that show high reactivity toward strained cyclooctynes via the strain-promoted alkyne-nitrone cycloaddition (SPANC) reaction. Transition metal complexes containing a nitrone moiety are weakly emissive but exhibit intense and long-lived emission upon reaction with strained alkynes such as (1R,8S,9s)-bicyclo[6.1.0]nonyne (BCN).[1] In this work, cyclometalated iridium(III) complexes functionalized with two nitrone units have been designed as novel phosphorogenic bioorthogonal reagents for bioimaging and phototherapy. Upon reaction with BCN substrates, the reaction mixture displayed significant emission enhancement and lifetime extension. Importantly, the complexes showed a higher reaction rate toward a *bis*-cyclooctyne derivative (*bis*-BCN) compared with its monomeric counterpart. Additionally, the cellular uptake, imaging and photocytotoxic properties of the complexes were explored. The crosslinking properties of the complexes mean that they are potential candidates for the construction of polymeric materials and stapled peptides.



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A Concerted Enzymatic and Bioorthogonal Approach for Extra- and Intracellular Activation of Environment-Sensitive Ruthenium(II)-Based Imaging Probes and Photosensitizers

Justin Shum,[a] Lawrence Cho-Cheung Lee,[a] Michael Wai-Lun Chiang,[a] Yun-Wah Lam,[a] and Kenneth Kam-Wing Lo[a,b]*

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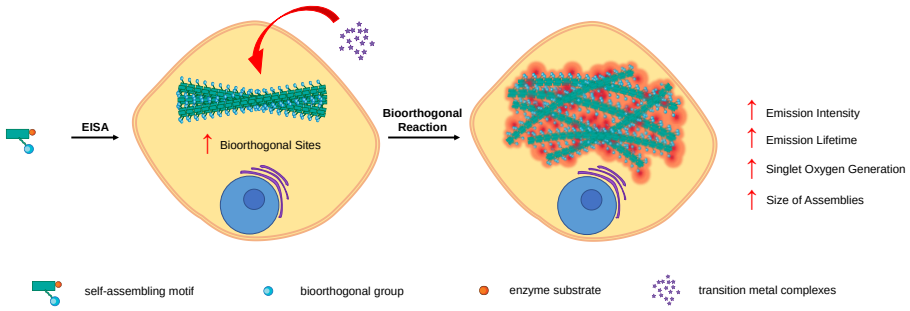
We report a novel targeting strategy involving the combination of an enzyme-instructed self-assembly (EISA) moiety and a strained cycloalkyne to generate a large accumulation of bioorthogonal sites in cancer cells. These bioorthogonal sites can serve as activation triggers in different regions for transition metal-based probes, which are new ruthenium(II) complexes carrying a tetrazine unit for controllable phosphorescence and singlet oxygen generation. Importantly, the environment-sensitive emission of the complexes can be further enhanced in the hydrophobic regions offered by the large supramolecular assemblies, which is highly advantageous to biological imaging. Additionally, the (photo)cytotoxicity of the large supramolecular assemblies containing the complexes was investigated, and the results illustrate that cellular localization (extracellular and intracellular) imposes a profound impact on the efficiencies of photosensitizers.



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Luminescent Iridium(III) Polypyridine Complexes Modified with a Molecular Glue as Photofunctional Cellular Reagents

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Over the last decade, transition metal complexes (TMCs) has gained considerable attention due to their excellent photophysical and photochemical properties. The introduction of cleavable dendritic molecular glue to transition metal complexes (TMCs) can create a new class of molecular glue-modified TMCs, which can be utilized as imaging, labeling, and therapeutic regents. In this project, two novel cyclometalated iridium(III) complexes containing stimuli-response linkers tethered to multiple guanidinium moieties as molecular glues for the delivery and controlled release of active biomolecules in cancer were designed. The binding of the molecular glue complexes to the biomolecules inhibits their activity, which can be reversed after cleavage of the linker in response to esterase in cancer. Additionally, this cleavage process simultaneously releases the iridium(III) complexes, leading to changes in emission intensity and lifetimes that can be used to monitor the delivery and release of the biomolecules. This work provides luminescent molecular glues that can inhibit and deliver biomolecules, release and activate them, and monitor the process in tumor tissues.

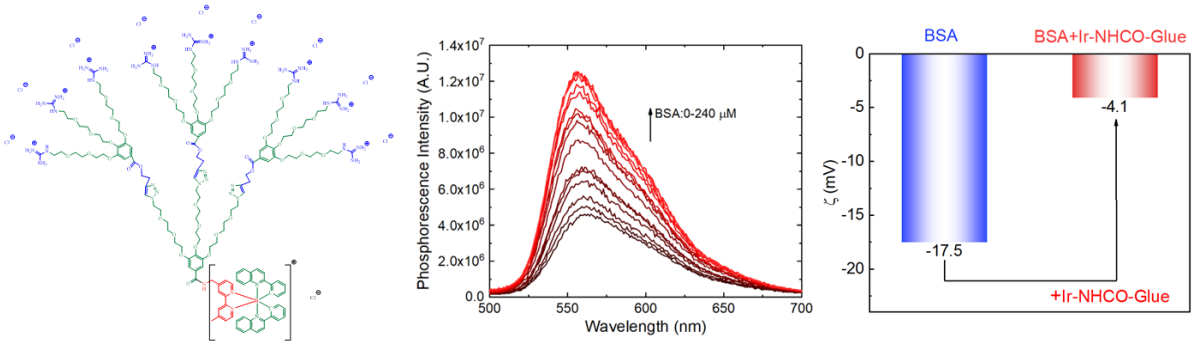

Fig 1. (Left) Structure of complex Ir-Glue. (Middle) Phosphorescence spectra of Ir-Glue upon titration with BSA. (Right) Zeta potential profiles of BSA in the absence (blue) and presence of Ir-Glue (red).

We thank the Hong Kong Research Grants Council (Project Nos. CityU 11302820, CityU 11301121, CityU 11317022, C6014-20W, and C7075-21GF) and the Hong Kong Research Grants Council, National Natural Science Foundation of China (Project No. N_CityU104/21) for financial support.

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Bioorthogonal Dissociative Rhenium(I) Photosensitizers for Controlled Immunogenic Cell Death Induction

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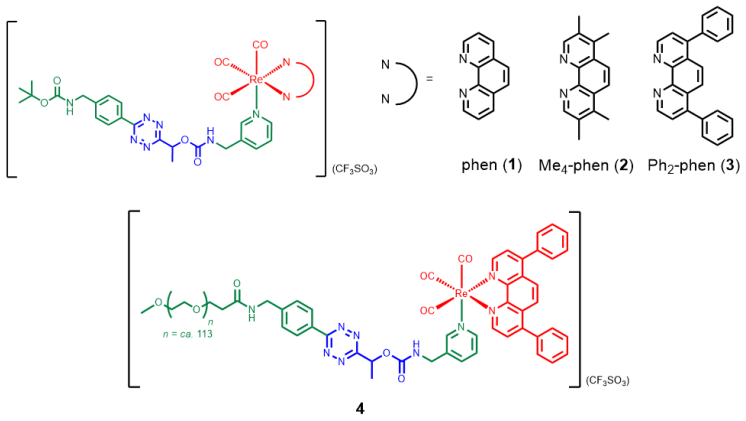
Bioorthogonal dissociation reactions have emerged as a promising approach for drug activation because of their high reaction specificity, kinetics, and biocompatibility. With our on-going interest in the development of luminescent transition metal complexes for photodynamic therapy, we functionalized rhenium(I) polypyridine complexes with a cleavable tetrazine carbamate linker as bioorthogonally dissociative photosensitizers for the controlled induction of immunogenic cell death (ICD). Upon reaction with *trans*-cyclooct-4-enol (TCO-OH), the complexes displayed increased emission intensities and singlet oxygen ($^1O_2$) generation efficiencies due to the departure of the tetrazine unit. One of the complexes bearing a poly(ethylene glycol) (PEG) group exhibited negligible dark cytotoxicity toward cancer cells. However, treatment of cells with the PEG complex, TCO-OH, and light induced lysosomal dysfunction and ICD because of the combined effect of the released cytotoxic rhenium(I) complex and increased $^1O_2$ generation.



Scheme 1. Structures of the rhenium(I) complexes.

We thank the funding support from Hong Kong Research Grants Council (Project Nos. CityU 11302820, CityU 11301121, CityU 11317022, C6014-20W, and C7075-21GF).

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Luminescent Iridium(III) 2-Cyanobenzothiazole Complexes as Site-specific Labels to Afford Matrix Metalloproteinase-responsive Bioconjugates for Bioimaging and Hydrogel Construction

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Abstract

In this study, we report cyclometalated iridium(III) complexes bearing a 2-cyanobenzothiazole (CBT) moiety for site-specific modification of peptides with an N-terminal cysteine. The high selectivity of the CBT unit towards N-terminal cysteine allows sequential and site-specific dual modification of peptides. Leveraging this advantage, one of the complexes was used in two distinct applications. First, we constructed a phosphorogenic conjugate, **2-MMP-QSY7**, sensitive to matrix metalloproteinase-2/9 (MMP-2/9) activity. It displayed weak emission intensity due to efficient quenching by QSY-7, but the sample solution exhibited emission enhancement (I/I_o = 9.8) upon the addition of MMP-2/9, allowing sensitive visualization of MMP-2/9 enzyme activity in live cells. Second, we fabricated MMP-2/9 responsive peptide hydrogels, **Gel-1** and **Gel-2**, with different crosslinking structures *via* thiol-ene Michael addition to create lysosome-targeted bioimaging and photocytotoxic agents. **Gel-1**, with a cleavable crosslinking structure, was completely degraded into a liquid solution upon treatment with MMP-2/9. Imaging of the catalytic activity of MMP-2/9 in live cells was demonstrated *via* laser confocal scanning microscopy (LSCM). Interestingly, **Gel-2**, with an uncleavable crosslinker while permitting the release of the iridium(III) complex through cleavage by MMP-2/9, proved suitable for sensing MMP-2/9 activity in 3D cell culture.

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Matrix Metalloproteinase-responsive Iridium(III)-based Hydrogels for Tumor Cell-specific Imaging, Anti-metastasis, and Lysosome-targeted Photodynamic Therapy

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Abstract

Many cancer cells have elevated matrix metalloproteinases (MMPs) levels, which are closely implicated in tumor growth and invasion. The most common MMP-related anticancer approach was the development of MMP-sensitive materials for stimuli-responsive drug release. Herein, we report the synthesis and characterization of MMP-sensitive iridium(III)-based PEG-peptide hydrogels through the inverse electron-demand Diels–Alder (IEDDA) reaction of a PEG polymer bearing four tetrazine units with an MMP-sensitive peptide containing two bicyclo[6.1.0]nonyne units in both ends and an iridium(III) *bis*-tetrazine complex (Figure 1). Upon degradation of the hydrogels by the MMPs excreted from the cancer cells, the iridium(III) complex fragments were subsequently released. Their (photo)cytotoxic effect on cancer cells and inhibition effects on cell migration and invasion were studied using laser-scanning confocal microscopy.

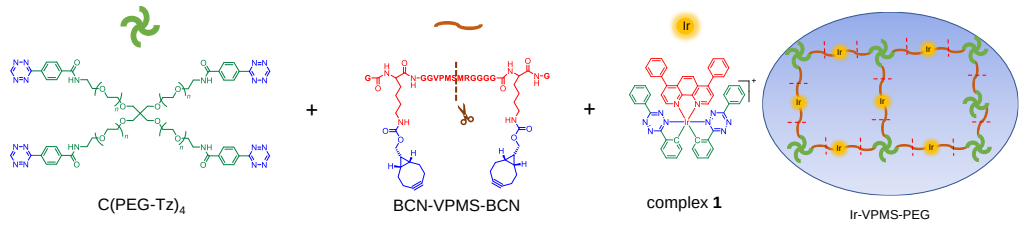

Figure 1. Structure of the hydrogels Ir-VPMS-PEG.

We thank the Hong Kong Research Grants Council (CityU 11302820) for financial support. We also thank the funding support from "Laboratory for Synthetic Chemistry and Chemical Biology" under the Health@innoHK Program launched by Innovation and Technology Commission, The Government of Hong Kong S.A.R, P. R. China.

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Using Sterically Bulky Amidinate and Guanidinate Ligands for Stabilization of Divalent Group 14 Metal Complexes

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Abstract

Amidinate and guanidinate are structurally related N-coordinating ligands, which exhibit excellent metal ion stabilizing ability.[1] Their tunable steric and electronic properties can be achieved by introducing appropriate substituents at the nitrogen atoms.[2a] The NCN backbone in amidinate and guanidinate ligands enables delocalization of anionic charge for stabilization of different metal complexes.[2b]

In the present study, divalent group 14 metal complexes supported by amidinate and guanidinate ligands were synthesized by salt metathesis reaction of MCl_2 (M = Ge^{II}, Sn^{II} and Pb^{II}) with two equivalents of the corresponding lithium amidinate complex **1** in Et_2O. These reactions led to isolation of Ge^{II} (**3**), Sn^{II} (**4**) and Pb^{II} (**5**) bis(amidinate) complexes. Meanwhile, the salt metathesis reactions of MCl_2 (M = Ge^{II}, Sn^{II}) and one equivalent of the corresponding potassium guanidinate complex **2** in THF, which led to the isolation of monosubstituted Ge^{II} (**6**), Sn^{II} (**7**) guanidinate complexes.

Acknowledgements

This work was supported by a Direct Grant (Project ID: 4053560) of The Chinese University of Hong Kong. We are grateful to Ms. Hoi-Shan Chan for assistance in crystallographic analysis.

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Groups 14 Complexes Supported by Sterically Bulky Guanidinate Ligands

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Abstract

A series of Groups 14 complexes supported by monoanionic and dianionic guanidinate ligands, $[(2,6\text{-}^{i}Pr_2C_6H_3N)C(NHPr^{i})(NPr^{i})]^{-}$ (**HL**$^{-}$) and $[(2,6\text{-}^{i}Pr_2C_6H_3N)C(NPr^{i})(NPr^{i})]^{2-}$ (**L**$^{2-}$), were prepared and structurally characterized. Metalation of 2,6-diisopropylaniline with *n*-butyllithium or potassium hydride in an appropriate solvent, followed by addition of *N,N'*-diisopropylcarbodiimide afforded lithium complex $[Li(\mathbf{HL})]_2 \cdot Et_2O$ and potassium complex $[K(\mathbf{HL})]_n$, respectively. Metathesis reactions of an appropriate Groups 14 metal chloride with $[Li(\mathbf{HL})]_2 \cdot Et_2O$ led to isolation of the corresponding guanidinate complexes [Ge(**HL**)Cl] and $[Sn(\mathbf{HL})_2]$. Reaction of germanium(II) complex [Ge(**HL**)Cl] with potassium metal afforded $[Ge\mathbf{L}]_2$ complex. Metathesis reactions of tin(II) chloride or lead(II) chloride with $[(Li_2\mathbf{L})_2 \cdot Et_2O]$ led to isolation of the corresponding guanidinate complexes $[Sn\mathbf{L}]_2$ and $[Pb\mathbf{L}]_2$.

Acknowledgements

This work was supported by a Direct Grant (Project ID: 4053560) of The Chinese University of Hong Kong. We are grateful to Ms. Hoi-Shan Chan for assistance in crystallographic analysis.

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Application of Indole-Based Monophosphine in ppm Level Pd-Catalyzed C–N Bond Formation

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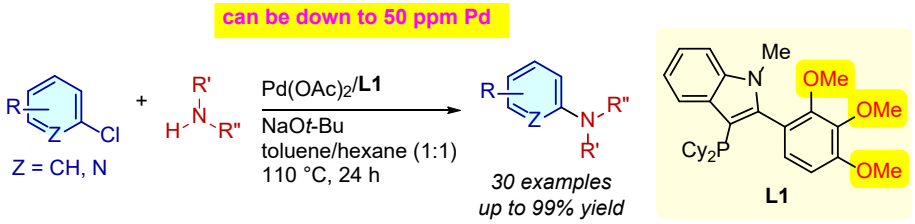
Abstract



A new indolyphosphine ligand bearing electron-donating methoxy groups has been tailor-made for Pd-catalyzed Buchwald-Hartwig amination. The new catalyst system demonstrated high effectiveness in facilitating the reaction even at parts per million levels of palladium catalyst. A wide range of aryl chlorides as well as amine nucleophiles were successfully employed for the C–N bond formation process. Remarkably, the extremely sterically congested amine (i.e. 2,6-diisopropylaniline) was coupled with aryl chloride smoothly under the newly developed catalyst system.

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Stereoselective Unsymmetrical 1,1-Diborylation of Alkynes with a Neutral sp^2 - sp^3 Diboron Reagent

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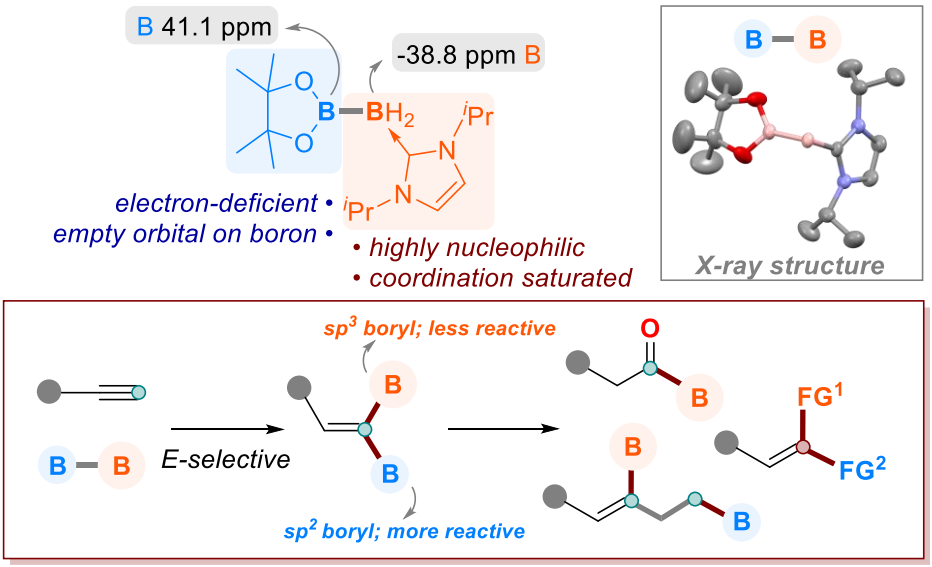
Keywords: Acryborane, Boron, *gem*-Diborylation, Stereoselective, Unsymmetrical Diborane.

Abstract:
The incorporation of boron into organic molecules has received growing research focus. Given the versatility of the carbon-boron bond, borylated compounds can readily undergo derivatization, enabling the facile introduction of various functional groups. 1,1-Diborylalkene is a class of diboryl species. It can serve as a precursor of multisubstituted olefins, which are prevalent building blocks in natural products and drug molecules. Diboron reagents such as B_2pin_2 and Bpin-Bdan, has been used in synthesizing 1,1-diborylalkenes.[1,2,3] However, two boryl groups with similar chemical properties making them difficult to distinguish during the late-stage functionalization.[2] Here we report a method to access unsymmetrical 1,1- diborylalkene (UDBA) stereoselectively via the reaction of readily available alkynes with a neutral sp^2-sp^3 diboron reagent.[4] Attributing to the chemically easily distinguishable nature of the sp^2 and sp^3 boryl moieties, controllable stepwise derivatization of the resultant UDBAs is realized. This process leads to various multifunctionalized olefins and organoborons, such as acylboranes, which are difficult to prepare by other methods.



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Synthesis of Monkey Saddle Containing Three Heptagons Sharing One sp3 Carbon

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Abstract

Embedding seven or eight-membered carbocycles in a graphitic lattice gives rise to negatively curved carbon allotropes, which are known as carbon schwarzites or Mackay crystals. These carbon allotropes with negative curvature are predicted to have interesting properties and potential applications based on computational studies but are yet to be synthesized. Carbon schwarzites present horse saddle and monkey saddle geometries as key structural features. The objectives of my study are synthesis of polycyclic aromatic monkey saddles and investigation into their properties. In order to obtain PAHs containing a central sp3 carbon atom that could be used to afford a radical cation, A variety of substrates were attempted to Heck and Scholl reactions under many different conditions. Unfortunately, incomplete cyclization and rearrangements have been observed. An alternative synthetic route has been designed, inspired by a reported boron-centered compound.

Synthesis, Properties and Thin-Film Transistors of Core-Modified Soluble Silylethynyl Perinone Derivatives

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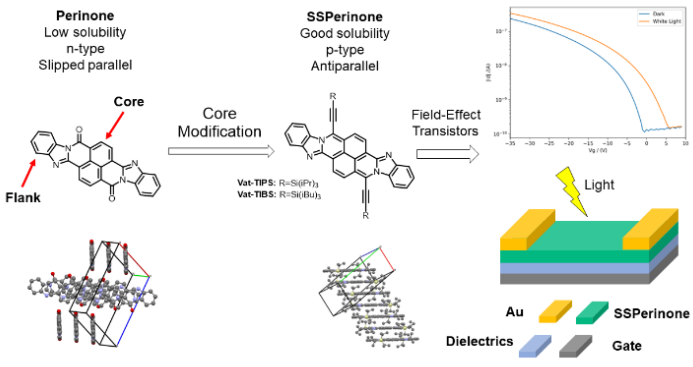
Abstract

Notable efforts have been applied to modify the perinone backbone on flank benzene rings[1], but the core modifications were rarely explored. Herein, the core-modified Soluble Silylethynylated Perinone (**SSPerinone**) derivatives have been synthesized. The silylethynyl core-modification strategy increased the solubility of the perinone backbone, boosting fluorescence quantum yield, changed the molecular packing of perinone backbone, and also turns the semiconducting property from n-type to p-type. Further, the OFET devices using vacuum-deposited **SSPerinone** thin film as channel materials show apparent photoresponse under ambient air. The photocurrent generated in **SSPerinone** thin-film can be erased by applying negative gate bias, which have potential application in optoelectronic memory[2].



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Functionalization of boranes through thiol/oxygen catalysis

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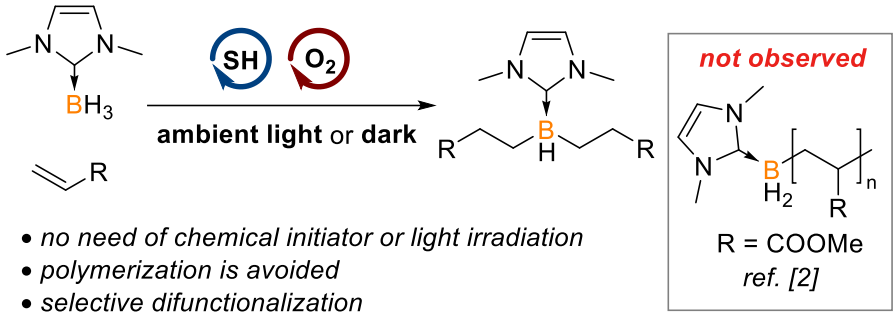
Keywords: Organoborane, Thiyl radical, Oxygen, Borane difunctionalization, Green synthesis.

Abstract:

Thiyl radical has been recognized as a powerful hydrogen atom transfer (HAT) catalyst, which competently abstracts hydrogen atoms from carbon-hydrogen or element-hydrogen functionalities to deliver the corresponding carbon- or element-centered radical suitable for subsequent transformations.[1] Here we proposed a greener and more convenient methods for the generation of thiyl radical as HAT catalyst, using molecular oxygen to oxidize thiol without the need for chemical initiators or light irradiation, successfully achieving selective di-alkylated or mono-alkaylated functionalizations of NHC borane. A thorough mechanistic investigation underscores the pivotal role of oxygen in directly generating thiyl radical from thiol in an efficient manner. The potential of this thiol/oxygen catalysis extends beyond borane functionalization, as demonstrated by the successful functionalization of silane, suggesting wider applicability in various other chemical transformations.



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C–N Axially Chiral Carbazolyl Phosphine Enabled Enantioselective Suzuki-Miyaura Cross-Coupling Reaction for Accessing *ortho*-Amino Atropisomers

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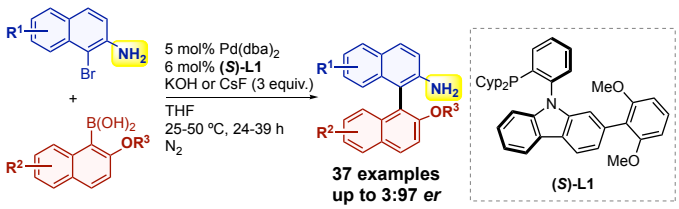
Abstract:

The $C_{(Ar)}$–N axis has garnered significant interest in asymmetric catalysis due to its potential for favorable stereocommunication with the metal center and substrates. Building upon our previous effort, a series of $C_{(Ar)}$–N axially chiral carbazolyl phosphine ligand was designed, and DFT calculations revealed an interchangeable Pd–N and Pd–π coordination, made possible by the unique carbazolyl framework. This allows for a dynamic steric environment during catalysis. It is anticipated that this novel series of carbazolyl phosphine ligands is compatible with substrates of varied steric properties. Herein, a tetra-*ortho*-substituted Suzuki-Miyaura cross-coupling was employed as a direct approach to access binaphthalenes containing free *ortho*-amines. Remarkably, the asymmetric Suzuki-Miyaura coupling was successfully achieved by using (*S*)-**L1** with enantiomeric ratio (*er*) up to 97:3.



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Palladium-Catalyzed Direct C-H Olefination of Polyfluoroarenes with Alkenyl Tosylates

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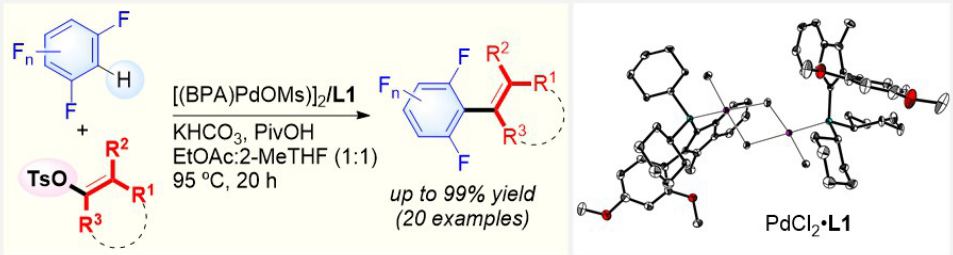
Abstract

The first general examples of palladium-catalyzed direct C-H olefination of polyfluoroarenes using alkenyl tosylates as electrophilic coupling partners are presented. By employing the Pd/**L1** catalyst system (**L1**=*N*-methyl-2-(2',4'-dimethoxyphenyl)-3-dicyclohexylphosphinoindole), the olefinated polyfluoroarenes can be obtained in good-to-excellent yields. Good structural and functional compatibility are also exhibited. In particular, the steric demanding and heterocyclic alkenyl tosylates react smoothly under this catalyst system. This reaction can be practicably performed on a gram-scale without significantly loss of product yields.



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Design and Applications of Cyclopropenium Chalcogen Dihalides in Catalysis via C(sp3)−H···X Interactions

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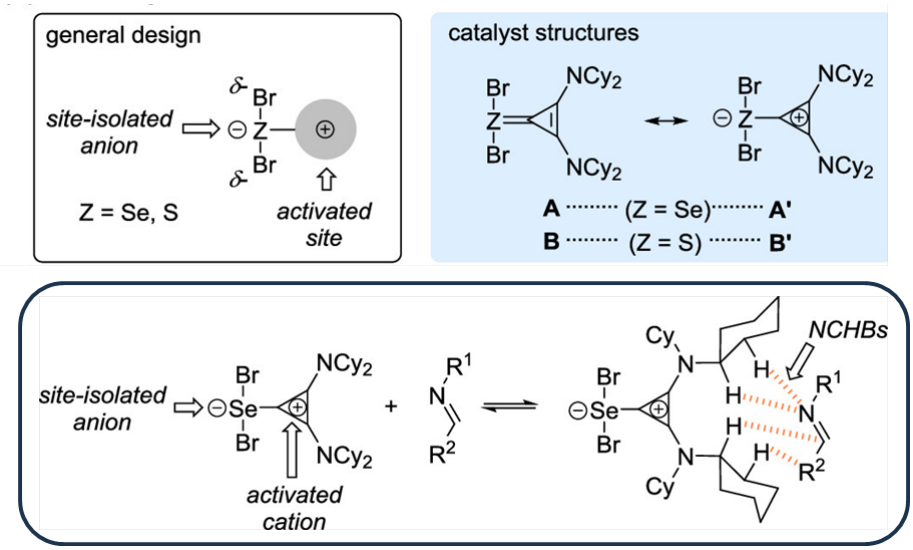
Keywords: chalcogen, cyclopropenium, noncovalent interactions, nonclassical hydrogen bond, organocatalysis

Abstract:
C(sp^3)−H···X hydrogen bonds are relatively weak , however, incorporation of electron-withdrawing substituents in close proximity to the C(sp^3)−Hs can enhance their noncovalent attractive interactions to electron donors. Herein, we report the use of cyclopropenium chalcogen dihalides as catalysts, in which effective site isolation of the counteranion significantly enhances the availability of the noncovalent interaction donor. The catalytic performance is comparable to those of some typical Lewis acids and much better than those of many common catalysts based on noncovalent interactions. Our mechanistic study suggests that the catalysts activate substrates via multiple C(sp^3)−H···X hydrogen bonds.



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Luminescent Eu(III) Probes for Thermometry Mapping *in Cellulo*

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Abstract

Being related to numerous cellular activities, variations in intracellular temperature are of great importance in investigative cell pathology and physiology.[1] Diseased tissues undergo higher metabolic rates, such as in rapid tumour growth, typically have a higher local temperature than the surrounding healthy tissue. It is therefore of particular interest to detect certain diseases at the cellular level, via real-time temperature monitoring.

An ideal thermo-sensor should demonstrate high brightness for low dose administration, high temperature sensitivity and low uncertainty with good spatiotemporal resolution under physiological conditions (310±5K).[2] Self-referencing, lanthanide-based thermometers covering the entire electromagnetic spectrum (from ultraviolet to near-infrared) are a promising emergent class that have potential to probe the cellular temperature changes, owing to their good photochemical stability, low cytotoxicity and a small number of temperature dependent luminescence properties. Emission intensity ratio and luminescence lifetime variations can be induced by thermal quenching processes such as thermally activated back energy and electron transfer from the Eu(III) excited state.[3] Here, a series of molecular-based Eu(III) probes have been compared, seeking to identify the most promising systems as temperature probes of the sub-cellular environment in living cells.

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The 30th Symposium on Chemistry Postgraduate Research in Hong Kong

Nickel-catalyzed enantioselective α-heteroarylation of ketones via C–F bond activation to construct all-carbon quaternary stereocenters

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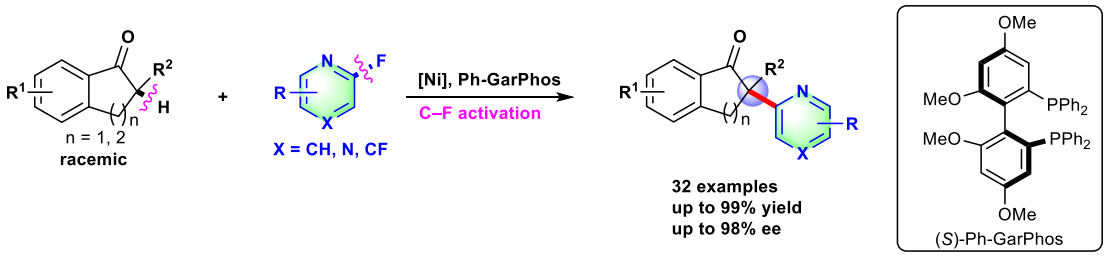
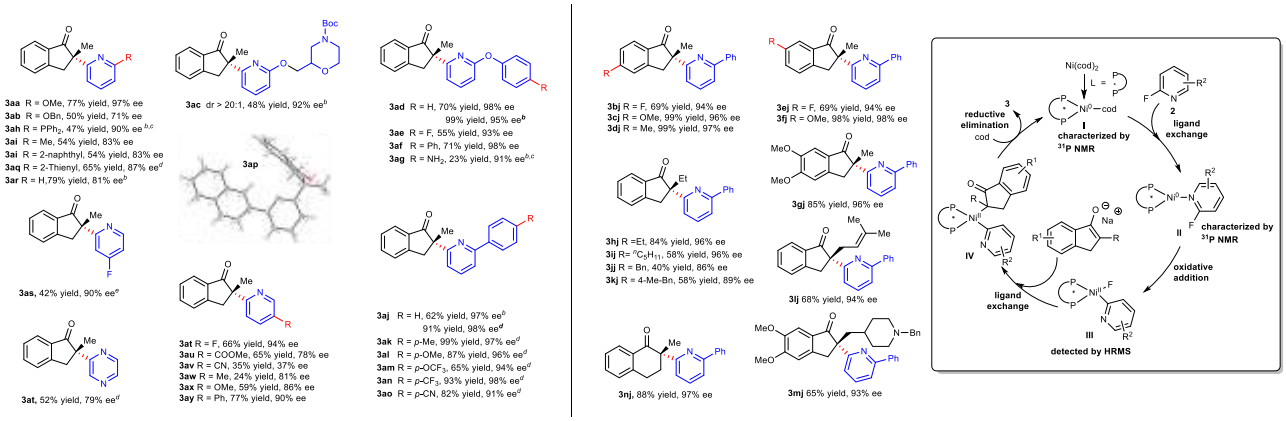
[b]*Department of Chemistry, Southern University of Science and Technology (SUSTech)*
[c]*College of Materials, Chemistry and Chemical Engineering, Hangzhou Normal University*
Jun (Joelle) Wang: junwang@hkbu.edu.hk; Mingliang Li: liml@mail.sustech.edu.cn; Xiaodong Gu: 21481377@life.hkbu.edu.hk



Abstract: Nickel-catalyzed asymmetric α-heteroarylation of ketones with fluorinated heteroarenes is reported via C-F bond activation. Although the C–F bond has high bond dissociation energy, catalytic C-F bond cleavage is a highly regioselective strategy to achieve late-stage functionalization of pharmaceuticals and construct diversified complex molecules. So far, there are rare examples of transition metal-catalyzed C(sp^3)-H/C_{Ar}-F cross-coupling reactions, let alone asymmetric transformations with aryl or heteroaryl fluoride derivatives as coupling partners via C-F bond activation. Prompted by the nickel-catalyzed arylation of indanones with aryl triflates, chlorides, pivalates or pyridyl ether as arylation reagents, we develop herein the Ni-catalyzed asymmetric α-heteroarylation of ketones via C-F bond activation to deliver all-carbon chiral quaternary carbon centers in good yields (up to 99% yield) and high ee values (up to 99% ee). In addition, drug molecule donepezil could also be compatible under the reaction conditions to afford late-stage diversification of pharmaceuticals.



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The 30th Symposium on Chemistry Postgraduate Research in Hong Kong

Pd-catalyzed Enantioselective and Regioselective Asymmetric Hydrophosphorylation and Hydrophosphinylation of Enynes

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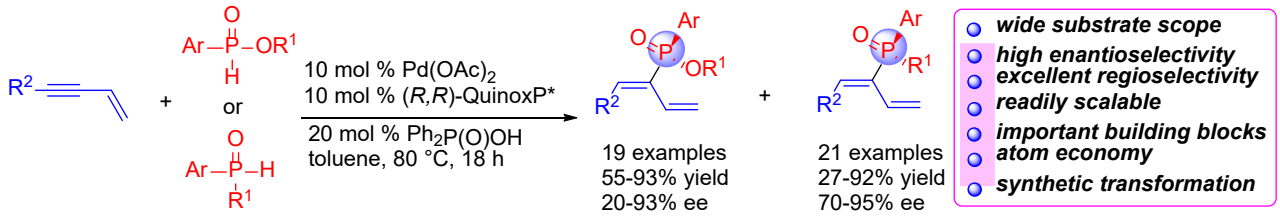
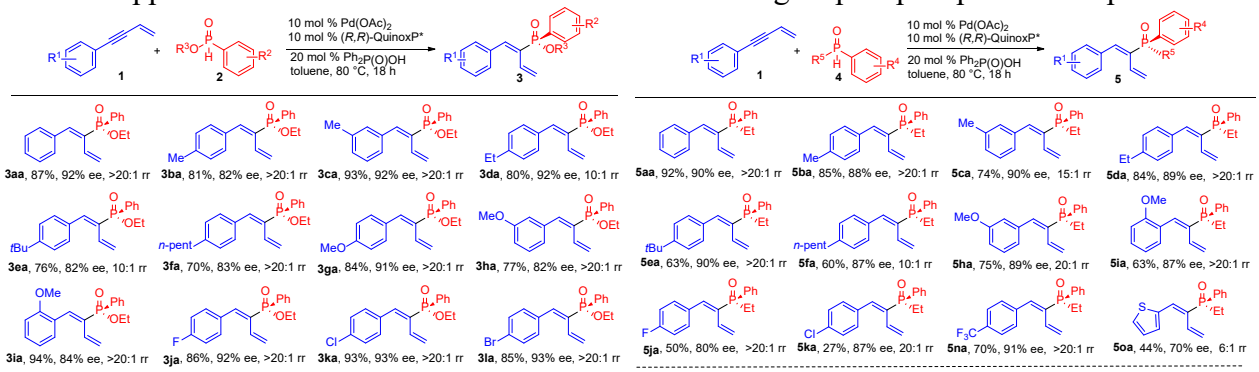
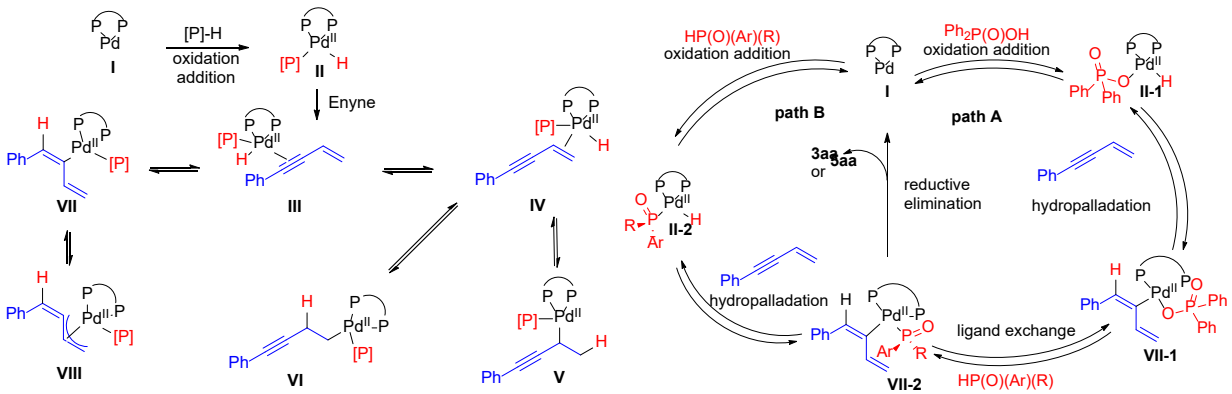
Jun (Joelle) Wang: junwang@hkbu.edu.hk; Yanxin Jiang: 20482531@life.hkbu.edu.hk



Abstract: The chemo-, regio-, and enantio-controlled synthesis of P-chiral phosphines in a general and efficient manner remains a significant synthetic challenge. In this study, a Pd-catalyzed hydrofunctionalization is developed for the highly selective synthesis of P-stereogenic alkenylphosphinates and alkenylphosphine oxides via conjugate addition of enynes. Notably, this methodology is suitable for both phosphine oxide and phosphinate nucleophiles, providing a versatile approach for the construction of diverse P-chiral organophosphosphorus compounds.





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Studies toward total synthesis of natural products of Miliusanes family

Bo WANG, Chi-Sing Lee*

Abstract

Miliusane monomers and the associated dimers are cytotoxic compounds isolated from Miliusa sinensis Finet and Gagnep.[1] Recent studies have shown that they have anti-inflammatory, antitumor, and antifibrotic activities.[2] Structurally, they are a cluster of compounds composed of a C-18 carbon skeleton including two substructural classes, One possesses a γ-lactone spiro-ring system and the other contains a tetrahydrofuran ring system. The synthesis of such molecules is extremely challenging because the whole molecule is spatially crowded due to the chiral center of the quaternary carbon and the chirality of the side chains. Our effort is concerned on the study of the total synthesis of this family of natural products.

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New structures for ratiometric luminescence analysis of urate/catecholates

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Abstract

New structures have been synthesized for Eu/Tb ratiometric analysis of urate and ascorbate, in vitro. Based on previous work, [1-2] it has been noted that species such as urate (0.59 V, pKa 5.49), **1**, ascorbate ($E_{1/2}$ = 0.30 V (for the one electron process), 298 K, pH 7; pKa 4.2), **2**, and certain aromatic phenols, like catecholates, are able to deactivate the triplet excited state of the sensitising moiety in certain lanthanide complexes, leading to a reduction in both the emission lifetime and intensity. This dynamic quenching process involves the formation of an excited state complex (exciplex) between the ligand triplet excited state and these electron-rich substances. In addition, terbium complexes were observed to be more sensitive to this excited state quenching than their Eu analogues, consistent with the higher energy of the Tb $^5D_4$ excited state compared to Eu $^5D_0$ (22,400 vs 17,200 cm $^{-1}$). [3] Thus, the ratio of the red (Eu, 620 nm) to green (Tb, 545 nm) luminescence intensity has been measured *in vitro* for samples of varying urate concentration using mixtures of the Tb and Eu complexes of a common ligand structure.

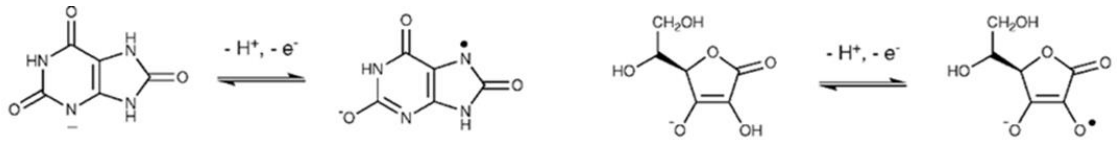

Figure The structures of urate and ascorbate.

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Chemical Synthesis of Isorhamnetin Derivatives Towards Parkinson's Disease

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Abstract

Parkinson's Disease (PD) features the accumulation of pathological protein aggregate and the dysfunction of autophagy to eliminate them.[1] Accumulating evidence has indicated that transcription factor EB (TFEB) has been discovered as a master regulator of autophagy, while the long-term usage of known TFEB activators can harm cell regulation by inhibiting mTOR 1, a regulator of cell growth.[1,2] Isorhamnetin has been proven to be an independent TFEB activator *in vitro*.

In this study, some isorhamnetin derivatives have been synthesized via the dimethyldioxirane (DMDO) oxidation pathway.[3] After the selective hydroxyl protection of benzyl, aldol condensation was conducted to form a chalcone structure, followed by cyclization in the presence of iodine.[4] An oxidation was performed by DMDO and deprotection of benzyl to afford the final flavonoids. Their biological profiles under PD pathological conditions, *in vitro* and *in vivo* will be studied. These compounds shall give a clearer picture of drug optimization of isorhamnetin towards PD.

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Efforts towards the Total Synthesis of Picrotoxane family

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Abstract:

Picrotoxinin was isolated from the poisonous plant *Anamirta cocculus* in 1812.[1] It has been identified as an inhibit of the chloride channel $GABA_A$ receptor as a non-competitive antagonist.[3,4] Picrotoxinin contains cis-fused hydrindane core with 8 continous chiral center also with 2 γ-lactone ring and an epoxide. To date, five group have published the total synthesis of (-)-picrotoxinin.

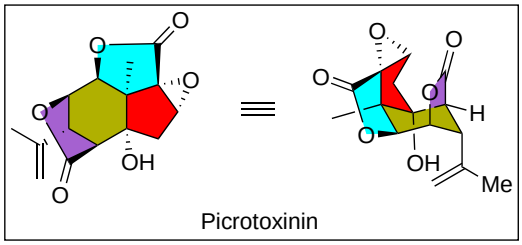

Figure 1: Structure of Picrotoxinin

A Lewis acid catalyzed cyclization had been well-developed[2] and we adopted as a key ring formation process for the obtention of the cis-fused hydrindane core skeleton, which is the key motif of the picrotoxane sesquiterpenoid. Then, cyclized the two γ-lactone rings in later stages is ongoing. Several efforts disclose the difficulties on the cyclization process and ring formation

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Thermally Activated Delayed Fluorescent Tetradentate Ligand-Containing Gold(III) Complexes with Preferential Molecular Orientation and Their Applications in Organic Light-Emitting Devices

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Abstract

A new class of thermally activated delayed fluorescent (TADF) pyridine-/pyrazine-containing tetradentate C^C^N^N gold(III) complexes has been designed and synthesized.[1] Displaying photoluminescence quantum yields (PLQYs) of up to 0.77 in solid-state thin films, these complexes showed an at-least six-fold increase in the radiative decay rate constants (k_r) in toluene upon increasing temperature from 210 to 360 K. Using variable-temperature (VT) ultrafast transient absorption (TA) spectroscopy, the reverse intersystem crossing (RISC) processes were directly observed and the activation parameters were determined, in line with the results from the Boltzmann two-level model fittings, in which the energy separation values between the lowest-lying singlet excited state (S_1) and the lowest-lying triplet excited state (T_1), $\Delta E(S_1-T_1)$, of these complexes were estimated to be 0.16−0.18 eV. Through the strategic modification of the position of the electron-donating $-^t$Bu substituent in the cyclometalating ligand, the permanent dipole moments (PDMs) of these tetradentate gold(III) emitters could be manipulated to enhance their horizontal alignment in the emitting layer of organic light-emitting devices (OLEDs). Consequently, the resulting vacuum-deposited OLEDs demonstrated an increase by 30 % in the theoretical out-coupling efficiencies (η_{out}), as well as promising electroluminescence (EL) performance with maximum external quantum efficiencies (EQEs) of up to 15.7 %.

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Bi(III) complexes activate non-potent antibiotics against *P. aeruginosa*

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P. aeruginosa intrinsically resistance to many clinically important antibiotics. Eg: macrolides and tetracyclines. Limited antibiotics work on carbapenem resistance *P. aeruginosa*, as a result it was listed as top priority in WHO list of "priority pathogens" for R&D of new antibiotics[1]. Fortunately, it was well known that Bi(III) complexes can have good synergy with some antibiotics against *P. aeruginosa*, eg: cefiderocol[2] and tobramycin[3]. However, the structure activity relationship remains unknown so as the best Bi(III) complexes against *P. aeruginosa*.

We synthesized more than 70 Bi(III) complexes with various binding motifs. We found that Bi-thiolate eg: $Bi(NAC)_3$, Bi-carboxylate eg: Bi-NTA and Bi-pyridine eg: $Bi\text{-}CF_3$ have a FIC <0.25 for the fluoroquinolones, macrolides and tetracyclines which are much better than others types of Bi(III) complexes and other antibiotics in PAO1.
Macrolides and tetracyclines are originally not potent against *P. aeruginosa*, however, with the assistance of 16μM of $Bi\text{-}NH_2$ or $Bi\text{-}CF_3$, it can activate them into antibiotics that is comparable to aztreonam and ceftazidime, which are the current antibiotics used to treat multi-resistance *P. aeruginosa* in PAO1. With the addition of $Bi\text{-}CF_3$ and $Bi\text{-}NH_2$, the MICs of azithromycin dropped from ≥256μM to 4μM and 0.5μM, respectively. A similar trend also observed in tetracyclines antibiotics such as the MICs of eravacycline dropped from 8μM to ≤0.0625μM for both Bi(III) complexes.
With the addition of Bi(III) complexes, it is possible to turn non-potent tetracyclines and macrolides into potent antibiotics, which open a new method to treat multi-drug resistance *P. aeruginosa*.

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Rhenium-catalysed Ring Opening Alkyne Metathesis Polymerisation (ROAMP)

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Abstract

Alkyne metathesis polymerizations generally employ air-sensitive catalysts which lead to laborious glovebox chemistry setups. To surmount this obstacle, an air stable catalyst that could be used routinely as Grubbs-type catalysts is needed. Here, we present our preliminary results which demonstrate the feasibility of a Ring Opening Alkyne Metathesis Polymerisation (ROAMP) catalysed by air stable Re(V) catalyst.

Thermo-Responsive Platinum(II) 2,6-Di(pyrid-2-yl)pyrazine Complexes with Unusual Aggregation Behaviour upon Heating

Tracy Ho-Ying Chan, Ming-Yi Leung, Michael Ho-Yeung Chan, Wai Kit Tang, Eric Ka-Ho Wong, Vivian Wing-Wah Yam*

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Abstract

A series of alkynylplatinum(II) complexes with 2,6-di(pyrid-2-yl)pyrazine ligand has been synthesized and characterized by ^{1}H NMR spectroscopy, HR-ESI mass spectrometry, elemental analysis and X-ray crystallography, and their photophysical properties have also been investigated. Interestingly, three of the complexes have been found to exhibit drastic colour changes upon increasing temperature. Transmission electron microscopy (TEM) and variable-temperature ^{1}H NMR spectroscopy suggest the association of such colour change with a thermo-responsive morphological transformation behaviour from rods at room temperature to ring-like aggregates at high temperature. The ring-like aggregates are formed via the domination of π–π and Pt···Pt interactions due to the disruption of hydrogen bonding at high temperature as suggested by solution-state fourier transform infrared (FT-IR) spectroscopy together with computational studies. This unusual morphological transformation is rarely observed, as it represents a stark contrast to the deaggregation behaviour of other typical platinum(II) complexes and organic compounds upon increasing temperature.

The Synthesis of Oxetan-2-yl and Azetidin-2-yl Enolsilanes and Their (4+3) Cycloaddition Reactions

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Abstract

The oxetane plays an important role in medicinal and synthetic chemistry and they are Oxetanes and azetidines play the important role in medicinal and synthetic chemistry, and they are isosteres of some functional groups in many medical drugs. However, comparing to their corresponding three membered rings, methods to synthesize the four-membered ones are quite limited, especially for the oxetanes. Thus, the synthesis of oxetanes and azetidines and the exploration of their applications in synthetic chemistry needs further exploration and study.

Here we report some methods on synthesis of 2-acyl oxetanes and azetidines, and they were then converted to the corresponding enolsilanes. These enolsilanes were induced to undergo (4+3) cycloadditions to generate seven-membered carbocycles. Both types of enolsilanes reacted with good yields in intermolecular (4+3) cycloadditions, which underscored that oxetanes were reactive enough to participate in these ring-opening cycloadditions.

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Post-Translational Modification of Proteins through Electrochemical Phosphorylation

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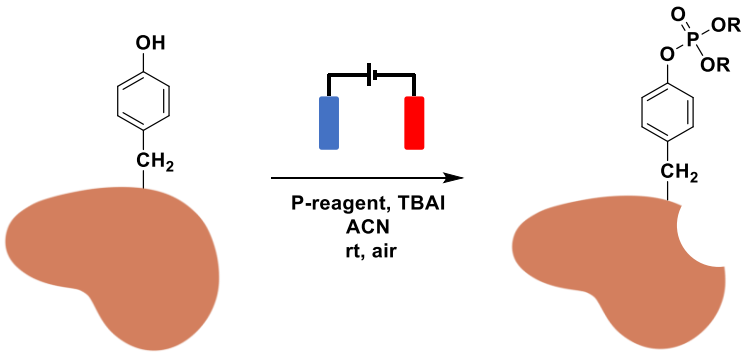
Abstract

Protein phosphorylation is one of the most important post-translational modifications (PTM) that directs phosphate groups to amino acid residues on proteins. The phosphorylated proteins provide essential cellular signalling process in living organisms, such as protein synthesis, metabolism, cell division, signal transduction, cell growth and development.[1,2] In this poster, we demonstrate that electrochemical phosphorylation of specific amino acids (tyrosine, serine, threonine) and peptide can be performed in the environmentally-friendly condition without the addition of a chemical oxidant. We envision to artificially activate the targeted protein that mimic cellular process by electrochemical catalysis.



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Two-Component Co-Assembly of Platinum(II) Complexes and Block Copolymers

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Abstract

The co-assembly of anionic alkynylplatinum(II) terpyridine (tpy) or bis(benzimidazol-2-yl)pyridine (bzimpy) complexes with poly(ethylene glycol)-*b*-poly(2-(dimethylamino)ethyl methracrylate) (PEG-*b*-PDMAEMA) diblock copolymers in aqueous solution has been studied. The electrostatic interaction between platinum(II) complexes and the PDMAEMA block of PEG-*b*-PDMAEMA brings the platinum(II) complexes into close proximity. The Pt···Pt and/or π–π stacking interactions favour directional stacking and growth of the platinum(II) complexes in the aggregates, resulting in anisotropic supramolecular nanostructures, together with observable changes in the spectroscopic and luminescence properties. The morphology of the nanostructures can be modulated by varying the composition and incubation condition of the system, such as structural parameters of polymers and complexes, as well as complex/polymer feed ratios. This work demonstrates the potential of multi-component co-assembly as a plausible strategy for the preparation of programmable supramolecular nanostructures.

[13]-Graphanyl-X: Expanding the 3D Saturate Chemical Space

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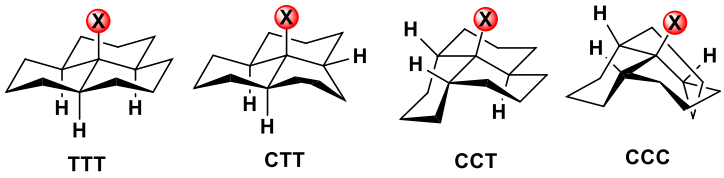
Abstract

[13]Graphanyl-X is a hydrocarbon scaffold consisting of three fused cyclohexane rings with functionalization on the central carbon. There are four possible stereoisomers depending on the relationship between the central C-X bond and the three vicinal C-H bonds (*trans-trans-trans*, *cis-trans-trans*, *cis-cis-trans* and *cis-cis-cis*). They feature hydrophobicity, conformational rigidity, and the all-*trans* isomer has C_3 symmetry, negative electron affinity and a hydrogen terminated surface. Possible applications of this class of saturated hydrocarbon include drug discovery,[1] metal organic frameworks[2] and nanoelectronics.[3] We envisage a new scalable synthetic route that would enable us to access these isomers of [13]-graphanyl-OH. Using modern radical catalysis pioneered by Macmillan,[4] we aim to derivatize the central carbon in order to access functional groups as handles for further derivatization or as an add-on to existing molecules.



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Benzo[*b*]Germole-Fused Diarylethenes as Photochromic Organogermanium Compounds

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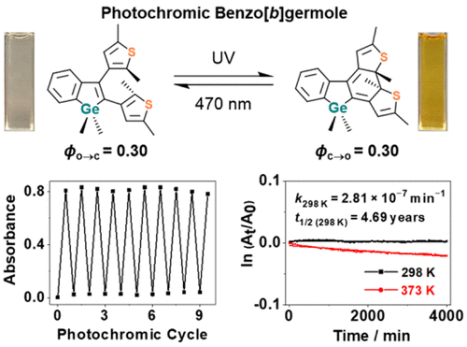
Abstract

The molecular design of various heterocycles incorporated into photochromic diarylethenes plays an important role in diversifying functionality. Herein, we report the design, synthesis, and structural characterization of photochromic benzo[*b*]germole-fused diarylethenes. Photochromic behaviors including clean conversion between the open and the photogenerated closed forms under ambient conditions over multiple photoswitching cycles with insignificant loss of photochemical reactivity, thermal irreversibility with negligible backward reaction of the photogenerated closed form back to the open form even at 100 °C, and satisfactory and comparable photochromic quantum yields for the forward and backward photoswitching processes are observed. This work demonstrates the employment of a rarely explored germole ring with weak aromaticity as a versatile building block for the ethene bridge of the photochromic diarylethene, which is the first of its kind to construct photochromic materials for potential applications, further expanding the diversity of the heterocycle-fused diarylethene-based system with interesting photocontrolled functions.[1]



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Supramolecular Assembly of Platinum(II) Complexes and Homocysteine Assisted by Platinum···Platinum and π–π Stacking Interactions: A Luminescence Sensor for Homocysteine

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Abstract

Thiol-containing amino acids play vital roles in physiological and pathological processes. Among them, homocysteine (Hcy) is an important biomarker of many disorders, including cardiovascular and Alzheimer's disease. Recent sensors for Hcy, which are based on nucleophilic addition reactions, suffer from low selectivity over other thiol-containing amino acids. In this work, platinum(II) terpyridine complexes incorporating α,β-unsaturated ketone have been synthesized for luminescence sensing of Hcy, which is realized by supramolecular co-assembly between the complex and Hcy with high selectivity. A recognition group with non-covalent binding ability to Hcy has been designed *via* the introduction of the pyridine to α,β-unsaturated ketone which not only can form hydrogen bond with Hcy but also increase the stability of the double bond. The binding-induced aggregation leads to the turning-on of emission of triplet metal–metal-to-ligand charge transfer (^{3}MMLCT) origin in the near-infrared (NIR) region upon addition of Hcy. The non-covalent interaction-based sensing mechanism can be confirmed by the presence of complexes after addition of Hcy. STEM-EDX mapping results suggest the supramolecular co-assembly of complex and Hcy. It is envisaged that this complex can be utilized as a valuable probe for clinical application.

Kinetics and Thermodynamic Correlation of Conformational Changes of the Flexible Naphthocage

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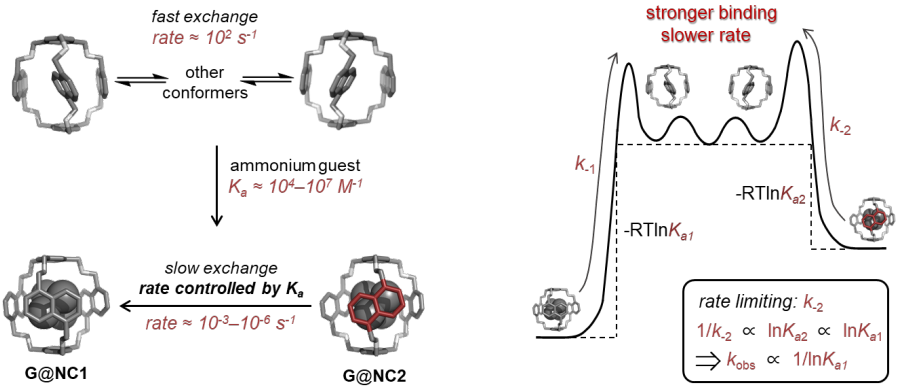
Although conformational changes are fundamental processes in many natural and synthetic systems, understanding the relationship between conformational thermodynamics and kinetics of host-guest binding is very limited because low-energy structural changes are usually difficult to monitor. Described in this work is a kinetic study of the conformational conversion of the inclusion complexes consisting of a flexible naphthocage host and quaternary ammonium guests featuring a relatively slow "guest dissociation-host conformational change-guest re-association" conformational exchange mechanism. The overall rate of the conformational change is found to be inversely correlated to the thermodynamic stability of the host-guest complexes, which is related to both the overall structure and local steric properties of the guests. Results from this work that bridges the kinetics and thermodynamics of molecular recognition to conformational changes are valuable for understanding of the kinetic contributions in guest binding and selectivity.



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A Switchable Pyrene-Functionalized [2]Catenane Host

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Abstract

This work describes the synthesis and photophysical properties of a stimuli-responsive tetrapyrene-functionalized [2]catenane. Co-conformation of the [2]catenane can be switched between the "unlocked" and "locked" states by cation binding.[1] Solvent polarity can also induce the stacking of the pyrenes in the unlocked states, and result in an intramolecular pyrene-pyrene excimer emission. The co-conformationally flexible [2]catenane may serve as a tweezer-like host to bind with aromatic guests.

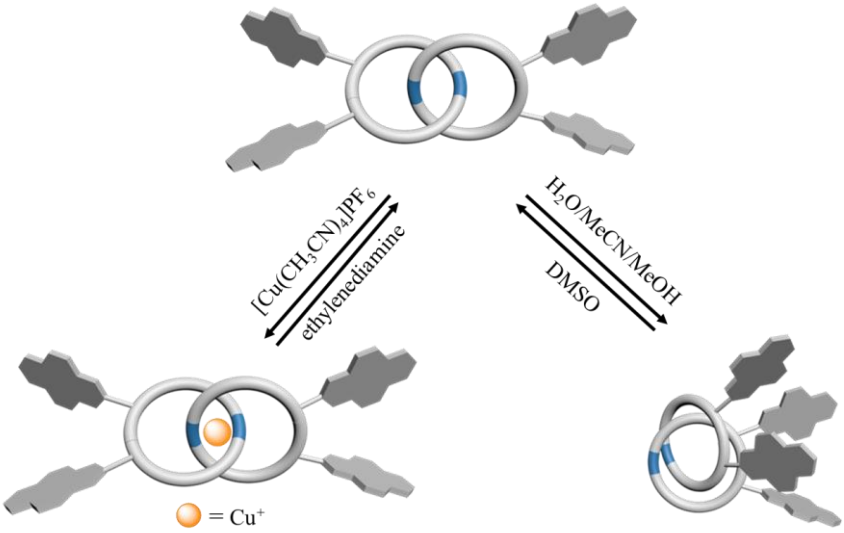

Fig 1. Tetrapyrene-functionalized [2]catenane responsive to cation binding and solvents.

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Supramolecular Co-Assembly of Luminescent Platinum(II) Complexes and Block Copolymers

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Abstract

Platinum(II) complexes have been known for their rich photophysical properties and intriguing supramolecular assembly. In recent years, two-component supramolecular co-assembly of cationic platinum(II) complexes and anionic polyelectrolyte-containing block copolymers has been studied. Cationic platinum(II) polypyridine complexes have been found to interact with the anionic poly(acrylic acid) (PAA) block of the diblock copolymers via electrostatic interaction to form water-soluble and crystalline core-shell nanofibers, which consist of a core with hexagonally packed columns of platinum(II) complexes and PAA blocks and a solvated shell of poly(ethylene glycol) (PEG) blocks. Herein, a series of isocyano platinum(II) complexes has been synthesized and their supramolecular co-assembly with PEG-*b*-PAA has been investigated. Drastic spectroscopic changes have been observed upon the supramolecular co-assembly of platinum(II) complexes and block copolymers, which is possibly directed by non-covalent metal–metal and/or π–π interactions. Results from electron microscopy revealed the formation of nanofibers and nanoribbons.

Tetradentate C^C^N^N Ligand-Containing Gold(III) Complexes with Orange to Deep-Red Thermally Activated Delayed Fluorescence (TADF) and Their Application in Organic Light-Emitting Devices

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Abstract

A new class of TADF tetradentate C^C^N^N ligand-containing gold(III) complexes containing acridinyl moieties has been designed and synthesized. These complexes exhibit orange-red to deep-red emission with photoluminescence quantum yields (PLQYs) of up to 0.76 in solid-state thin films. Short excited-state lifetimes of ≤ 2.0 μs and large radiative decay rate constants (k_r) in the order of 10^5 s^{-1} have also been found in the complexes. High-performance solution-processed and vacuum-deposited organic light-emitting devices (OLEDs) based on these complexes have been fabricated, demonstrating high maximum external quantum efficiencies (EQEs) of 12.2 and 12.7 %, respectively, which are among the best values ever reported for red-emitting gold(III)-based OLEDs. In addition, satisfactory operational half-lifetime (LT_{50}) values of up to 34,058 h have been attained in these red-emitting devices. It is found that the operational stability is strongly dependent on the choice of functional groups on the acridinyl moieties, of which the incorporation of −O− and −S− linkers can effectively prolong the LT_{50} value by an order of magnitude. The TADF properties of the complexes are substantiated by the hypsochromic shift in emission energies and the remarkable enhancement in the emission intensity upon increasing temperature. The TADF properties have also been supported by temperature-dependent ultrafast transient absorption studies, with the direct observation of reverse intersystem crossing (RISC) and the determination of the activation parameters for the very first time, together with their excited-state dynamics.

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Kwok, W.-K.; Li, L.-K.; Lai, S.-L.; Leung, M.-Y.; Tang, W. K.; Cheng, S.-C.; Tang, M.-C.; Cheung, W.-L.; Ko, C.-C.; Chan, M.-Y.; Yam, V. W.-W., *J. Am. Chem. Soc.* **2023**, *145*, 9584.

Bismuth(III) compounds eradicate *Burkholderia cepacia* and inhibit biofilm formation *via* disrupting redox balance

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Burkholderia cepacia complex (Bcc), often lurking in medical devices and intravenous solution, is a group of Gram-negative opportunistic bacteria with intrinsic resistance to common antibiotics and extremely possibly causes severe nosocomial infections in cystic fibrosis (CF) patients[1]. Previously, we have demonstrated that a metallodrug or metal complex can restore the activity of certain antibiotics[2,3]. Herein, we show that bismuth drugs could inhibit the growth of clinical antibiotic-resistant Bcc strains. The mode of antimicrobial action of bismuth(III) was investigated by home-made GE-ICP-MS and RNA-sequencing, enabling proteome-wide tracking of over 20 bismuth-binding targets and search of Bi(III)-induced differential expression of genes. This multiple-*omics* approach reveals that electron transport chain (ETC), NO detoxification, tricarboxylic acid cycle (TCA) and oxidative stress, were crucial in mode of action of Bi(III), which contributed together to result in bacterial death. Moreover, we surprisingly observed that bismuth in the combination with antibiotics exhibited excellent activity against notorious biofilm and persister cells. Our findings offer a new strategy for combating drug resistant Bcc infections via combination of bismuth drugs with antibiotics.

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Inter- and intramolecular (4+3) cycloadditions with epoxy allylsilanes as dienophiles

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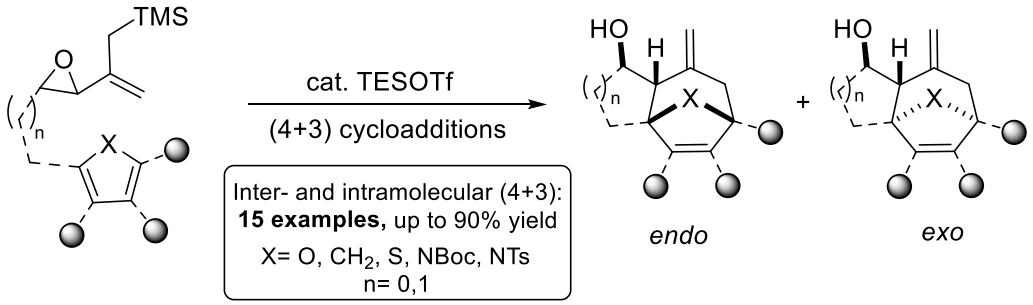
Abstract

The formation of methylenated bicyclic adducts was achieved by formal (4+3) cycloadditions of epoxy allylsilanes with different dienes. The epoxy allylsilane functions as a dienophile in the (4+3) cycloaddition reaction. The oxirane in the epoxy allylsilane, once activated by a Lewis acid, serves as a good dienophile while the allylsilane moiety completes the construction of the cycloadducts by desilylation of the (trimethylsilyl)methyl group. Epoxy allylsilane reacts with simple dienes in the presence of a catalytic amount of TESOTf results in the formation of intermolecular (4+3) cycloadducts with moderate yields. The epoxy allylsilane tethered to different dienes with TESOTf constructs cycloadducts with 6,7- and 5,7-fused bicyclic systems in excellent yields. Both *endo* and *exo* cycloadducts are formed in the cycloaddition reaction. The synthesis of the dienophile precursor and the inter- and intramolecular (4+3) cycloadditions of epoxy allylsilanes with different dienes to provide methylenated cycloheptanes are presented.



Variable-Temperature Emission Studies on Decanuclear Gold(I) Sulfido Clusters

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and Vivian Wing-Wah Yam*

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Abstract

Various gold complexes with intriguing structural and spectroscopic properties have been designed and synthesized based on intra- and intermolecular aurophilic interactions. The luminescence and structural properties of polynuclear gold(I) complexes have been found to be distinct from their mononuclear counterparts. Polynuclear gold(I) chalcogenido cluster has emerged as one of the popular research areas in gold chemistry in recent decades. With judicious molecular design of the peripheral phosphine ligands, polynuclear gold(I) chalcogenido clusters that show interesting properties such as cluster-to-cluster transformation, photoinduced isomerization, heterochiral self-sorting and stimuli-responsive properties have been reported. Herein, we report the synthesis, structural determination and luminescence properties of several decanuclear Au(I) sulfido clusters.

Evolution of Polynuclear Gold(I) Sulfido Complexes from Clusters and Cages to Macrocycles

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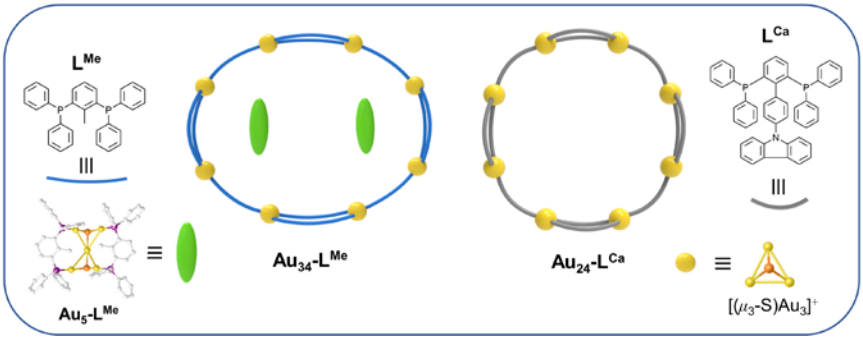
Abstract： Two unprecedented tetratriacontanuclear and tetraicosanuclear gold(I) sulfido clusters (denoted as **Au$_{34}$-L^{Me}** and **Au$_{24}$-L^{Cbz}**) with different temperature-induced stimuli-responsive behavior and emission property have been constructed by taking advantage of the judiciously designed bidentate phosphine ligand.[1] **Au$_{34}$-L^{Me}** represents the highest nuclearity of gold(I) sulfido cluster with more than a thousand atoms in the molecule. Octagonal macrocycles based on metal-cluster nodes have been assembled for the first time. The self-assembly and temperature-induced stimuli-responsive processes have been monitored by ^{1}H and ^{31}P{^{1}H} NMR spectroscopy, and the identities of the discrete gold(I) complexes have been established by single-crystal structural analysis and HR-ESI-MS data. The steric effects exerted by the substituents on the V-shaped 1,3-bis(diphenylphosphino)benzene ligand have been shown to govern the self-assembly from 1D cluster and 3D cage to 2D macrocycles. This work not only offers a new strategy to construct and regulate the structure of 2D macrocyclic gold(I) sulfido complexes but also lays the foundation for the future precise design and controlled construction of higher polygonal and cluster-node macrocycles.



Scheme 1. Rational design strategy of 2D polynuclear gold(I) sulfido macrocycles.

Reference：

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Mechanical achiral-chiral switching of a co-conformationally flexible [2]catenane

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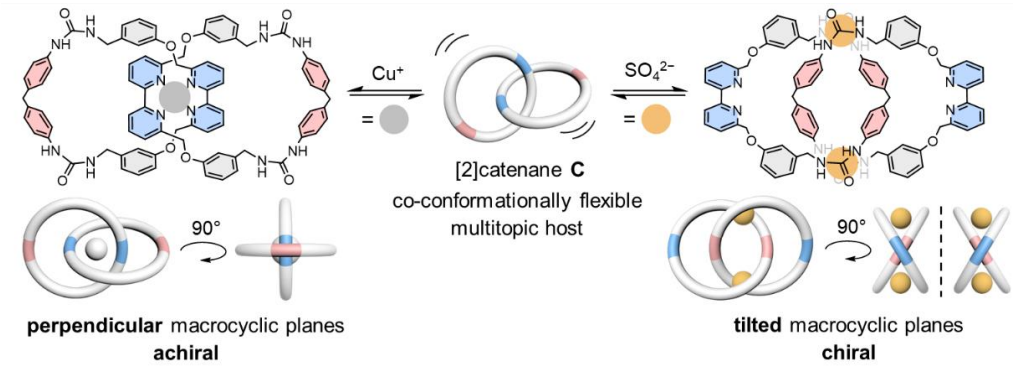
Abstract

The ability of catenane-based receptors to undergo large-amplitude structural adaptation via low-energy co-conformational motions represents a unique mechanism to achieve selective and strong guest binding.[1] In this work, a heteroditopic, co-conformationally flexible [2]catenane for selective copper(I) cation or sulfate anion binding is described. The interlocked macrocycles in the catenane host can freely rotate and flip, and as such can easily adjust its co-conformation to fit for the ionic guests of opposite charge, different geometry and binding stoichiometry. Binding of the copper(I) cation and sulfate anion is strong, and respectively induces an achiral and chiral co-conformation of the catenane host, thereby rendering this work as a rare example of reversible guest-controlled mechanostereochemical switching.[2]



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Design and Synthesis of Trinuclear Platinum(II) Complexes for Supramolecular Assemblies

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Abstract

A new class of C_3-symmetric trinuclear platinum(II) complexes has been successfully synthesized and characterized. Through variable-concentration UV–vis spectroscopy and dynamic light scattering (DLS) experiments, it is found that the platinum complexes show strong tendency to aggregate *via* Pt···Pt and π–π stacking interactions into supramolecular nanostructures, in which sheet-like aggregates could be observed in transmission electron microscopy (TEM) images. Furthermore, the polycrystalline X-ray diffraction (PXRD) pattern of **1** at 298 K displayed diffraction peaks with the ratio of the *d*-spacings in line with the diffraction rule of a 2D hexagonal lattice.

A Convergent, Modular Approach to Trifluoromethyl-Bearing 5-Membered Rings via Catalytic C(sp^3)–H Activation

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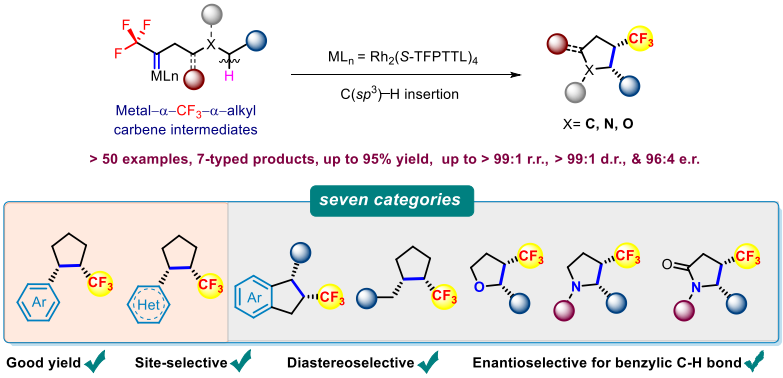
Abstract:

Trifluoromethyl-bearing 5-membered rings are prevalent in bioactive molecules, but modular approaches to these compounds by functionalization of robust C(sp^3)–H bonds in a direct and selective manner are extremely challenging.[1,2,3] Herein we report the rhodium-catalyzed α-CF_3-α-alkyl carbene insertion into C(sp^3)–H bonds of a broad range of substrates to access 7 types of CF_3-bearing saturated 5-membered carbo- and heterocycles. The reaction is particularly effective for benzylic C–H insertion exerting good site-, diastereo- and enantiocontrol.



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Three-Coordinated [2]Rotaxane Cu(I) Catalyst for Cross Dehydrogenative C-O Coupling

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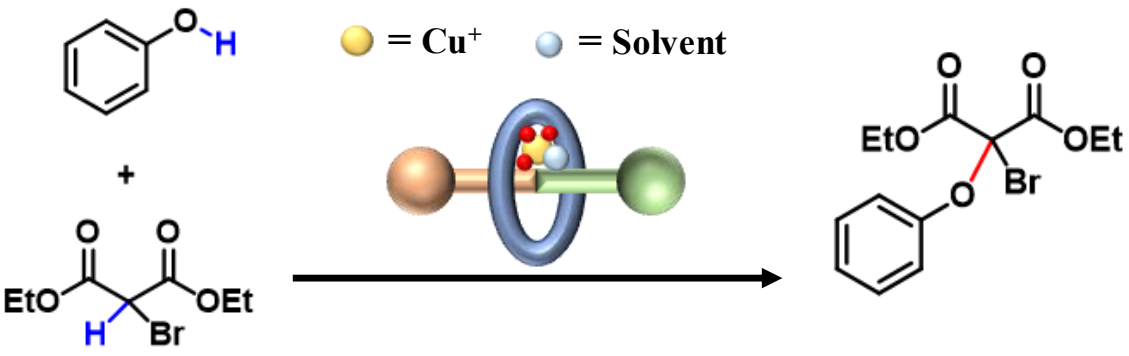
Catalytic activity of copper(I) complexes supported by rotaxane ligands towards a dehydrogenative C–O cross coupling is reported. By comparing the catalytic efficiency of 3-coordinated [2]rotaxanes obtained from active templated synthesis and our previously reported 4-coordinated [2]catenane, we found that unsaturated 3-coordinated [2]rotaxanes could catalyze the C–O cross coupling more efficiently at room temperature, but more susceptible to side reaction at higher temperature. Effects of the size of macrocycle and the distance of the stopper groups to the Cu(I) center in the 3-coordinated [2]rotaxanes were also investigated.



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Asymmetric Syntheses of Aziridine-2-carboxylates via Reductive Kinetic Resolution of 2*H*-Azirines

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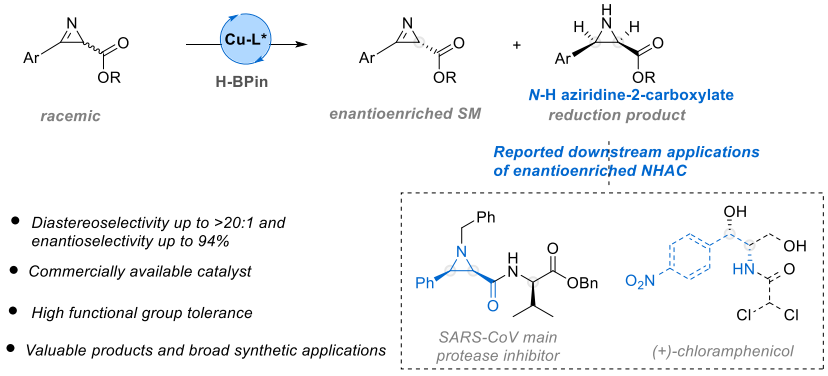
Abstract

Enantioenriched aziridine-2-carboxylates are valuable organic compounds not only for their presence in bioactive molecules but also for their versatile utilities as chiral building blocks. Extensive medicinal molecules are reported with aziridine-2-carboxylates as crucial synthetic intermediate, e.g. antibiotics (+)-thiamphenicol. However, traditional strategies access *N*-protected aziridines, which are poorly stable and undergo unwanted ring-opening. Herein, we present a novel methodology for *N*-H aziridine-2-carboxylates as they are more applicable building blocks and generally bench stable. As a result, high diastereoselectivity (>20:1) and enantioselectivity (up to 94%) of *N*-H aziridines are obtained from racemic 2*H*-azirines. Under the presence of commercially available copper catalysts, the kinetic resolution process could progress smoothly to produce aziridines with high functional group tolerance. Additionally, the merit of this strategy is demonstrated by the optimized synthesis SARS-CoV main protease inhibitor.[1]



Reference

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Holomycin Conjugates Mimic Sideromycins to Selectively Disrupt Bacterial Metal Homeostasis

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With the emergence of multidrug-resistant bacteria, antibiotics that target a single site are no longer effective in combating rapidly mutating bacterial strains. Compared to the traditional antimicrobial agents, holomycin exhibits potent broad-spectrum, multi-target inhibitory activity against bacteria[1]. As a type of prodrug, holomycin undergoes reduction within the cell and disrupts essential cellular processes by chelating zinc ions from zinc finger proteins[2]. Despite its potent antibacterial activity, the clinical development of holomycin and its analogues has been hindered by their attendant toxicity[1]. In this talk, inspired by the natural sideromycins sequestered exclusively by bacteria, a series of mono/bi-catechol-based siderophore conjugates were designed and synthesized (**Figure 1**) [3]. Our focus will be placed on the selection of the siderophores moiety and linking manners determining the selectivity between bacteria and mammalian cells, as well as the delivery efficacy, respectively.

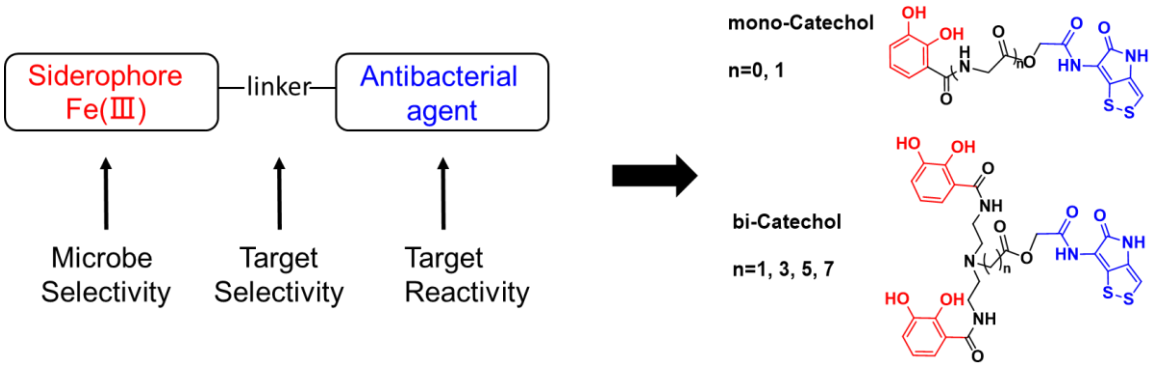

Fig 1. Schematic representation of generalized sideromycins (*left*) and designs of target compounds(*right*)

We thank the Research Grants Council (R7070-18, 17308921, 17318322, 2122-7S04) and the University of Hong Kong financial support.

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Extreme Potential Photocatalysis Enabled by Spin-Exchange Auger Processes in Magnetic-Doped Quantum Dots

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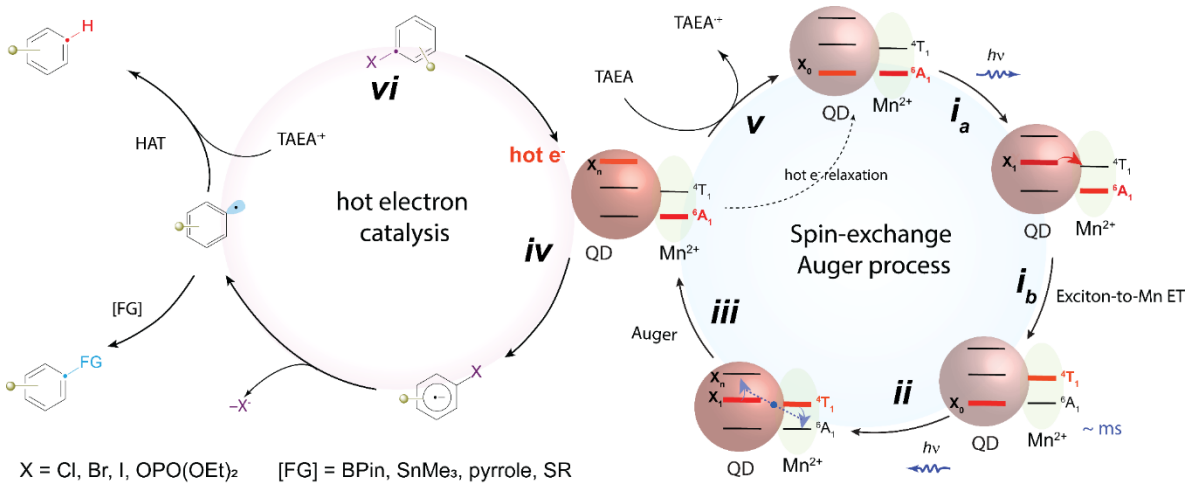
Abstract

Visible-light-absorbing semiconductor nanocrystals have shown great promise as photocatalysts for promoting photoredox chemistry. However, their utilization in organic synthesis remains considerably limited compared to small molecule photosensitizers. Recently, the generation of hot electrons from quantum-confined systems has emerged as a powerful means of photoreduction. However, the efficiency of hot electron generation heavily depends on high light intensity. In this study, we present an efficient hot-electron generation system facilitated by the spin-exchange Auger process in Mn^{2+}-doped CdS/ZnS quantum dots. These hot electrons can be effectively utilized in a wide range of organic reactions, such as reductive cleavage of C-Cl, C-Br, C-I, C-O, C-C, and N-S bonds. Notably, these reactions accommodate substrate reduction potentials as low as -3.4 V versus the saturated calomel electrode. Through two-photon excitation, we have achieved the generation of a "super" photoreductant using visible-light irradiation power that is only 1% of that previously reported for quantum dots. By modulating the intensity of light output, the spin-exchange Auger process enables the on/off generation of hot electrons, allowing for programmable assembly-point cross-coupling cascades. Our findings demonstrate the

unprecedented potential of quantum-confined semiconductors in facilitating challenging organic transformations that were previously unattainable with molecular photocatalysts. This study opens new avenues for the development of cost-effective, safe, and efficient photoredox organic synthesis using quantum dots.



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Examining the stabilising role of metal centre on inter-ligand delocalisation

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Abstract

Non-innocent ligands are a class of ligands that gains attention in organometallic chemistry in recent years, and many remarkable coordination complexes with multiple non-innocent ligands have been synthesised. These complexes admit special electronic configurations that could be rationalised by "inter-ligand delocalisation". In this work, we make use of the Principal Interacting Orbital analysis we developed to examine the role of metal centre in these cases. We found that the metal orbitals used in such kind of stabilisation can differ between early and late transition metals, and the geometry of the complex is also influenced by symmetry factors. These analyses not only complement the earlier understanding of "inter-ligand delocalisation", but also give hint to the controversial roles of p orbitals in coordination chemistry.

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Palladium-Catalyzed Asymmetric Carboamination of Olefins Enabled by SPHENOL-Derived Phosphoramidites

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Abstract

Asymmetric catalysis provides one of the most attractive access to enantioenriched molecules from achiral or racemic precursors. In this process, chiral catalysts serve as the source of chirality during the formation of stereogenic centers. Specifically, in transition metal catalysis, chiral ligands are a very crucial part of the catalyst complex, which provide control over the stereochemical course of bond formation, leading to enantioselectivity and/or diastereoselectivity. Among all the known ligands, phosphoramidites have evolved as a highly versatile family of chiral ligands that can induce chirality in many different types of asymmetric reactions in combination with various transition metals. The easy synthesis and modification as well as their good performance have greatly advanced asymmetric synthesis.

Recently our laboratory has reported a new chiral framework, SPHENOL, which featured combined advantages of BINOL and SPINOL and thus provided as a new platform for the development of chiral ligands and catalysts. Herein we would like to further demonstrate that SPHENOL-derived chiral phosphoramidites as superior ligands in palladium-catalyzed enantioselective coupling of *N*-allyl ureas with aryl bromides to afford 4-substituted imidazolidin-2-ones. Excellent enantioselectivity and chemical efficiency can be achieved. In contrast, the conventional BINOL- and SPINOL-derived counterparts were less effective in these reactions, further highlighting the potential of this new backbone. Details will be provided in due course.

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Synthesis, Structure and Reactivity of Cerium(IV) Complexes Containing Substituted Iodosylarene Ligands

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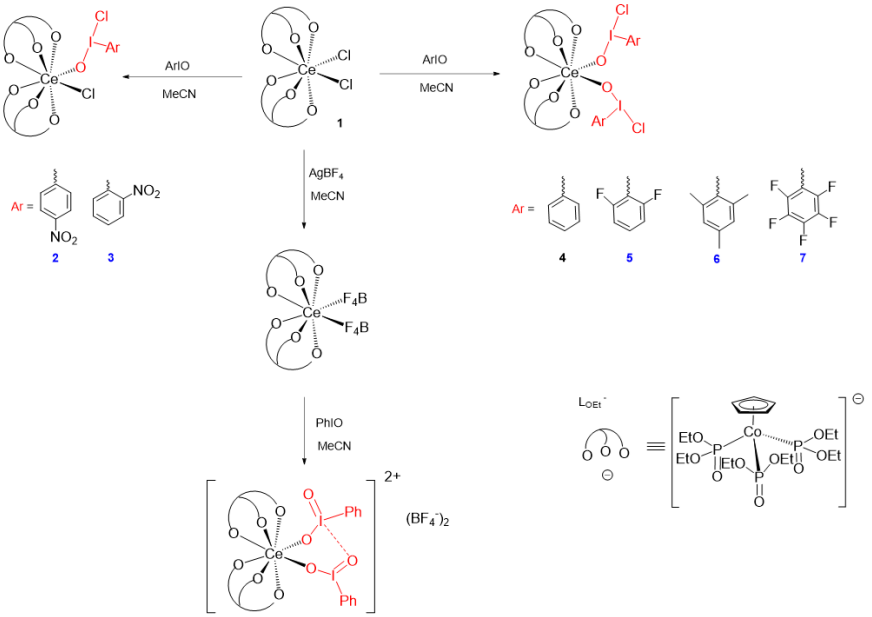
Abstract

Metal-iodosylbenzene complexes are of interest because they have been proposed as alternative active oxidants in metal-catalyzed oxidations with iodosylbenzene. While some transition metal iodosylarene adducts that are capable of oxidizing organic substrates have been isolated and structurally characterized, very few lanthanide complexes with iodosylarene ligands have been reported. In this work, we report the synthesis, structure, and reactivity of cerium(IV) iodosylarene adducts supported by Kläui's' tripodal ligand. The steric and electronic factors of the ArIO ligands on the stability and reactivity of Ce(IV) iodosylarene complexes have been studied.



Acknowledgment.

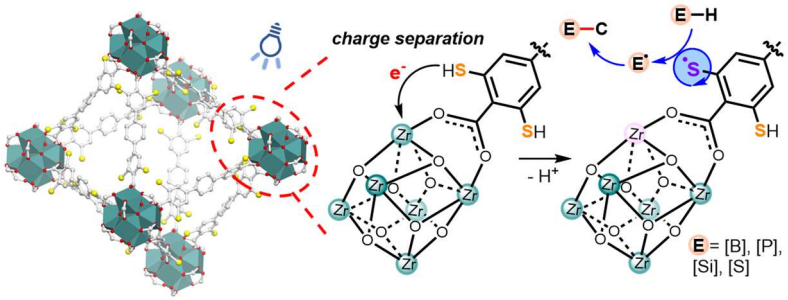
We thank the Hong Kong Research Grants Council for support (project no. 16301621 and 16301019).

Charge Separation in Metal-Organic Framework Enables Heterogeneous Thiol Catalysis

Shengxian Cheng,[†,‖] Jing Ouyang,[†,‖] Muqing Li,[‡] Yingxue Diao,[‡] Jiachen Yao,[†] Fengxing Li,[†] Yat-For Lee,[†] Herman Ho-Yung SUNG,[†] Ian Williams,[†] Zhengtao Xu,[§,*] and Yangjian Quan[†,*]

Abstract

Photoinduced metal-organic framework (MOF) enabled heterogeneous thiol catalysis has been achieved for the first time. MOF Zr-TPDCS-1, consisting of Zr_6-clusters and TPDCS linkers (TPDCS = 3,3'',5,5''-tetramercapto[1,1':4',1''-terphenyl]-4,4''-dicarboxylate), effectively catalyzed the borylation, silylation, phosphorylation, and thiolation of organic molecules. Upon irradiation, the fast electron transfer from TPDCS to Zr_6-cluster is believed to facilitate the formation of thiyl radical, a hydrogen atom transfer catalyst, which competently abstracts the hydrogen from borane, silane, phosphine, or thiol for generating the corresponding element radical to engender the chemical transformations. The elaborate control experiments evidenced the generation of thiyl radicals in MOF and illustrated a radical reaction pathway. The gram-scale reaction worked well, and the product was conveniently separated via centrifugation and vacuum with a TON of ~3880, highlighting the practical application potential of heterogeneous thiyl-radical catalysis.



Application of SPHENOL-based Bis(oxazoline) Ligands in Enantioselective Carbene Insertion into Si─H Bonds

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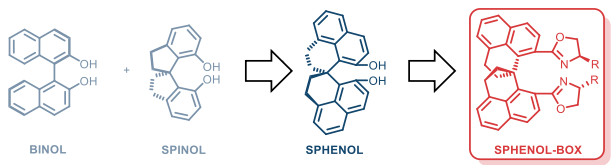
Abstract

Bis(oxazolines), commonly known as BOX, are a family of molecules with two oxazoline rings. Owing to the superior coordination ability combined with the well-positioned chirality of the oxazoline ring, they have served as privileged chiral ligands in organic synthesis. When grafted onto a chiral backbone, such as BINOL-, and SPINOL-type of chiral structures, their catalytic performance and asymmetric induction ability can be further enhanced, as demonstrated in many transitional-metal-catalyzed reactions.

SPHENOL is a new chiral backbone designed by our laboratory.[1] Owing to its unique structural rigidity, conjugation system, chirality and tunability, it integrates many advantages of the BINOL and SPINOL type of backbones and is expected to outperform these two predecessors in asymmetric synthesis. Based on this new backbone, herein we describe a new generation of BOX ligands, 9,9'-bis(2-oxazolyl)-2,2',3,3'-tetrahydro-1,1'-spirobi[phenalene] (SPHENOL-BOX). An efficient synthetic route has been designed for efficient access to such ligands. More importantly, as expected, these newly synthesized SPHENOL-BOX ligands exhibit improved catalytic performance in asymmetric carbene insertion of Si─H bonds, relative to the known BOX ligands.[2] Efficient reactivity and excellent enantioselectivity can be achieved with these new ligands. More details will be provided in due course.



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Mild Stereoselective Synthesis of Densely-Substituted [3]Dendralenes via Ru-Catalyzed Intermolecular Dimerization of 1,1-Disubstituted Allenes

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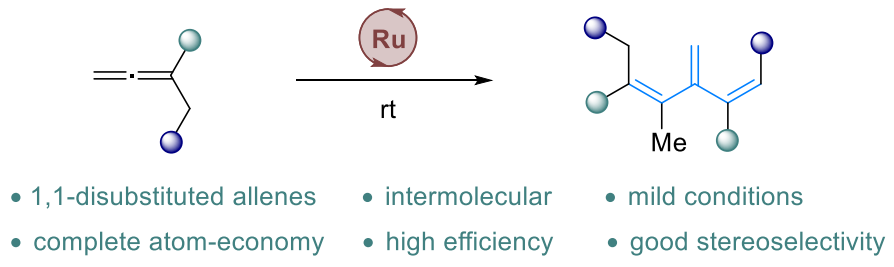
Abstract

Described here is a mild and stereoselective protocol for the synthesis of [3]dendralenes via intermolecular dimerization of allenes. With the proper choice of a ruthenium catalyst, a range of unactivated 1,1-disubstituted allenes, without pre-functionalization in the allylic position, reacted efficiently to provide rapid access to densely-substituted [3]dendralenes. An intermolecular C–C bond and three different types of C=C double bonds embedded in an acyclic structure were constructed with good to high *E/Z* stereocontrol. This is in contrast to the known catalytic protocols that focus on allenes with pre-functionalization at the allylic position and/or mono-substituted allenes, which would proceed by a different mechanism or require less stereocontrol. The silyl-substituted dendralene products are precursors to other useful dendralene molecules. DFT studies and control experiments supported a mechanism involving oxidative cyclometalation, *β*-H elimination (rate-determining step), and reductive elimination.



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Metal-Organic Framework Boosts Heterogeneous Electron Donor–Acceptor Catalysis

Jiaxin Lin,† Jing Ouyang,† Tianyu Liu, Fengxing Li, Herman Ho-Yung Sung, Ian Williams, Yangjian Quan*

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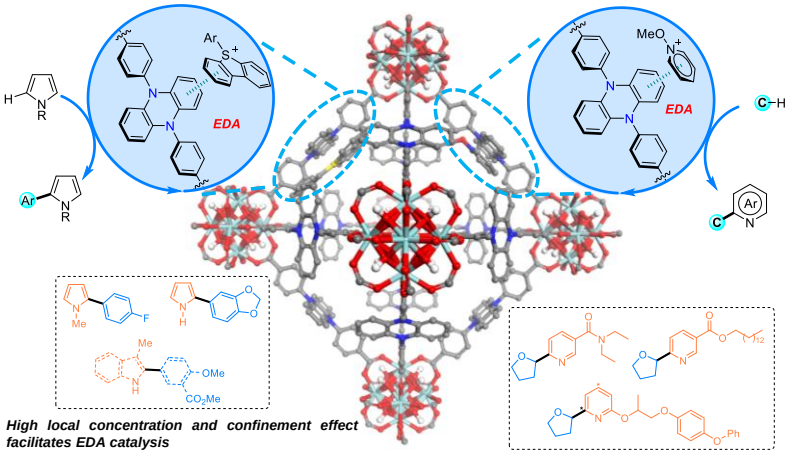
Abstract:

Metal-organic framework (MOF) is a class of porous materials, providing an excellent platform for engineering heterogeneous catalysis.[1] This research represents the **first** example of MOF-enabled heterogeneous EDA catalysis. More importantly, the high-local concentration of dihydrophenazine active centers and confinement effect in **Zr-PZDB** are discovered to promote the EDA interaction and related EDA catalysis, therefore resulting in superior catalytic performance over homogeneous counterparts. **Zr-PZDB** serves as the competent heterogeneous donor catalyst to interact with pyridinium or sulfonium salts for generating the photoactive EDA complex. Upon visible light irradiation, intra-complex single electron transfer triggers the formation of open-shell radical species and enables the coupling reactions.[2]



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Asymmetric Synthesis of Remotely Chiral Naphthols and Naphthylamines via Naphthoquinone Methides

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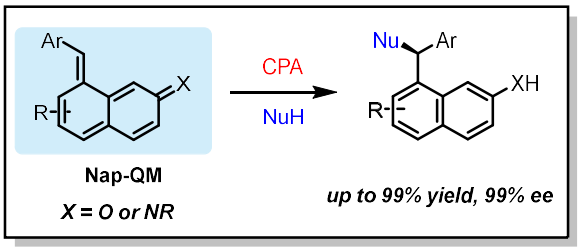
Abstract

Quinone methides are well-established intermediates in asymmetric synthesis.[1,2,3] In contrast, their extended analogues with the carbonyl and methide units distributed across two different rings have not been exploited in asymmetric synthesis. Herein we achieved the first asymmetric process involving such intermediates. Specifically, the use of suitable chiral phosphoric acids enabled in-situ generation of 2-naphthoquinone 8-methides and the corresponding aza counterparts for mild one-pot asymmetric nucleophilic addition. These processes provided rapid access to a wide range of previously less accessible remotely chiral naphthols and naphthylamines with both high efficiency and excellent enantioselectivity. Control experiment and DFT calculations provided important insights into the reaction mechanism, which likely involves two phosphoric acid molecules in the enantiodetermining transition states. This work serves as a proof-of-concept for the exploitation of a new type of extended quinone methides as versatile intermediates for asymmetric synthesis, thus providing a new platform for the efficient construction of remote benzylic stereogenic centers of aromatic compounds.



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Rapid Access to Divergent Fused Polycycles via One-pot A3 Coupling and Intramolecular Diels-Alder Reaction

Rajashekar Reddy Narra, Vignesh Gopalakrishnan Unnithan, Yifan Liu, and Zhihong Guo*

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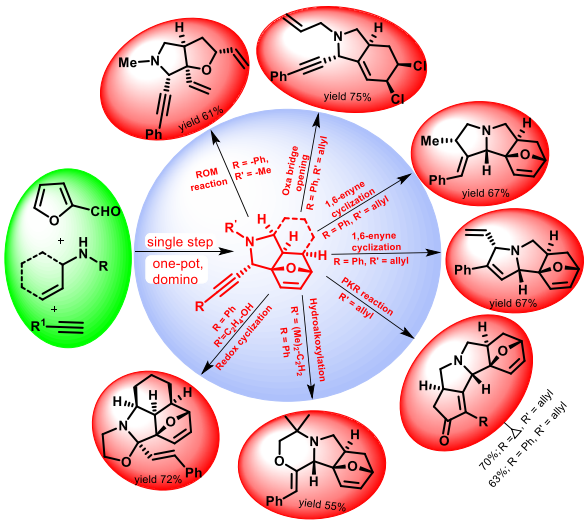
Heterocyclic or carbocyclic rings are important structural components of the pharmacophores in therapeutic agents.[1] They vary in size and shape and are often combined either by ring fusion or through a linker to form a vast range of ring systems. Among the top 100 ring systems in known drugs, many contain at least one aromatic ring and one heteroatom in fused rings;[2] whilst fused rings with mostly sp3-carbons, or fused three-dimensional (3D) rings, are scarce except the saturated polycyclic ring scaffolds of steroids and alkaloids, which are two major groups of medicinal natural products. We have developed divergent nitrogen-containing fused polycyclic ring systems constructed from simple starting materials via a one-pot aldehyde-alkyne-amine (A3) coupling and intramolecular Diels-Alder reaction. This domino reaction directly furnishes linear 5/5/5 and 5/5/6, or nonlinear 5/5/6/5, polycyclic rings containing an oxo-bridged 5/5 fused bicycle and a 1,6-enyne substructure.



Scheme 1. Rapid access to divergent fused polycycles via one-pot A3 coupling/IMDA

Acknowledgement

This work was supported in part by the General Research Fund GRF16301922 and the Collaborative Research Fund C6022-22WF from the Research Grants Council of the Hong Kong SAR Government.

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Synthesis and Structure of Lanthanum Complexes with Tripodal Tris(chalcogenoposphinic amide)amine Ligands

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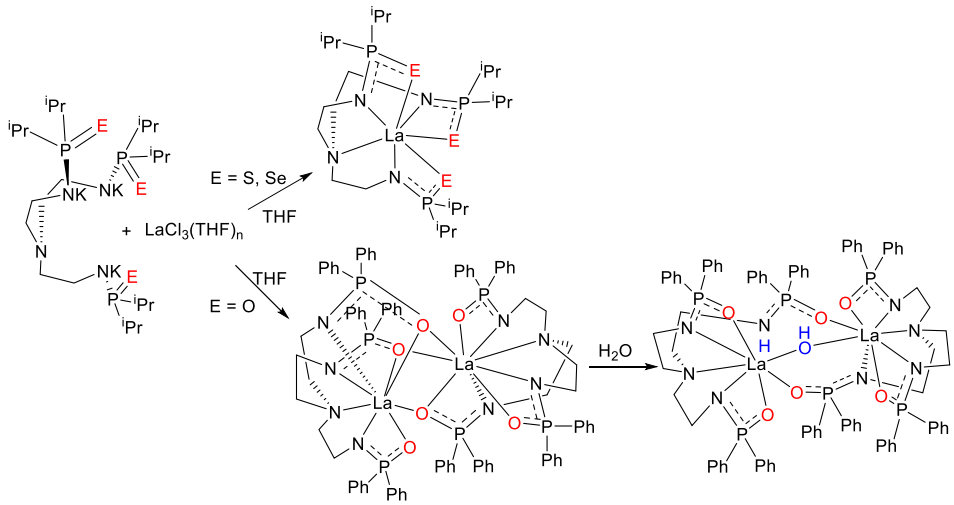
Abstract

Tripodal tris(phosphinic amide) ligands are of interest because of their ability to stabilize high-valent metal oxo/hydroxo species through intramolecular H-bonding. While transition metal (e.g., Mn, Fe) complexes with tris(phosphonic amide)amine ligands (poat) have been reported, analogous complexes with rare earth elements are unknown. Also, the coordination chemistry of related thio- and seleno-phosphinic amide ligands has not been explored. In this work, we describe the synthesis and structure of La(III) complexes containing tripodal tris(chalcogenophosphinic amide) ligands (L^E; E = O, S, Se).



Acknowledgment.
We thank the Hong Kong Research Grants Council for support (project no. 16301621 and 16301019).

Understanding the Organometallic Step: SO2 Insertion into Bi(III)-C(Ph) Bond

Hok Tsun Chan, Tilong Yang* and Zhenyang Lin*

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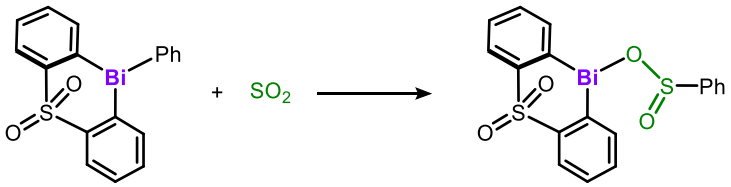
Abstract

Heavier main-group element-catalyzed reactions provide an increasingly attractive tool to perform transformations mimicking the behaviors of transition metal catalysts. Recently, Magre and Cornella[1] reported a Bi-catalyzed synthesis of aryl sulfonyl fluorides, which involves a fundamental organometallic step of SO_2 insertion into the Bi-Ph bond. Our theoretical studies reveal that i) the ability of hypervalent coordination of the Bi(III) center allows facile coordination sphere expansion for the SO_2 coordination via one oxygen atom; and ii) the high polarity of the Bi-Ph bond makes the Ph migration from the Bi(III) center feasible. These features enable the heavier main group element to resemble the transition metal having flexibility for ligand association and dissociation. Furthermore, iii) the available π electron pair of the migrating Ph group stabilizes the SO_2 insertion transition state by maintaining interaction with the Bi(III) center during migration. The insight helps us better understand the heavier main-group catalysis.[2]



Structure and Bonding Analysis

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“Boron walking” for remote borylation

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Abstract

Remote functionalization of alkenes, typically achieved through progressive, orientational olefin isomerization, has long relied on transition metal catalysis[1,2]. Transition metal catalyst is deemed crucial. In this work, we present a pioneering approach that employs a borenium ion as a catalyst for site-selective, remote borylation, eliminating the need for metal catalysts. As the reaction progresses, borylation isomers at different positions emerge, gradually and ultimately converging into the predominant α-borylation product. This process is akin to a “walking” of boron moiety along a carbon skeleton toward an aryl terminus. Detailed mechanistic studies and DFT calculations substantiate the borenium-catalyzed, stepwise migration via a reversible B-H insertion/elimination sequence. This remote borylation exhibits good functional group compatibility, complementing those methods reliant on transition metals. Furthermore, this metal-free protocol permits the convenient synthesis of silyl-remote-boryl compounds, demonstrating an opposite regioselectivity to that observed in transition metal catalyzed tandem silylation-borylation reactions.

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C,O-Chelated BINOL/Gold(III) Complexes as Efficient Catalysts for Enantioselective Carboalkoxylation of Ethynylbenzaldehydes

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Abstract

Gold catalysis has been developed for a wide range of organic transformations with selective functionalization of C-C multiple bonds in the past decades. With gold(I) and gold(III) as the common oxidation states, numerous chiral gold(I) complexes have been designed for asymmetric catalysis, while gold(III) catalysis remains largely unexplored. We have previously developed a series of novel C,O-chelated BINOL/cyclometallated gold(III) complexes and chiral O,O'-chelated 4,4'-biphenol cyclometallated oxazoline gold(III) complexes achieving high enantioselectivity (up to 90% ee) in asymmetric carboalkoxylation of alkynes.[1-2] Here we present a new class of C,O-chelated chiral oxazoline-based C^N-cyclometalated gold(III) complexes with an easily accessible synthetic pathway. The chiral C,O-chelated BINOL/gold(III) complexes were synthesized from racemic C^N-cyclometalated dichloride gold(III) complexes and were easily isolated by simple filtration. The new synthetic approach overcomes the limitations of using expensive chiral source and chiral HPLC separation. These complexes catalyze carboalkoxylation of alkynes with excellent enantioselectivity of up to 99% ee.

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Tailoring Multicontrolled Supramolecular Assemblies of Stiff-Stilbene Amphiphiles into Macroscopic Soft Scaffolds as Cell-Material Interfaces

Leong-Hung Cheung[1], Jeffery C. To[1+], Wai-Ki Wong[1+], Marc C. A. Stuart[2], Takashi Kajitani[3], Vincent W. Keng[1]*, and Franco King-Chi Leung[1]*

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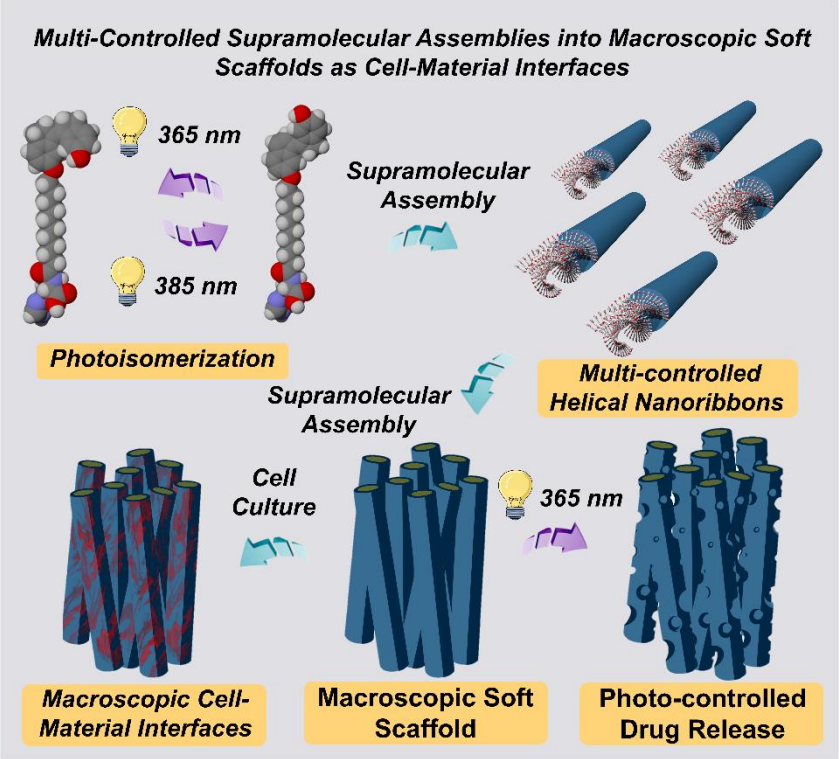
Abstract

Biocompatible synthetic supramolecular systems have shed light on biomedical and tissue regenerative material applications. The intrinsic functional applicability, tunability, and stimuli-responsiveness of synthetic supramolecular systems allow to develop various multi-controlled supramolecular assemblies in aqueous media. However, it remains highly challenging to use state-of-the-art supramolecular assemblies of photoresponsive amphiphiles controlled by multiple stimulations, in fabricating macroscopic materials. Herein, we demonstrate a stiff-stilbene amphiphile (SA) multi-controlled supramolecular assembling system which is comprised of two different charged end groups.[1] The good photoswitchabilities of SA in both organic and aqueous media are demonstrated. Furthermore, the multi-stimulus, *i.e.*, light, pH and counterions are applied to control the supramolecular assembling behaviors, which are monitored by circular dichroism spectroscopy and electron microscopies. This multi-controlled supramolecular system can be systematically assembled into macroscopic soft functional scaffolds of which the structural parameters are investigated by electron microscopies and X-ray diffraction techniques, suggesting large aspect-ratio of SA nanostructures assembled into macroscopic soft scaffolds. The fabricated soft functional scaffold is highly

biocompatible for photocontrolled biotarget encapsulation/release selectively, as well as a cell-material interface for diverse cells attachment. This new synthetic multi-controlled



soft functional material provides a new strategy towards development of next-generation controllable and biocompatible soft functional materials.

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Regio- and Chemoselective Palladium-Catalyzed Additive-Free Direct C–H functionalization of Heterocycles with Chloroaryl Triflates Using Pyrazole-Alkyl Phosphine Ligands

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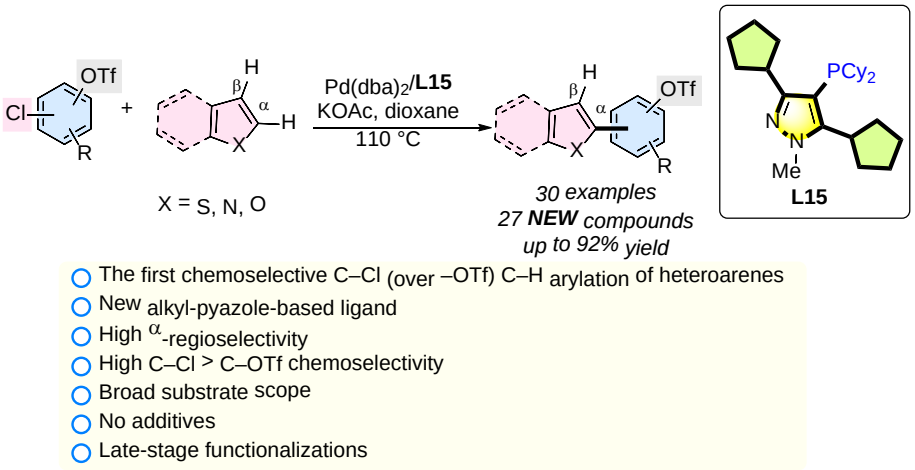
We report a new series of pyrazole-alkyl-phosphine ligands with varying cycloalkyl ring sizes that facilitate additive-free, regio- and chemoselective C–H arylation of heterocycles under relatively mild conditions (Scheme 1).[1] These ligands demonstrate excellent α/β selectivity for various heterocycles, including benzo[b]thiophene, thiophene, furan, benzofuran, and thiazole. Furthermore, they exhibit unprecedented chemoselectivity for C–Cl over C–OTf in chloroaryl triflates. Mechanistic studies, underpinned by both experimental findings and DFT calculations, reveal that pyrazole phosphine ligands with optimal ring sizes lower the energy barrier of the reaction proceeding via a CMD pathway.



Scheme 1 Pd-catalyzed regio- and chemoselective C–H arylation

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Precise Spatial Arrangement of Single Atom and Cluster in Covalent Organic Frameworks Achieves Tandem Oxygen Reduction

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Abstract

Transition-metal single atom catalysts (SACs) have been regarded as promising substitutes for Pt-based catalysts in oxygen reduction reaction (ORR) due to their excellent catalytic performance, unique structure, and high atom utilization.[1] However, the discrete nature of individual sites in SAC makes it prone to aggregation and insufficient to capture high concentrations of reactants/intermediates during electrocatalytic processes, thus dramatically reducing intrinsic activity/selectivity. Herein, we demonstrate, using covalent organic frameworks (COFs), the precise control of metal single atom sites as well as the size and position of metal clusters.[2] The Ni single atom on COF (Ni-COF) demonstrates favorable $2e^-$ selectivity under alkaline conditions, showing around 90% HO_2^- yield. Incorporating Cu clusters in the Ni-COF improves catalytic activity and switched on $4e^-$ selectivity. Cu clusters convert H_2O_2 produced by Ni SACs to H_2O, serving as a secondary active site in a tandem ORR system. This study provides a good example of coupling and interaction between single atoms and clusters, achieving enhanced activity and selectivity transformation.

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Palladium-Catalyzed Chemoselective Phosphorylation of Poly(pseudo)halides: A Route for Organophosphorus Synthesis

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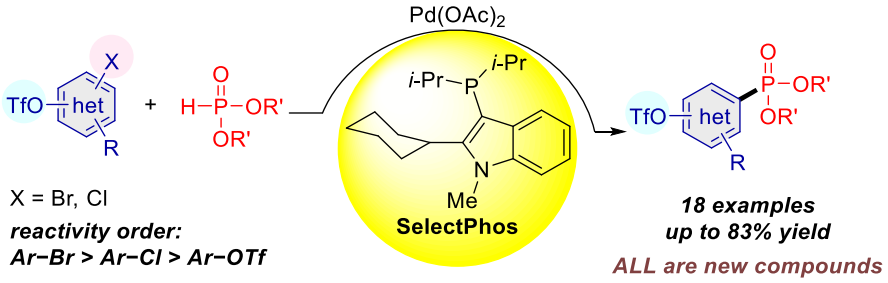
Abstract

We present an advancement in synthesizing organophosphorus compounds via chemoselective phosphorylation achieved by palladium and SelectPhos ligand system (Pd/**SelectPhos**). This catalysis system exhibits remarkable chemoselectivity, even in poly(pseudo)halide substrates and overcoming toxicity and substrate scope limitations. The catalytic system is robust, demonstrated across diverse substrates such as chloroaryl and bromoaryl triflates. Furthermore, we present a one-pot sequential strategy combining phosphorylation with Suzuki−Miyaura coupling, providing a versatile platform for efficient synthesis of complex organophosphorus compounds, challenging conventional reactivity paradigms.[1]



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Red-light-controlled supramolecular assemblies of indigo amphiphiles at multiple length scales

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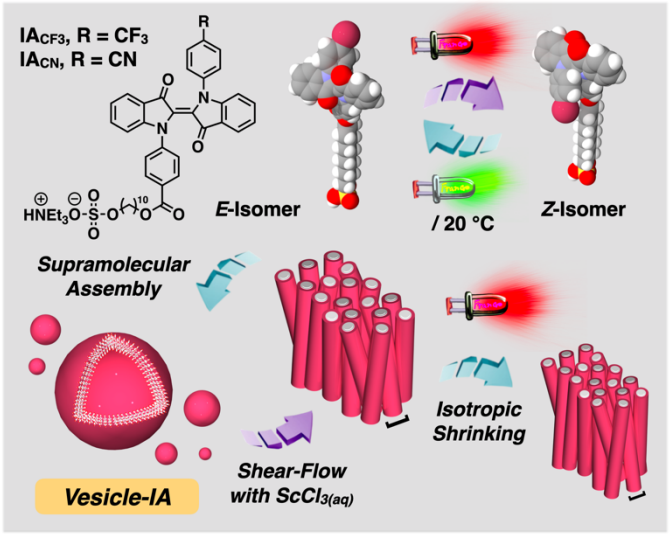
Abstract

Amphiphilic molecules featured with photoresponsive motif have attractive prospects for applications in smart bio-material owing to the controllable functionality of self-assembled supramolecular structures in aqueous media by light stimulation. However, most of reported photoresponsive amphiphiles are triggered by bio-damaging UV-light, which greatly limits the potential in bio-related applications. Herein, we report red-light controlled *N*,*N'*-diaryl-substituted indigo amphiphiles (**IA**), exhibiting excellent photoswitchablity and photostability in organic media. At macroscopic length-scale, morphological changes of **IA** macroscopic scaffold prepared by a shear-flow method can be fine adjusted upon red-light irradiation. Moreover, the preferential attachment of live h-MSCs to **IA** macroscopic scaffold surface showed a limited cytotoxicity. These results provide the potential for developing the next generation of red-light controlled soft functional materials with good biocompatibility.



Theoretical study of C-H bond activation in CH_4 by vanadium cation (V^+)

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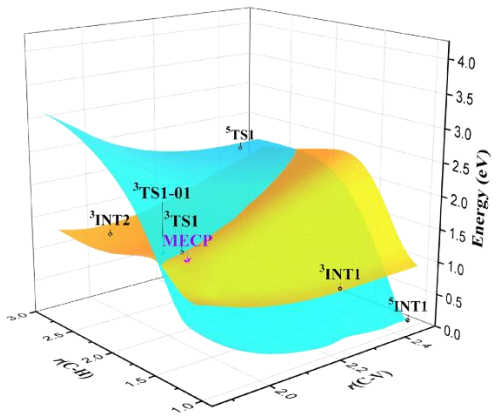
Abstract

Methane is the essential component of natural gas and one of the primary non-CO_2 greenhouse gases with shorter lifetime than CO_2 in atmosphere today.[1,2] In this project, the potential energy surface (PES) for V^+ (triplet and quintet states) approaching CH_4 and the reaction between them ($V^+ + CH_4 \rightarrow VCH_2^+ + H_2$ and $V^+ + CH_4 \rightarrow VH^+ + CH_3$) are studied at DFT (B3LYP/aug-cc-pVQZ) and coupled cluster (UHF-CCSD(T)/aug-cc-pVTZ and ROHF-CCSD(T)/aug-cc-pVTZ) levels. Typical hydrogen atom transfer (HAT) occurred between the INT2s and INT3s are confirmed in the PES of generating $VCH_2^+ + H_2$. A three-dimensional scan of the quintet and triplet states reveals the spin-crossing fact in the reaction between the ^{5}INT1 and ^{3}TS1.

Quintet (blue) and triplet (orange) PESs for ^{3}INT1 → ^{3}INT2 and ^{5}INT1 → ^{5}TS1 at B3LYP/ aug-cc-pVQZ level.



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Computational Predictions of Molecular Structures and Energetics of Carbon rings

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Abstract: Both DFT and high-level coupled-cluster theory including single and double excitations with a perturbative correction for triple excitations (CCSD(T)) with the cc-pVDZ basis sets, have been performed to predict the molecular structures and energetics of carbon rings. Theoretically, in our calculation a small bond length alternation (BLA = 0.053 Å) by using ωB97XD/cc-pVTZ) explains C_{14} is not confirmed as a polyynic structure. Indeed, our calculations at the CCSD(T) level of theory with cc-pVDZ basis sets, reveal that the ground state structure of the C_{14} molecule has a C_s (cumulenic) symmetry (i.e., BLA = 0, BAA ≠ 0), which is in excellent agreement with experimental results. Similarly, in the C_{16} ring structure, our DFT ωB97XD/cc-pVTZ confirms a polyynic D_{8h} symmetry is the ground state structure with a strong BLA, (BLA=0.151 Å, BAA=0). However, CCSD(T) calculation with cc-pVDZ basis sets, reveals a polyynic C_{2h} symmetry is the ground state structure with no significant bond angles alternating θ_1 and θ_2 (BLA=0.13 Å, BAA=0). Finally, the ground state structure of C_{18} cluster has a D_{9h} (polyynic) symmetry (i.e., BLA ≠ 0, BAA=0), using ωB97XD/cc-pVTZ method. Furthermore, our calculations at the CCSD(T) level of theory with cc-pVDZ basis set, demonstrate that C_{18} is a polyynic structure with C_s symmetry (i.e., BLA ≠ 0, BAA ≠ 0), as the ground state structure, this is due to the Peierls distortion in large carbon ring clusters. The combined DFT and CCSD(T) calculations provide a comprehensive understanding of the ground state structures and properties of carbon rings.

Key words: Polyynic and cumulenic structure, BLA and BAA, CCSD(T) and DFT calculations

Theoretical Understanding of Structure−Property Relationship of Oxygen-Doped Gallium Selenide as Efficient Photo-catalyst for Oxygen Evolution Reaction

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Abstract

A single-layer of GaSe is widely regarded as one of the most promising photocatalysts for solar-driven water-splitting reactions. However, its catalytic performance is limited by the high onset potential for oxygen evolution reaction (OER). Achieving the ideal adsorption strength of each intermediate involved in OER process (HO*, O*, and HOO*) simultaneously via surface modification of 2D materials is a significant challenge. In this study, the effects of partial replacement of Se atoms of GaSe with O atoms on the catalytic activity of the resulting $GaSe_{1-x}O_x$ surface toward OER have been systematically examined using density functional theory calculations. Our theoretical results revealed that manipulating the atomic configuration of O dopants can improve the surface activity of $GaSe_{1-x}O_x$. When O-dopants are separated by a -Ga-Se-Ga- unit, the OER is limited by the strong adsorption of the O* intermediate. On the contrary, when a -Ga- unit is bonded with three O-dopants, this O-saturated Ga atom serves as the best site to initiate OER and also exhibit high catalytic performance with a predicted overpotential of 0.38 V, comparable with the values of many state-of-the-art precise-metal-based catalysts.

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Masked Reactivity of Hydrated Clusters of Monovalent Manganese Ion: Water Insertion versus Nitrous Oxide Activation ---- A Density Functional Theory Investigation

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Abstract

From previous experimental MS studies, hydrated manganese(I) cluster ion, denoted as $[Mn(H_2O)_n]^+$, is shown to have a high reactivity toward the intra-cluster water insertion and inert toward the activation of nitrous oxide. This chemical behavior has been clarified through our current theoretical studies, which explore the transformation between the original manganese(I) ion, $[Mn^I(H_2O)_n]^+$, and its oxidized form, manganese(III) hydride-hydroxide, $[HMn^{III}OH(H_2O)_{n-1}]^+$. Their respective abilities to react with nitrous oxide were also examined. Our theoretical conclusions are determined by quantum chemical computations using density functional theory (DFT), which was performed across different forms of the hydrated clusters varying in size from n = 1 - 12. According to our DFT result, clusters with $n \geq 8$, water insertion is both a kinetically and thermodynamically favored process, indicating that the $[HMn^{III}OH(H2O)_{n-1}]^+$ form is the dominant species as seen in the experimental result. Although the activation of nitrous oxide with $[Mn^I(H_2O)_n]^+$ clusters is highly exothermic, the binding between nitrous oxide and $[HMn^{III}OH(H_2O)_{n-1}]^+$ clusters is weak. This research illustrates how the presence of water molecules can alter the inherent reactivity of the manganese(I) center and provides insights into the influence of water in the chemical behaviors of transition-metal systems.

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Wavelength-Dependent, Orthogonal Photoregulation of DNA Liberation for Logic Operations

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Abstract

Light serves as a powerful input with the advantages of high spatiotemporal control and multiple wavelength accessibility compared to chemical or biological inputs in DNA computation. However, the challenge of constructing DNA logic devices with dual-wavelength activations lies in the orthogonal activation of photoresponsive compounds. In this study, we synthesized a phosphoramidite based on (4,4'-bis-{8-[4-nitro-3-(2-propyl)-styryl]}-3,3'-dimethoxybiphenyl (BNSMB) structure as a visible light-cleavable linker for oligonucleotide conjugation. The BNSMB linker, along with the commercial ultraviolet (UV) photocleavable *o*-nitrobenzyl (PC) linker, was used to construct photoregulated DNA devices. Additionally, the DNA duplex was conjugated with Cyanine 3 (Cy3) fluorophore and black-hole quencher (BHQ) as signal reporters. Selective cleavage of PC and BNSMB molecules by UV and visible light irradiations resulted in controllable fragmentation of the DNA duplex, leading to changes in fluorescence as signal outputs. By adjusting the length of DNA duplex and the positions of the photocleavable molecules, fluorophores and quenchers, DNA devices were developed to mimic Boolean logic operations of AND, OR, NOR and NAND in response to two different wavelengths. Our results demonstrate the successful construction of orthogonal light-controlled DNA-based logic devices using two selective photocleavable molecules. Through careful sequence design with antisense functions, these devices have potential applications in controllable gene release in a logic manner.

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Crystal-Phase-Selective Etching of Heterophase Au Nanostructures

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Abstract

Selective oxidative etching is one of the most effective ways to prepare hollow nanostructures and nanocrystals with specific exposed facets. The mechanism of selective etching in noble metal nanostructures mainly relies on the different reactivity of metal components and the distinct surface energy of multimetallic nanostructures. Recently, crystal phase engineering of multimetallic nanomaterials offers new opportunities for the preparation of unique heterostructures, including heterophase nanostructures. However, the synthesis of hollow multimetallic nanostructures based on crystal-phase-selective etching has been rarely studied. Here, we report a crystal-phase-selective etching method, which is successfully used to selectively etch the unconventional 4H and 2H phases in the heterophase Au nanostructures. Due to the coating of Pt-based alloy after the crystal-phase-selective etching of 4H-Au in 4H/face-centered cubic (*fcc*) Au nanowires, the well-defined ladder-like Au@PtAg nanoframes are synthesized. In addition, the 2H-Au in the *fcc*-2H-*fcc* Au nanorods and 2H/*fcc* Au nanosheets can also be selectively etched by using the same method. As a proof-of-concept application, the ladder-like Au@PtAg nanoframes show excellent performance towards the electrocatalytic hydrogen evolution reaction (HER) in acidic media that is comparable to the commercial Pt/C catalyst.

Preparation of 2H/*fcc* heterophase multimetallic Pd-based heterostructures *via* epitaxial growth route for highly efficient electrocatalysis

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Abstract

Noble metal heterostructures and alloys have been regarded as highly efficient catalysts toward various electrochemical applications. Seed-mediated synthesis is one of the most powerful strategies to prepare noble metal nanomaterials with desired composition, morphology and dimensionality. Nowadays, the rapid development of phase engineering of nanomaterials (PEN) offers new opportunities towards the construction of novel noble metal heterostructures and alloys with unconventional crystal phases, which contribute excellent performance towards electrocatalysis. Recently, we have prepared three-dimensional (3D) Pd@Ir nanodendrites with a facet centered cubic (*fcc*)-2H-*fcc* heterophase[1] and (2D)/zero-dimensional (0D) Pd@Rh hierarchical heterostructures with a 2H/*fcc* heterophase[2] *via* the epitaxial growth of secondary metals on 0D Pd nanoparticles with unconventional hexagonal close-packed (*hcp*, 2H type) phase, denoted as 2H-Pd. Specifically, during the synthesis of *fcc*-2H-*fcc* Pd@Ir nanostructures, the *fcc*-Ir is selectively grown on the two opposite $(002)_h$ facets of 2H-Pd, while 2H-Ir is epitaxially grown on the other exposed facets of 2H-Pd, demonstrating a phase-selective epitaxial growth. Moreover, during the construction of 2D/0D Pd@Rh hierarchical heterostructures, two parallel triangular Rh nanoplates are selectively grown on the two opposite $(002)_h$ facets of 2H-Pd, exhibiting a facet-selective epitaxial growth. As proof-of-concept applications, the as-prepared *fcc*-2H-*fcc* Pd@Ir nanodendrites and 2D/0D Pd@Rh hierarchical heterostructures show superior performances for electrochemical hydrogen evolution reaction in acid electrolytes compared with their conventional *fcc* counterparts.

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Phase-Controlled Growth of 1T′-MoS_2 Nanoribbons on 1H-MoS_2 Nanosheets

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Abstract

Two-dimensional (2D) heterostructures are emerging as alternatives to conventional semiconductors, such as silicon, germanium, and gallium nitride, for next-generation electronics and optoelectronics owing to their ultrathin thickness, absence of dangling bonds, and strong light-matter interaction. However, the direct growth of 2D heterostructures, especially for those with metastable phases still remains challenging. To obtain 2D transition metal dichalcogenides (TMDs) with designed phases, it is highly desired to develop phase-controlled synthetic strategies. Here, a facile chemical vapor deposition (CVD) method is reported to prepare vertical 1H/1T′ MoS_2 heterophase structures. By simply changing the growth atmosphere, semi-metallic 1T′-MoS_2 can be *in-situ* grown on the top of semiconducting 1H-MoS_2, forming vertical semiconductor/semi-metal 1H/1T′ heterophase structures with a sharp interface. The integrated device based on the 1H/1T′ MoS_2 heterophase structure displays a typical rectifying behavior with a current rectifying ratio of ~10^3. Moreover, the 1H/1T′ MoS_2-based photodetector achieves a responsivity of 1.07 A/W at 532 nm with an ultra-low dark current of less than 10^{-11} A. The aforementioned results indicate that 1H/1T′ MoS_2 heterophase structures could be a promising candidate for the future rectifiers and photodetectors. Importantly, our approach might pave the way toward tailoring the phases of TMDs, which can help us understand and utilize phase engineering strategies to promote the performance of electronic devices.

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Mechanistic insights Into the Reactivity of a Seven-coordinate Ruthenium Iodosylbenzene Complex

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Keywords: C-H bond activation, oxygen-atom transfer, density functional theory (DFT)

Abstract:

Seven-coordinate (CN7) ruthenium-oxo species have attracted much attention as highly reactive intermediates in both organic and water oxidation. Apart from metal-oxo, other metal-oxidant adducts, such as metal-iodosylarenes, have also recently emerged as active oxidants. The first example of a CN7 **[Ru^{IV}-OIPh(Cl)]$^{+}$** complex, {[Ru^{IV}(bdpm)-(pic)$_2$(O)I(Cl)Ph]$^{+}$ (H_2bdpm = [2,2′-bipyridine]-6,6′-diylbis-(diphenylmethanol); pic = 4-picoline)}, is proved to be highly reactive, and it readily undergoes C−H bond activation and O-atom transfer (OAT) reactions with a variety of organic substrates. The density functional theory (DFT) calculations herein demonstrate the oxidation mechanisms of 9,10-dihydroanthracene (DHA) by **[Ru^{IV}-OIPh(Cl)]$^{+}$** complex, thereby expanding the understanding of **[Ru^{IV}-OIPh(Cl)]$^{+}$** catalytic system. [1] This work should provide mechanistic insights for the development of new highly reactive oxidizing agents based on CN7 geometry.

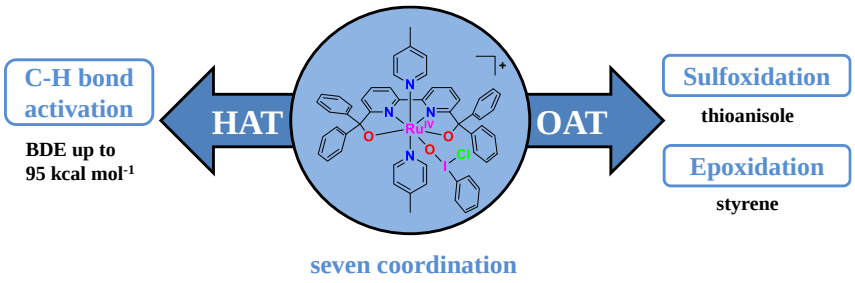

Fig. 1 Structure and reactivity of a seven-coordinate Ruthenium iodosylbenzene complex

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Photo-Responsive Phase-Separating Fluorescent Molecules for Intracellular Protein Delivery

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Cellular membranes, including the plasma and endosome membranes, are barriers to outside proteins. Various vehicles have been devised to deliver proteins across the plasma membrane, but in many cases, the payload gets trapped in the endosome. Here we designed a photo-responsive phase-separating fluorescent molecule (**PPFM**) with a molecular weight of 666.8 daltons. The PPFM compound condensates as fluorescent droplets in the aqueous solution by liquid-liquid phase separation (**LLPS**), which disintegrate upon photoirradiation with a 405 nm LED lamp within 20 min or a 405 nm laser within 3 min. The PPFM coacervates recruit a wide range of peptides and proteins and deliver them into mammalian cells. Photolysis disperses the payload from condensates into the cytosolic space. Altogether, a type of small molecules that are photo-responsive and phase separating are discovered; their coacervates can serve as transmembrane vehicles for intracellular delivery of proteins, whereas photo illumination triggers the cytosolic distribution of the payload.

Synthesis of unconventional noble metal facets via wet-chemical epitaxial growth and crystal structure-dependent catalytic behaviors of Pt in selective hydrogenation reaction

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Pt-based nanocatalysts are promising heterogeneous catalysts in hydrogenation reactions. However, it remains a great challenge to achieve high chemoselectivity for high-value intermediates and avoid over-hydrogenation when substrates contain multiple competing functional groups. Numerous efforts have been made to improve the chemoselectivity of Pt-based nanocatalysts in hydrogenation, including tuning their size, composition, and surface ligands. However, to the best of our knowledge, the effect of crystal structure of Pt on hydrogenation reactions has not been investigated because it is still difficult to synthesize Pt nanocrystals with high purity metastable phases with well-defined facets. In this work, we develop a novel hexagonal close-packed (2H) Pt nanocatalyst exposed with well-defined unconventional 2H Pt facets via epitaxial growth and reveal the crystal structure-dependent catalytic performance of Pt in hydrogenation reactions. Moreover, our distinctive epitaxial growth strategy could also be used to synthesize 2H/face-centered cubic (3C) heterophase Au and Ag shells. Impressively, the 2H Pt shell exhibits remarkably high catalytic selectivity toward the high-value intermediate and excellent durability, superior to conventional 3C Pt counterpart with nearly-same morphologies and identical surface ligand. This work not only provides a general strategy for crystal structure-controlled epitaxial growth of noble metal-based heterogeneous catalysts, but also demonstrates crystal structure-dependent catalytic behaviors of Pt in heterogeneous selective hydrogenation.

Electropolymerized 3D Cobalt Porphyrin for Electrochemical CO_2 Reduction

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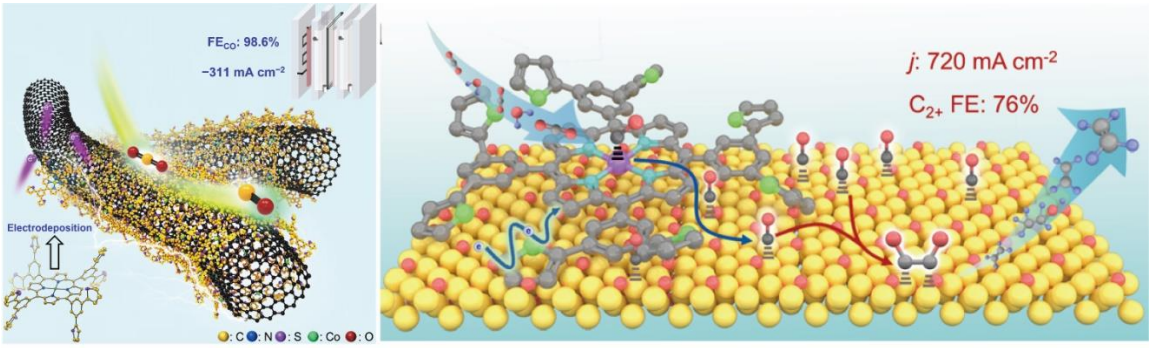
Abstract

Elecrochemical CO_2 reduction (ECR) is a promising approach to mitigate climate crisis. However, catalyst developments based on either molecular catalysts or copper (Cu) catalysts still suffer from many issues, such as aggregation, mass transfer limitation, weak C-C coupling, etc. In this context, we introduce a facile method based on electropolymerization to in situ deposit 3D microporous cobalt porphyrin film (EP-CoP) on electrode in a few minutes. ECR from EP-CoP can reach current density of 310 mA cm^{-2} with a high CO faradaic efficiency (FE_{CO}) of 98.6% on carbon nanotubes[1], and 726 mA cm^{-2} with FE_{2+} of 76% on Cu, which show great enhancement than that from monomer and Cu. Studies towards the mechanism of the high efficiency, selectivity, stability will be further discussed.



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Covalent Organic Framework: an engineer approach towards high efficiency electrocatalytic CO2 reduction

Kin Cheung Li, Xunjin Zhu

Abstract

Energy and environment related issues have become highlighted worldwide problems for the last few decades. Among which, CO_2 emissions and fossil fuel reserves are especially the most concerned issues. The prior results in a series of environmental damages, such as ocean acidification and extreme weather[1], while the later affect the continuity of human development. In view of the situation, providing a secure energy supply that relies on non-fossil fuel is an urge, where electroreduction is considered to be a promising method.

Therefore, Covalent Organic Frameworks (COFs), one of the representing subclasses in reticular chemistry that possesses characteristics of polymers, which are covalently bonded and grown from repeating units to form the backbones and stacked by pi-pi interaction to construct a highly ordered framework. COFs exhibit controllable syntheses, predesigned structures, high crystallinity, tunable porosity, and high surface area which had enabled a diversity of applications in the past decade, including semiconductors, catalysis, gas sorption and separation[2]. Despite its outstanding applications, COFs failed to industrialize due to their difficulties in processing.

Herein, we introduced a method that can be used to synthesize highly crystalline COFs with no further processing required before fabricating into cathode for eCO_2RR. Hence, the performance reached the level of industrial requirements, and exhibited high stability over most of the applied potential, which further opened possibility for inorganic-organic hybrid catalysis[3].

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A facile method to prepare stearic acid-TiO_2/zinc composite coating with multipronged robustness, self-cleaning property, and corrosion resistance

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Abstract

Despite that some superhydrophobic coatings have been developed to enhance the corrosion resistance of steel, there lacks a solution that also fulfills both robustness and service durability. [1-3] Taking advantage of the controlled generation of particles during electrodeposition, a multifunctional stearic acid (STA)-TiO_2/zinc composite (TZC) coating with hierarchical micro/nanostructures by codeposition of TiO_2 nanoparticles and Zinc ions was prepared on carbon steel substrates. The structures of STA-TZC coating were characterized by a series of means. The micro/nanoscale structured surface based on TZC with STA overcoat imparted the prepared STA-TZC coating with outstanding superhydrophobic property; the water contact angle and sliding angle were 160 ± 1.4° and 5.4 ± 0.2°, respectively. According to the tests of knife scratching, adhesive tape peeling, sandpaper abrasion, and chemical corrosion resistance, the STA-TZC coating presented good mechanical and chemical stabilities. Additionally, STA-TZC coating showed excellent self-cleaning property, corrosion resistance, and superhydrophobic stability. The results indicated that filling the voids of porous zinc coating with TiO_2 nanoparticles and subsequently modifying with STA film could greatly improve the coating's resistance to corrosion and mechanical abrasion. This electrochemical codeposition-modification method has broad application prospects for exploring and preparing metal-based superhydrophobic coatings.

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Gold(I) Multi-Resonance Thermally Activated Delayed Fluorescent Emitters for Highly Efficient Ultrapure-Green Organic Light-Emitting Diodes

Siyuan Cai, Glenna So Ming Tong, Lili Du, Gary Kwok-Ming So, Faan-Fung Hung, Tsz-Lung Lam,* Gang Cheng,* Hui Xiao, Xiaoyong Chang, Zong-Xiang Xu, and Chi-Ming Che*

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Abstract

Multi-resonance thermally activated delayed fluorescent (MR-TADF) emitters were limited by the inefficient singlet-triplet intersystem crossing (ISC), resulting in severe efficiency roll-off and unsatisfactory operational lifetime in organic light-emitting diodes (OLEDs). To accelerate the ISC process, besides expending the conjugated system to reduce the singlet-triplet gap (ΔE_{ST}), introducing heavy atoms would markedly enhance the spin-orbit coupling (SOC) of MR-TADF emitters. This work provides a concise and efficient gold(I) coordination strategy, which observably increases the rate constants of ISC (k_{ISC}) up to 3×10^9 s^{-1} along with close-to-unit ISC quantum yields (Φ_{ISC}). Utilization of several optically transparent and sterically bulky NHC ancillary ligands minimizes the perturbation of MR-type emission, making gold(I)-MR emitters preserve narrowband emissions (FWHM=30–37 nm) and high emission quantum yields (ca. 0.9). The vapor-deposited OLEDs fabricated with gold(I)-MR emitters delivered ultrapure-green emission with CIE coordinates (0.18, 0.70) very close to National Television System Committee (NTSC) standard green luminescence CIE (0.21, 0.71), external quantum efficiency (EQE) roll-offs as low as 0.8% and long device lifetimes (LT_{60}) of 1210 h at 1000 cd m^{-2}.[1]

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Title of Poster

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Abstract

Nitrate, a contaminant in groundwater, is typically discharged anthropogenically from nitrogen-containing fertilizers. Excess nitrate accumulated in human bodies can be converted into carcinogenic N-nitroso species, leading to severe diseases. Besides, the nitrate in water bodies can kill aquatic life and mess up the balance of ecosystems. Electrochemical reduction of nitrate to ammonia goes an eight-electron pathway.[1] Noble metal Pt has been considered a typical heterogeneous catalyst for nitrate reduction. Considering the economic sustainability of the catalyst,[2] we synthesized a trimetallic LDH catalyst for nitrate electroreduction. This CuCoAl LDH has outcompeted state-of-the-art materials in terms of catalytic nitrate electroreduction performance, ranging from activity and selectivity to durability and scalability.

Nonprecious metal CuCoAl LDH exhibits excellent electrocatalytic performance toward nitrate reduction with an onset potential at 0 V vs RHE, while generating ammonia exclusively with FE for ammonia reaching 99.5% and a yield rate of 0.22 mol. h^{-1} g^{-1}, exceeding the performance of state-of-the-art NPM nitrate reduction catalysts during long-term electrocatalysis.[3]

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Thermal Conductivity of Active Nanofluids based on Different Nanomotors under Various Lights

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Abstract

Nanofluids exhibit a range of remarkable properties, such as nanoparticles' tunable photochromism [1], tunable viscosity [2], particularly in the context of heat transfer and dissipation [3]. This unique characteristic has demonstrated promising potential for applications in machine radiators and electronic cooling systems, where effective thermal conductivity (kappa) management is crucial. However, conventional nanofluids often face challenges in providing accurate control and quantification of heat transfer. Additionally, passive nanofluids can result in the accumulation of surface heat due to a lack of slip flow.

To address these issues, we first introduce an active nanofluid that can generate specific movements and flow fields within its interior when stimulated by various light sources externally, eliminating surface heat accumulation. Furthermore, we have successfully developed a platform for rapid-response thermal conductivity testing. This platform, based on varying light illumination, allows us to precisely control thermal conductivity and determine the factors (such as concentration, size, and activity) that influence it. Moreover, through tracking and calculation of velocity field, vortex field, and energy spectrum, we establish a connection between changes in kappa and the occurrence of turbulence within the nanofluids. In the future, our goal is to explore further the practical applications and principles of active nanofluid systems in relation to their thermal conducting properties.

Key Words: Thermal Conductivity, Active Nanofluids, Lights, Accurate control

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Artificial Intelligence-aided Nano-phase Diagram for Revealing the Phase Stability and Hydrogen Evolution Reaction Activity of Molybdenum Nitride

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Abstract

Transition-metal nitrides (TMNs) play a significant role in various fields and industrial processes, primarily due to their diverse crystal structures and surface properties. However, traditional synthesis methods of TMNs frequently involve the formation of metastable phases during particle growth, which cannot be adequately characterized by conventional phase diagrams. In this study, we employ density functional theory (DFT) calculations and thermodynamic analyses to develop particle size-dependent phase diagrams for multiple Molybdenum (Mo) nitrides. Through this approach, we elucidate the correlations between phase stability and the nanoparticle size of TMNs and predict the synthesis conditions of different Mo nitrides. Furthermore, the machine learning model was utilized to accelerate DFT calculation for screening the energy-stable high-miller index facets of Mo nitrides. We computed the Hydrogen Evolution Reaction (HER) free energy diagram for both low-miller index facets and the screened high-miller index facets, revealing that certain high-miller index facets of nitrides exhibit both stability and activity for HER. Our study offers insights into the relationship between particle size and phase stability during synthesis, and our work presents a computationally guided approach for efficiently navigating the discovery of stable and active catalytic materials for HER.

Controlled Self-Assembly of Gold(I) Complexes by Multiple Kinetic Aggregation States with Nonlinear Optical and Waveguide Properties

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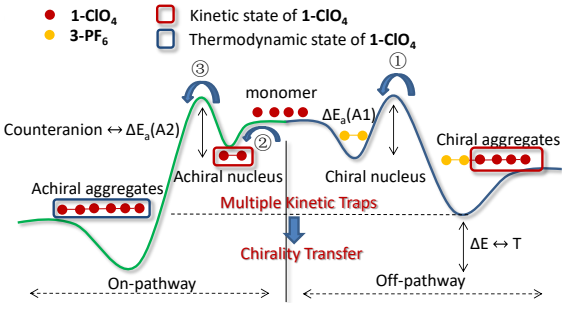
Abstract

Introduction of multiple kinetic aggregation states (Aggs) into the self-assembly pathway could bring complexity and flexibility to the self-assemblies, which is difficult to realize due to the delicate equilibria established among different Aggs bonded by weak noncovalent interactions. Here, we describe a series of chiral and achiral d^{10} Au^{I} bis(N-heterocyclic carbene, NHC) complexes, and the achiral complex could undergo self-assembly with multiple kinetic Aggs. Generation of multiple kinetic Aggs was realized by applying chiral or achiral seeds exhibiting large differences in elongation temperatures for their respective cooperative self-assembly processes. We further showed that the chiral Au^{I} self-assemblies having non-centrosymmetric packing forms exhibit nonlinear optical response of second harmonic generation (SHG), while the SHG signal is absent in the achiral analogue. The crystalline achiral Au^{I} self-assemblies could function as optical waveguides with strong emission polarization.



Au(I)-TADF emitters for high efficiency full-color vacuum-deposited OLEDs and TADF-sensitized fluorescent OLEDs with ultrahigh brightness and prolonged operational lifetime

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Herein we report a class of structurally simple, efficient, and operationally stable Au(I)-TADF (TADF = thermally activated delayed fluorescence) materials based on a carbene-metal-amide (CMA) molecular scaffold comprising of sterically bulky N-heterocyclic carbene (NHC) ligands with N-heterocyclic π-annulation. These CMA(Au) emitters, supported by pyridine-, pyrazine-, or quinoxaline-fused NHC ligand, are thermally stable (decomposition temperature of 302 – 348 ^{o}C), adopt co-planar or orthogonal geometry between the carbene and amide ligands, and show strong blue to deep red TADF emissions (468 – 666 nm) from a thermally-equilibrated singlet ligand-to-ligand-charge-transfer (^{1}LL'CT) excited state with emission quantum yields of 0.63 – 0.99 and fast radiative decay rate constants of 0.68 – 3.2 × 10^{6} s^{-1} in thin film samples at room temperature. The effect of increasing π-extension and number of N-substitution of the NHC backbone as well as orthogonal molecular geometry are similarly manifested in the reduction of both singlet-triplet energy gap and S_1 transition dipole moment. The vacuum-

deposited Au(I) devices displayed superior electroluminescence characterized by ultrahigh brightness up to 300,000 cd m^{-2} and external quantum efficiencies (EQEs) up to 26.2% with roll-offs down to 2.6% at 1000 cd m^{-2} alongside record-setting device lifetimes (LT_{95}) up to 2082 h among reported metal-based TADF OLEDs. Ultrapure-green hyper-fluorescent OLEDs employing the CMA(Au) emitter as sensitizer and a multi-resonance terminal emitter achieved EQEs of up to 25.3%.

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Layer-Expanded NiFe LDH for Electrocatalytic C–N Bond Formation in Aqueous Solution

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Abstract

Management of wastes and pollutants becomes worldwide issues to achieve a sustainable society. Treatment and recycling of C-wastes and N-toxins are among upmost importance. Beyond recycling, individual upgrading of C-wastes and N-toxins to produce C- and N-containing feedstocks can improve the level of integrated utilization of resources. In recent years, electrolysis, especially CO_2RR, NO_3RR and NO_2RR, to obtain energy-rich fuels and fertilizers become much-anticipated. However, compared to C-only and N-only reduction, co-electrolysis from C-wastes and N-toxins to form structurally complicated and functionally diverse C–N containing compounds are highly desired. The C–N bond containing compounds exist everywhere in our daily life from natural products in soil, human body like amino acids to synthetic compounds such as drugs, electronic materials and polyamides. Most of the researchers focused on the electrosynthesis of urea with CO_2 and nitrate.[1] To expand the range of product categories, I recently achieved the electrosynthesis of formaldoxime with HCHO and nitrite with NiFe LDH in aqueous solution. The Faradaic efficiency can be further improved to 24% by expanding the interlayer spacings with alkyl chains.

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Thermophoresis Behavior and influence of poly(Acrylic Acid)

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Abstract

By modified with certain polymers, micro/nanomotors(MNMs) can generate thermophoretic motion, which has been proved by previews work[1,2]. The polymer, PAA(polyacrylic acid), PEG(polyethylene glycol) and PSS(polystyrene sulfonate) have been taken into comparation for thermophoretic behavior and the result shows that it can dominate MNMs motion model. Especially, the MNMs coated with PAA, the motion can be reverse totally, which is thermophilic. Later research shows that enthalpic contributions from polymer–solvent interactions should play a fundamental role in the self-thermophoretic MNMs. Quantitative microcalorimetry and molecular dynamics simulations are performed to support the hypothesis. However, same mechanism can expand to molecular level thermophoretic motion is uncertain. Therefore, for exploring this question, we design new device for generating temperature gradient field and record fluorescence change of target molecular with fluorescence to measure molecular thermophoretic behavior and related influence factors.

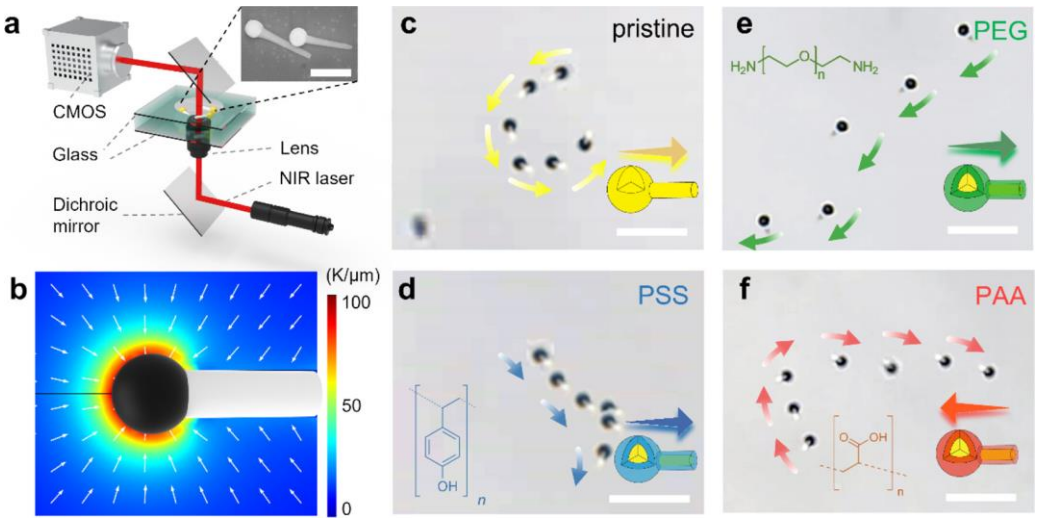

Figure 1 . Thermophoretic motion of matchstick MNMs. (a) Schematic illustration for

observing the thermophoretic motion of matchstick MNMs. The inset is the SEM image of matchstick MNMs. (b) Simulated temperature gradient distribution around a heated matchstick MNM (R = 0.25 μm, L = 1 μm) under NIR light (λ = 808 nm) radiation, where the arrows indicate the direction of the temperature gradient. Time-lapsed trajectories of directional motion of (c) pristine and (d–f) polymer-coated matchstick MNMs (R = 0.25 μm, Δ ≈ 40 nm) under NIR radiation (0.04 mW μm^{-2}) at room temperature (298.15 K); scale bars: (a) 5 μm and (c–f) 5 μm; time steps in c–f: 0.4 s.

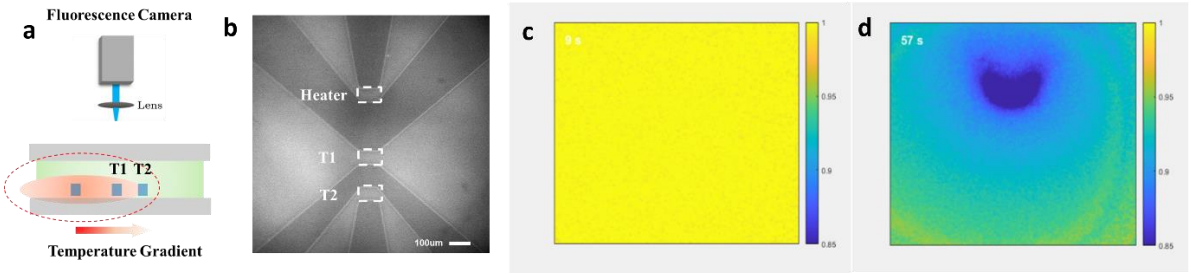

Figure 2 . The method for evaluating molecular. (a) Schematic illustration for recording and observing molecular thermophoretic motion. The cell's height is limited around 10um for avoiding convection caused by temperature gradient. (b) The image of the device pattern for generating and recording temperature and the pattern is made by plated ITO film. In experiment, high frequence AC electric field will be added in heater and record T1 and T2's temperature change by temperature-conductance relationship. (c) The fluorescence image at 0s (without temperature gradient), treated by heatmap, shows the space fluorescence intensity compare under no temperature gradient. (d) The fluorescence image at 57s (with temperature gradient), treated by heatmap, shows the space fluorescence intensity compare under temperature gradient.

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Selective Oxygen Reduction to H_2O_2 Enhanced by Pulsed Laser Treatment on Fe Complex of Benzene-1,3,5-Tricarboxylate Optimized by Taguchi Method

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Abstract

At present, over 95% of H_2O_2 is produced via the anthraquinone process that requires large infrastructure, generates organic pollution, and poses safety issues.[1] Electrochemical H_2O_2 generation through oxygen reduction can serve as an alternative, reliable, and decentralized production method if affordable and high-performance electrocatalysts can be developed.[2] Herein, a two-step process was used to prepare a Fe-based complex that was applied to catalyze oxygen reduction reaction (ORR) and produce an alkaline H_2O_2 solution. The Fe complex of benzene-1,3,5-tricarboxylate (FeBTC) was first synthesized using a hydrothermal method and then treated with pulsed laser optimized by the Taguchi method.[3] The FeBTC after pulsed laser treatment (PL-FeBTC) exhibited a 20 mV improvement in onset potential at -0.1 mA/cm^2 and a 25% higher H_2O_2 product selectivity at 0.4 V vs. RHE. The experimental results indicated that metal-based electrocatalysts can be improved through pulsed laser treatment while optimized by the Taguchi method. The improvement in catalytic performance was rationalized by an oxygen doping mechanism, thus providing a systematic methodology for precise structure-performance tuning. Beyond H_2O_2 generation, this study further has implications for the development of cost-effective electrocatalysts that are central to other commodity production and sustainable resourcification processes.

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Observation of Ferromagnetism in Dilute Magnetic Halide Perovskite Semiconductors

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Abstract:

Dilute magnetic semiconductor (DMS) has attracted much attention because of their potential use in spintronic devices.[1,2] Here, we demonstrate the observation of robust ferromagnetism in a solution-processable halide perovskite semiconductor with dilute magnetic ions. By co-doping of magnetic (Fe^{2+}) and aliovalent (Bi^{3+}) metal ions into $CH_3NH_3PbCl_3$ ($MAPbCl_3$) perovskite, ferromagnetism with well-saturated magnetic hysteresis loops and a maximum coercivity field of 1280 Oe was observed below 12 K. The ferromagnetic resonance measurements revealed that the incorporation of aliovalent ion modulates the carrier concentration and plays an essential role in realizing the ferromagnetism in dilute magnetic halides perovskites. Magnetic ions are proposed to interact through the bound magnetic polarons to achieve ferromagnetic coupling. Our work provides a new avenue for the development of solution-processable magnetic semiconductors.

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A Photoactivatable Luminescent Motif through Ring-Flipping Isomerization for Multiple Photopatterning

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Abstract

Photoactivatable luminescent materials have garnered enormous attention in the field of intelligent responsive materials, yet their design and applications remain challenging due to the limited variety of photoactivatable motifs. In the work described herein, we discovered a new photoactivatable luminescent motif that underwent ring-flipping isomerization under UV irradiation. The emission of this motif exhibited a rapid transformation from dark yellow to bright green, accompanied by a significant enhancement of quantum yield from 1.9% to 34.2%. Experimental and theoretical studies revealed that the effective intramolecular motion (EIM) was crucial to the distinct luminescence performance between two isomers. In addition, polymers containing this motif were achieved through a one-pot alkyne polymerization, exhibiting both photofluorochromic and photo-cross-linking properties. Furthermore, multiple types of photopatterning, including luminescent encryption, fluorescent grayscale imaging, and high-resolution photolithographic patterns, were realized. This work developed a new photoactivatable luminescent motif and demonstrated its potential applications in both small molecules and macromolecules, which will help in the future design of photoactivatable luminescent materials.[1]

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Rashba Band Splitting and Bulk Photovoltaic Effect Induced by Halogen Bonds in Hybrid Layered Perovskites

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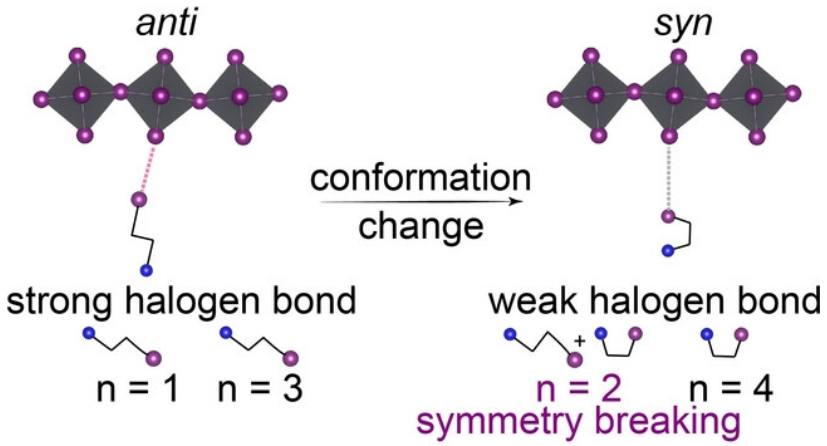
Abstract

Non-covalent interactions play an essential role in directing the self-assembly of hybrid organic–inorganic crystals. In hybrid halide perovskites, hydrogen bonding has been the paramount non-covalent interaction. Here, we show another non-covalent interaction, namely, the halogen bond interaction, that directs a symmetry-breaking assembly in a new series of two-dimensional (2D) perovskites $(ICH_2CH_2NH_3)_2(CH_3NH_3)_{n-1}Pb_nI_{3n+1}$ (n is the layer thickness, n= 1– 4). Structural analysis shows that the halogen bond strength varies with the layer thickness. For the odd number (n=1, 3) layered perovskites, stronger halogen interaction leads to centrosymmetric structures, whereas for the n=2 layered perovskites, weaker halogen bonds result in non-centrosymmetric structures. Transient reflection spectroscopy shows a suppressed radiative recombination rate (k2≈0) and prolonged spin lifetime for n=2 structure, suggesting an enhanced Rashba band splitting effect. The structural asymmetry is further confirmed with a reversible bulk photovoltaic effect. Our work provides a new design strategy to enable hybrid perovskites with emerging properties and functionalities associated with structural asymmetry.[1]



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Induced Circularly Polarized Luminescence and Exciton Fine Structure Splitting in Magnetic-Doped Chiral Perovskites

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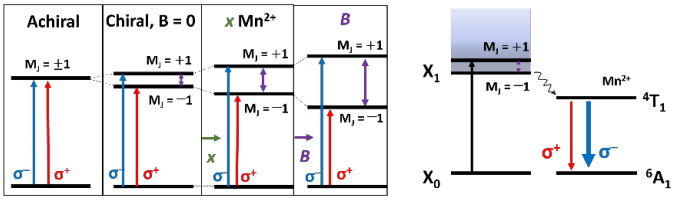
ABSTRACT

Magnetic impurity doping in semiconductors has emerged as an important strategy to endow exotic photophysical and magnetic properties. While most reported hosts are centrosymmetric semiconductors, doping magnetic ions into a noncentrosymmetric chiral semiconductor can offer additional control of photonic and spin polarization. In this work, we synthesized Mn^{2+}-doped chiral two-dimensional (2D) perovskite Mn^{2+}:(*R*-MPA)$_2$PbBr$_4$ (*R*-MPA$^+$=*R*-methyl phenethyl ammonium). We found that the optical activity of chiral 2D perovskite is enhanced with the increased concentration of Mn^{2+} ions. Additionally, efficient energy transfer from the chiral host to Mn^{2+} dopants is observed. This energy transfer process gives rise to circularly polarized luminescence from the excited state of Mn^{2+} ($^4T_1 \rightarrow {}^6A_1$), exhibiting a photoluminescence quantum yield up to 24% and dissymmetry factor of 11%. The exciton fine structures of undoped and Mn^{2+}-doped (*R*-MPA)$_2$PbBr$_4$ are further studied through magnetic circular dichroism (MCD) spectroscopy. Our analysis shows that chiral organic cations lead to an exciton fine structure splitting energy as large as 5.0 meV, and the splitting is further increased upon Mn^{2+} doping. Our results unveil the strong impacts of molecular chirality and magnetic dopants on the exciton structures of halide perovskites.



Mn^{2+}:(*R*-MPA)$_2$PbBr$_4$

Reference

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Steady-state and ultrafast time-resolved spectroscopic study on human telomeric i-motif

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Abstract

I-motifs formed from cytosine-rich strands through hemi-protonated base pairs exhibit notable stability under acidic conditions.[1] However, their stability in such conditions has limited research focus in the past. Recent studies have shown their potential existence in vivo and highlighted their potential in nanotechnological applications.[2] Despite the increasing interest, the excited-state dynamics of i-motifs, important for biotechnological advancements, remain largely unexplored. To shed light on these dynamics, we conducted investigations using steady-state and femtosecond time-resolved fluorescence (fs-TRF) spectroscopy on i-motifs formed from the human telomeric sequence and selected methylated cytosine sequence. The fs-TRF results demonstrate complex decay processes of the excited states of the examined i-motifs, involving different states deactivating through varied pathways across a broad timescale, including rapid nonradiative decay of monomer-like locally excited state and deactivation of charge transfer state.

References

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