香港浸會大學
HONG KONG BAPTIST UNIVERSITY

DEPARTMENT of CHEMISTRY

The 28th Symposium on CHEMISTRY POSTGRADUATE RESEARCH in Hong Kong

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Information & Abstracts

Organizer:
Department of Chemistry
Hong Kong Baptist University

Event Website:
https://chem.hkbu.edu.hk/chemsym28th/

Scientific Programme

Time	Event
9:30 am – 9:45 am	**Opening remark by Prof. Rick Wong, Provost and Chair Professor of Chemistry, Hong Kong Baptist University**
9:50 am – 10:00 am	**Group photo taking (inside the Auditorium)**
10:00 am – 10:25 am	**"Critical Stable Length in Wrinkles of Two-Dimensional Materials"** **- by Quoc Huy Thi, City University of Hong Kong**
10:30 am – 10: 55 am	**"Alkylperoxocobalt(III) Complexes Catalyzed Aerobic Peroxidation of Alkanes and Alkenes"** **-by Yunzhou Chen, Hong Kong Baptist University**
11:00 am – 11:25 am	**"Charging a Negatively Curved Nanographene and its Covalent Network"** **-by Yiqun Zhang, The Chinese University of Hong Kong**
11:30 am – 11: 55 am	**"C-S Coupling for Thioether Synthesis using Stable and Safe Commodity Chemicals"** **-by Long Yin Lam, The Hong Kong Polytechnic University**
12:00 pm – 2:55 pm	**Poster Session & Lunch Break**
3:00 pm – 3:25 pm	**"Reactivity of Osmanaphthalyne"** **-by Tsz Kin Ng, The Hong Kong University of Science and Technology**
3:30 pm – 3:55 pm	**"The ab-initio DMRG's Perspective for the Fundamentals and Analysis of Singlet Fission"** **-by Rajat Walia, The University of Hong Kong**
4:00 pm – 5:00 pm	**Keynote Lecture** **"Fluorescent and Bioluminescent Probes for Imaging and Diagnostics"** **– By Prof. Kai Johnsson, Max Planck Institute for Medical Research**
5:00 pm – 5:30 pm	**Closing Ceremony & Award Presentation**

List of Abstracts

- *Keynote Lecture*

Fluorescent and Bioluminescent Probes for Imaging and Diagnostics

Prof. Kai Johnsson

(Director at the Max Planck Institute for Medical Research, Department of Chemical Biology)

- *Postgraduate Student Oral Presentations*

Critical Stable Length in Wrinkles of Two-Dimensional Materials (ORAL-1)

Mr. Quoc Huy Thi (City University of Hong Kong)

Alkylperoxocobalt(III) Complexes Catalyzed Aerobic Peroxidation of Alkanes and Alkenes (ORAL-2)

Ms. Yunzhou Chen (Hong Kong Baptist University)

Charging a negatively curved nanographene and its covalent network (ORAL-3)

Mr. Yiqun Zhang (The Chinese University of Hong Kong)

C-S coupling for thioether synthesis using stable and safe commodity chemicals (ORAL-4)

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Reactivity of Osmanaphthalyne (ORAL-5)

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The ab-initio DMRG's Perspective for the Fundamentals and Analysis of Singlet Fission (ORAL-6)

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- *Poster Presentations (Total: 185)*

Keynote Lecture

Fluorescent and Bioluminescent Probes for Imaging and Diagnostics

Prof. Kai Johnsson, Director at the Max Planck Institute for Medical Research, Department of Chemical Biology, 69120 Heidelberg, Germany; EPFL Lausanne, Institute of Chemical Sciences and Engineering, Switzerland; E-mail: johnsson@mr.mpg.de

Abstract

The combination of protein engineering and synthetic chemistry can be exploited to generate fluorescent and bioluminescent probes for live-cell imaging.

Specifically, I will review our attempts to introduce new fluorescent dyes and sensor proteins that permit to visualize biochemical activities in living cells with high spatial and temporal resolution. I will also discuss how these sensor proteins can be utilized for point-of-care therapeutic drug monitoring.

Biography

Prof. Kai Johnsson is Director at the Max Planck Institute for Medical Research, Department of Chemical Biology since 2017. He was appointed after being Full Professor at the Institute of Chemical Sciences and Engineering of the École Polytechnique Fédérale de Lausanne (EPFL) and co-director of the NCCR Chemical Biology.Kai Johnsson is Executive Editor of the Journal of the American Chemical Society since 2021. He is member of the Editorial Advisory Board of Science and of the Research Council of the Swiss National Science Foundation. He is co-founder of Covalys Biosciences which was based on protein labeling technologies developed in his laboratory; these technologies are now available through New England BioLabs. He received the Prix APLE for the invention of the year 2003 of EPFL, the Novartis Lectureship Award 2012/13, the Karl-Heinz Beckurts Prize 2016 and is elected member of EMBO.

Critical Stable Length in Wrinkles of Two-Dimensional Materials

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Abstract

The emergent two-dimensional (2D) materials are atomically thin and ultra-flexible, promising for a variety of miniaturized, high-performance, and flexible devices in applications. On one hand, the ultrahigh flexibility causes problems: the prevalent wrinkles in 2D materials may undermine the ideal properties and create barriers in fabrication, processing, and quality control of materials. On the other hand, in some cases the wrinkles are used for the architecting of surface texture and the modulation of physical and chemical properties. Therefore, a thorough understanding of the mechanism and stability of wrinkles is highly needed. Herein, we investigate a critical length for stabilizing the wrinkles in 2D materials, observed in the wrinkling and wrinkle elimination processes upon thermal annealing by AFM imaging, as well as by in situ TEM manipulations on individual wrinkles.[1] Wrinkles with lengths below a critical value are unstable and removable by thermal annealing, while wrinkles with lengths above a critical value are self-stabilized by van der Waals interactions.[1] Our findings empower numerous applications that require architecting nanoscale ordered surface wrinkles.[2]

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Alkylperoxocobalt(III) Complexes Catalyzed Aerobic Peroxidation of Alkanes and Alkenes

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Abstract

Room temperature aerobic oxidation of hydrocarbons is highly desirable and remains a great challenge. O_2 is regarded as an ideal oxidant because it is abundant and the only byproduct is H_2O. Transition metal complexes catalyzed aerobic peroxidation of hydrocarbons are usually carried out at high temperature.[1] On the other hand, these complexes catalyze hydrocarbon oxidation efficiently at ambient condition when ROOH/H_2O_2 are used.[2] In this work, we present a robust cobalt(III) alkylperoxo complex, $[Co^{III}(qpy)(OO^tBu)(NCCH_3)]^{2+}$, (qpy = 2,2′:6′,2″:6″,2‴-quaterpyridine) that function as efficiently catalysts to perform aerobic peroxidation of various alkanes and alkenes at room temperature. The detail mechanism of this catalytic reaction will be discussed.

Reference

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Charging a Negatively Curved Nanographene and Its Covalent Network

Yiqun Zhang,[a] Yikun Zhu,[b] Danni Lan,[c] Sai Ho Pun,[a] Zheng Zhou,[b] Zheng Wei,[b] Ying Wang,[a] Hung Kay Lee,[a] Chao Lin,[c] Jiangpeng Wang,[c] Marina A. Petrukhina,[b] Quan Li,[c] and Qian Miao[a]

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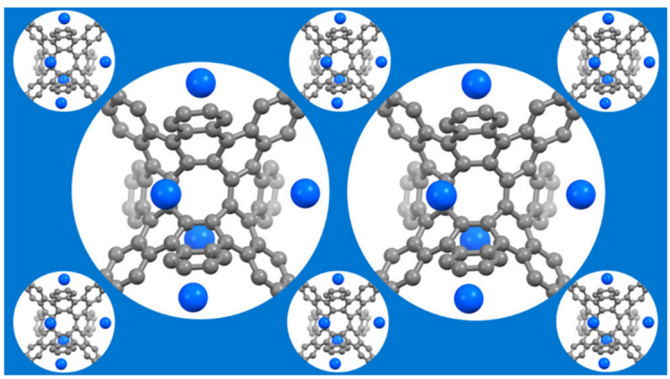
Abstract

This study explores a bottom-up approach toward negatively curved carbon allotropes from octabenzo[8]circulene, a negatively curved nanographene.[1,2] Stepwise chemical reduction reactions of octabenzo[8]circulene with alkali metals lead to a unique highly reduced hydrocarbon pentaanion, which is revealed by X-ray crystallography suggesting a local view for the reduction and alkali metal intercalation processes of negatively curved carbon allotropes. Polymerization of the tetrabromo derivative of octabenzo[8]circulene by the nickel-mediated Yamamoto coupling reaction results in a new type of porous carbon-rich material, which consists of a covalent network of negatively curved nanographenes.[3] It has a specific surface area of 732 m^2 g^{-1} and functions as anode material for lithium-ion batteries exhibiting a maximum capacity of 830 $mAh \cdot g^{-1}$ at a current density of 100 $mA \cdot g^{-1}$. These results indicate that this covalent network presents the key structural and functional features of negatively curved carbon allotropes.



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C-S coupling for thioether synthesis using stable and safe commodity chemicals

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Abstract

Thioether is a common structure in pharmaceuticals, bioactive molecules, and other industrial chemicals.[1] Current methods for thioether synthesis often involve the use of thiols with repulsive odor which may also lead to organ/tissue damage upon long-term exposure. Some sulfur surrogates have been developed to replace thiols such as sulfonyl chloride, xanthate, and sulfonyl hydrazine but issues of instability and toxicity still remain. To circumvent these problems, we invented a method using sodium sulfinate as an optimal sulfur source with high stability and safety. As a result, a C-S coupling reaction of aryl iodides with sodium arylsulfinates using CuO as the catalyst and DABCO as the deoxygenative reagent has recently been reported.[2] Furthermore, to expand the method versatility, we alternatively developed a Chan-Lam type C-S coupling reaction between sodium arylsulfinates and various organoboron compounds using potassium sulfite as the deoxygenative reagent.[3] Mechanistic studies demonstrated that both conditions underwent radical process. These findings suggest the potency of our method using stable and safe commodity chemicals.

Reference

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Reactivity of Osmanaphthalyne

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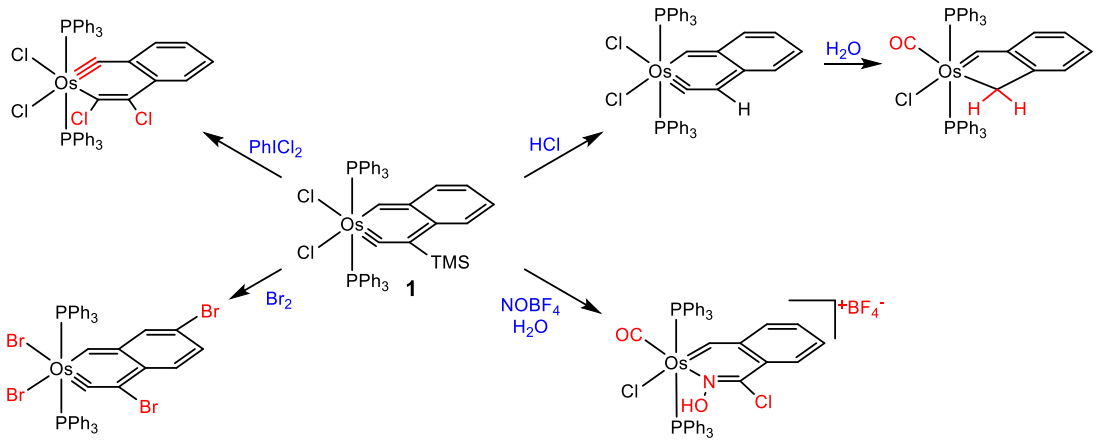
Osmanaphthalyne **1** is derived from formal substitution of one of the carbyne carbons in naphthalyne by the isolobal 14-electron [$OsCl_2(PPh_3)_2$] fragment. Unlike organic arynes, metallaarynes can have a significantly higher stability and therefore allow us to develop their chemistry. Reactions of metallabenzynes have been reported in these two decades, yet those of polycyclic metallaarynes are rare because of the difficulties in their syntheses. Recently we have developed a facile method to synthesize polycyclic osmaarynes using alkyne-functionalized phosphorus ylides.[1] We herein report some examples of the reactivity of the β-osmanaphthalyne **1**. It can undergo reactions similar to its organic counterparts, such as electrophilic substitutions or addition reactions, but with different regioselectivity and products' stability, reflecting its organometallic properties.



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The *ab-initio* DMRG's Perspective for the Fundamentals and Analysis of Singlet Fission

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Undoubtedly, the sun is one of the most powerful energy sources, yet its potential has not been unraveled. However, the electronic excitation in some organic molecules can split to form two triplet excitons. This singlet fission process can potentially be utilized to harness more energy than the conventional photovoltaic devices, thus surpassing the Shockley–Queisser limit. While there are many proposed mechanistic assertions and rationale about the fission process, its application has remained relatively obscure due to the complex quantum interactions between strongly correlated electrons and their vibrational environment.

We present a novel wavefunction analysis methodology based on the *ab-initio* density matrix renormalization group (DMRG) method to precisely capture the strong correlation between various triplet-pair and charge-transfer states. This algorithm includes the 'two-particle formalism' to quantify the multiexcitonic character of associated electronic states, rather than employing the crude approximations of diabatic states employed in most existing reports. Our analysis discloses the role of dual charge-transfer states and their admixture with the correlated triplet-pair state *via* crucial vibrational pathways in governing the population generation and delocalization kinetics associated with the triplet-pair state within distinct vibronic regions in pentacene dimer. Additionally, these computational tools are employed to develop various doped and molecular-linker based new singlet fission molecules with enhanced charge-mobility in the molecular skeleton and extraordinary singlet fission rates.

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Circular L-RNA aptamer promotes target recognition and controls gene activity

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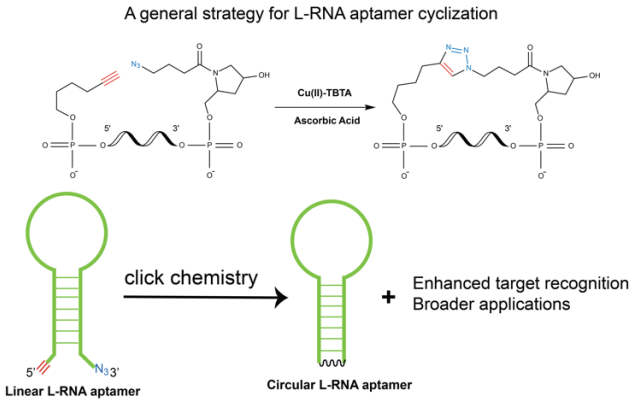
Abstract

Rational design of aptamers to incorporate unnatural nucleotides and special chemical moieties can expand their functional complexity and diversity. Spiegelmer (L-RNA aptamer) is a unique class of aptamer that is composed of unnatural L-RNA nucleotides, and so far there are limited L-RNA aptamer candidates and applications being reported. Moreover, the target binding properties of current L-RNA aptamers require significant improvement. Here, using L-Apt.4-1c as an example, we develop a simple and robust strategy to generate the first circular L-RNA aptamer, cycL-Apt.4-1c, quantitatively, demonstrate substantial enhancement in binding affinity and selectivity towards its target, and notably report novel applications of circular L-RNA aptamer in controlling RNA-protein interaction, and gene activity including telomerase activity and gene expression. Our approach and findings will be applicable to any L-RNA aptamers and open up a new avenue for diverse applications.



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Target, Nontarget and Suspect Screening and Temporal Trends of Per- and Polyfluoroalkyl Substances in Marine Mammals from the South China Sea

Qi Wang, Yuefei Ruan, Kennth M. Y. Leung, Paul K.S. Lam

Abstract

Per- and polyfluoroalkyl substances (PFASs) have been manufactured and widely used for over sixty years. Currently, there are thousands of marketed PFASs, but only dozens of them are routinely monitored. This work involved target, nontarget and suspect screening of PFASs in the liver of Indo-Pacific humpback dolphin (*Sousa chinensis*) and finless porpoise (*Neophocaena phocaenoides*), two resident marine mammals in the South China Sea, stranded between 2012 and 2018. Among the 21 target PFASs, perfluorooctane sulfonate and 6:2 chlorinated polyfluoroalkyl ether sulfonate (6:2 Cl-PFESA) predominated in the samples, accounting for 46.2% and 30.3% of the total PFASs, respectively. Significantly higher PFAS concentrations (p<0.05) were found in dolphin liver samples [$3.23\times10^3\pm2.63\times10^3$ ng/g dry weight (dw)] than in porpoise liver samples ($2.63\times10^3 \pm1.10\times10^3$ ng/g dw), mainly because of their different spatial distributions and dietary habits. Significant increasing temporal trends (p<0.05) were found in the concentrations of two emerging PFASs, perfluoroethylcyclohexane sulfonate and 2,3,3,3-tetrafluoro-2-propanoate, indicating increasing pollution by these emerging alternatives. Forty-four PFASs from 9 classes were additionally identified by nontarget and suspect screening, among which 15 compounds were reported for the first time in marine mammals. A primary risk assessment showed that the emerging PFAS 6:2 Cl-PFESA could have adverse effects on most of the investigated cetaceans.

The Influence of Different Carbonate Ligands on the Hydrolytic Stability, Reduction, and Cytotoxicity of Platinum(IV) Prodrugs

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Abstract

Pt(IV) complexes bearing axial carbonate linkages have drawn much attention recently.[1,2] A synthetic method behind it allows to attach the OH of bioactive ligands to Pt(IV) complexes, and the rapid release of free drugs is achieved after the reduction of carbonate-linked Pt(IV) complexes. Further understanding on the properties of Pt(IV) carbonates such as hydrolytic stability and reduction profiles, however, is hindered by limited research. In this study, we aim to figure out the properties of Pt(IV) carbonates with different axial ligands. Accordingly, six mono-carbonated Pt(IV) complexes in which the carbonate axial ligands possess various electron-withdrawing powers were synthesized and their properties were investigated, and the corresponding mono-carboxylated analogues were also prepared as references to highlight the different properties. This study provides new information on the influence of axial carbonate ligands with different electron-withdrawing abilities on the properties of the Pt(IV) complexes, which may inspire new thoughts on the design of "multi-action" Pt(IV) prodrugs.

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Design and Synthesis of A Reactive Monotrifluoromethyl-Substituted Platinum(IV) Compound: Proof-of-Concept for S_N2 Nucleophilic Substitution Reaction

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Abstract: Platinum-based anticancer drugs, including cisplatin, carboplatin, and oxaliplatin, are extensively used in clinics. All these chemical drugs are square planar platinum(II) complexes, and the notion that platinum(IV) prodrugs are chemically and biological inert has been widely accepted. However, octahedral platinum(IV) structure is an attractive form due to the presence of extra axial ligands, and more characteristics can be endowed to platinum(IV) units than platinum(II) moieties. Disappointingly, platinum(IV) complexes can only be used as prodrugs, and two ligands have to be released before exerting their biological activities. Herein, we design and synthesize a monotrifluoromethyl-substituted platinum(IV) compound. We detected the direct reactions of platinum(IV) and various substrates in water at 37 ℃. The monotrifluoromethyl-substituted platinum(IV) exerts great stability in water but high reactivity to various buffers and 5'-*d*GMP at 37 ℃. The reaction mechanism study indicates that this compound interacts with phosphate via S_N2 nucleophilic substitution reaction, which is different from platinum(II) compounds.

Ultrasound-Activatable Platinum(IV) Prodrug for Imaging-Guided Sono-Sensitized Chemotherapy

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Abstract

Utilization of exogenous activators is an effective way to controllably activate metal-based anticancer therapeutics. Beyond light-driven activation of Pt(IV) prodrugs, herein, an ultrasound-responsive Pt(IV) prodrug is presented for multimodal imaging-guided sono-sensitized chemotherapy. The prodrug molecule consisted of sonosensitizer and carboplatin moieties, which can utilize ultrasound energy to excite the prodrug molecule and subsequently release carboplatin as well as reactive oxygen species for combinatorial ablation of cancer cells. As validated by *in vitro* experiments, this prodrug can effectively accumulate in cancer cells and tumor tissues. Upon exposure to ultrasound, the acute cancer cell-killing effect is generated. With the guidance of optical/photoacoustic/ultrasound tri-modal imaging and concisely controlled focused-ultrasound, the *in vivo* ultrasound-triggered antitumor therapy can be confirmed with minimal systemic adverse effects due to its non-invasiveness and stimuli-responsiveness. The overall theranostic outcomes achieved by this ultrasound-activable Pt(IV) prodrug may open up novel approaches towards sono-sensitized chemotherapy to fight against cancer.

Proteome-Wide Target Profiling of Pt-based Anticancer Drugs in Native Biological Systems

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Abstract

Since FDA approval just over 40 years ago, cisplatin and its more recently approved analogues, carboplatin and oxaliplatin, have been widely used to treat a spectrum of different cancers worldwide. Pt(IV) prodrugs represent a promising class of non-conventional platinum-based anticancer agents that attract increasing attention from scientific community. Despite the overall success of this class of anticancer prodrugs, little is known about their cellular targets in cancer cells.[1] Herein, we reported the first attempt to comprehensively profile cellular targets of Pt-based drugs in native biological systems. Four platinum-based probes, P1/2/3/4, were successfully developed by attaching alkyne-containing and "minimalist" photo-crosslinkers to Pt(II) and Pt(IV) moeities. Initial stability test indicate the rapid hydrolysis of the Pt(IV) probes in the PBS buffer. In the presence of the sodium ascorbate, Pt(IV) probes first undergo fast hydrolysis, and then are reduced to Pt(II) counterparts, which contradicts to our general understanding on Pt(IV) activation. In addition, in the presence of excess organic solvent, the resulting hydroxido ligands were substituted, suggesting a new synthetic way of introducing equatorial ligands into existing Pt(IV) complexes.

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Synthesis, Stability, and Cytotoxicity of Cisplatin- and Carboplatin-Based Platinum(IV) Anticancer Complexes Bearing Axial Pyridine

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Abstract

Oxygen-donors have been widely used as axial ligands in Pt(IV) anticancer prodrugs. In recent years, other types of axial ligands including nitrogen- and halogen-donors also show promising applications.[1] To obtain these Pt(IV) complexes, oxidation of the corresponding Pt(II) species with selected oxidants was the major approach to introduce axial ligands.[2,3] Novel Pt(IV) complexes bearing non-conventional axial ligands may possess unexpected properties. Herein, we reported the synthesis of Pt(IV) complexes bearing axial pyridine by oxidation and ligand exchange reactions. All the tested Pt(IV) complexes were hydrophilic, water soluble, and effective to kill non-small cell lung cancer cells as well as the corresponding Pt-resistant ones. These pyridinyl Pt(IV) complexes enriched the family of axially N-coordinated Pt(IV) prodrugs. Our studies also indicate that conjugating axial ligands via pyridine moiety to Pt(IV) center could be a new strategy for the development of Pt(IV) antitumor prodrugs.

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Mass Spectrometry Imaging Revealed Alterations of Lipid Metabolites in Multicellular Tumor Spheroids in Response to Hydroxychloroquine

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Abstract

Three-dimensional (3D) multicellular tumor spheroids (MCTS) that mimic the complex tumor microenvironment provide a good platform for in vitro study of drug and endogenous metabolites.[1] Hydroxychloroquine (HCQ) has shown anti-tumor activity in a variety of tumor models.[2] However, the effect of the drug on the alteration of lipid metabolism spatial composition and distribution in the MCTS model is not clear. Herein, we utilized matrix-assisted laser desorption/ionization-mass spectrometry imaging (MALDI-MSI) in the analysis of A549 lung cancer multicellular spheroids to investigate the in situ spatial distribution of HCQ and its effect on lipid metabolism. We have successfully observed the spatial variations of HCQ in the inner region of the spheroid at different drug-treated time points. The MSI results also demonstrated that HCQ treatment altered the spatial composition of lipids in the inner and outer regions of treated spheroids. Furthermore, the lipidomic results showed that the identified phosphatidylcholines (PC), lysophosphatidylcholines (LPC), phosphatidylethanolamines (PE), lysophosphatidylethanolamines (LPE), phosphatidylinositols (PI), ceramides (Cer), glucosylceramides (CerG), and diglycerides (DG) were significantly up-regulated, and phosphatidylglycerol (PG) and triglycerides (TG) were remarkable down-regulated. MSI method combined with LC-MS/MS profiling of endogenous metabolites can obtain more detailed information about how spheroids respond to drug and spatial distribution information, thus fostering a better understanding of the relationship between drug-altered lipid metabolism and cancer microenvironment.

Reference

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Cellular mechanism of triclosan-induced dermal toxicity from a combined metabolomic and lipidomic approach

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Abstract

Triclosan (TCS), an antimicrobial chemical, has been extensively used in consumer and personal care products. Considering *in vivo* evidences have indicated that topical use of TCS could lead to serious skin lesions[1], it is thus in urgent need to unveil the underlying mechanisms of dermal toxicity caused by TCS application. In this study, we applied metabolomics and lipidomics to investigate TCS-induced changes of endogenous small molecular metabolites and lipids in human HaCaT keratinocytes. Metabolic biomarker analysis revealed that TCS exposure was associated with the elevation of purine and glutathione metabolism, and down-regulation of amino acid metabolism in keratinocytes. TCS-induced oxidative stress was further validated, functioning as the crucial factor for the generation of pro-inflammatory cytokines that triggered inflammation and lipid disturbances related to cell apoptosis. Our findings update the existing understanding of skin health risks of TCS application at the molecular level[2].

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Integrated metabolomics analysis reveals altered energy metabolism in adipose tissue of diabetic mice

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Abstract

Adipose tissue regulates many important physiological processes, and its dysfunction such as insulin resistance (IR) in type 2 diabetes is closely related to its disordered metabolic profile. However, the potential mechanism is still unclear[1]. To this end, non-targeted combined with targeted metabolimics based on ultra performance liquid chromatography coupled with mass spectrometry systems were used to assess the metabolic profile of subcutaneous adipose tissue between db/ + and db/db diabetic mice. Sixty-seven metabolites were identified that contributing to the discrimination of normal and diabetic mice. Among these differential metabolites, the abnormal metabolic profile of free fatty acids is mainly manifested in the significant decrease of propanoic acid (C3), myristic acid (C14:0), palmitic acid (C16:0), stearic acid (C18:0) and arachidic acid (C20:0). In addition, several metabolites in TCA cycle were increased significantly in adipose tissue which were associated with compensatory increase of energy metabolism in mitochondria under hyperglycemia[2]. The present results suggest that abnormal energy metabolism in mitochondria may be a potential mechanism of adipose tissue dysfunction and insulin resistance in diabetic mice.

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Characterization of linkage between biotin and rheumatoid arthritis

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Abstract

Rheumatoid arthritis is a chronic, disabling and incurable disease characterized as a complex genetic autoimmune disorder[1]. Gut microbiota (GM) have been implicated in RA[2]. However, the identity and pathogenicity of specific microbes are still inconclusive. Using metabolomics, a potential GM-associated biomarker called biotin was found. Mammals cannot synthesize biotin which can be obtained only through diet and synthesis of the gut microbiome. We hypothesized that symbiotic gut microbiota linking biotin metabolism might contribute to metabolic phenotypes and pathogenesis of RA.

To test this hypothesis, collagen-induced arthritis (CIA) mice were fed with a biotin-deficient diet. Based on the platform of mass spectrometry (MS)-based metabolomics, we investigated alterations of host metabolites in response to RA inflammation and interaction with GM. Meanwhile, the corresponding inflammatory phenotypes and GM alterations were assessed. We found that the arthritis incidence attenuated in the CIA mouse model under biotin-deficient conditions, accompanied by restored splenic CD4+ cells, suggesting that biotin-deficiency has impacts on the host immune system. And there were alterations in host amino acids, which were closely related to inflammatory and immune responses. Furthermore, these altered microbial signaling molecules were associated with the host gut microbiome. Thus, biotin deficiency had links with a lower risk of RA via its influence on the cross-talk between GM and host metabolic phenotype.

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DNA/RNA adducts formation from bisphenol F 3,4-quinone metabolite *in vitro*

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Abstract

Bisphenol F has been used to substitute BPA to manufacture industrial and consumer products due to its similar structural characteristics. However, no data are available to evaluate the genotoxic effect of BPF in forms of DNA/RNA-adducts formation. In this study, the mechanisms of the reaction between BPF with deoxyribonucleosides/ribonucleosides *in vitro* were investigated by using ESI-MS/MS. According to the mechanism of Michael Addition, BPFQ has one electron-deficient carbon (C-6) available for nucleophilic attack by N-7 and the exocyclic NH_2 group at position N-2 of dG, G, dA and A, which could result in the formation of two types of adducts theoretically. For the reactions between BPFQ and dG and dA, the results showed that Michael Addition was initiated between the electron-deficient C-6 from BPFQ and the N-7 and the exocyclic NH_2 group from dG and dA, which results in the formation of type I and type II adducts. However, for A, G, dC and C, the adducts were only formed by nucleophilic attack of the NH_2 group at C-6 position of BPFQ. For T and U, Michael addition did not take place because of the steric hindrance. The results for the biotransformation processes of dG, dA, G, A, dC and C were in accordance with the results of synthesis.The results for the ESI-MS/MS analysis of the digestion mixture of DNA treated with BPFQ were also consistent with the results of synthesis. We conclude that BPF could covalently bind to DNA/RNA *in vitro* to form DNA/RNA adducts mediated by quinone metabolites.

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Redox proteomics for investigation the cellular toxicity of 1-Nitropyrene

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Abstract

1-nitropyrene (1-NP) is one of the most representative diesel exhaust-sourced component of fine particulate matter (PM2.5) and a potential carcinogen[1]. In addition, 1-NP demonstrates a significant higher cytotoxicity than its structural analogs and precursor[2]. In this study, we compare 1-NP with its structural analog 3-nitrofluoranthene and precursor pyrene in human lung epithelial cell lines. An acute ROS accompanied with cell death was observed for 1-NP. Using compound-centric redox proteomics analysis, we showed that 1-NP significantly re-modeled the redox proteome and specifically targeted on ROS reduction pathway. Superoxide dismutase 1 (SOD1) was identified as a potential target. We further demonstrated that 1-NP directly acted on cysteine residue Cys111 and inhibited SOD activity. The position of nitroxide determines its direct target and contributes to the unique mechanism of 1-NP. A novel mechanism for 1-NP cytotoxicity and ROS induction was therefore proposed[3].

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Comprehensive Characterization of Environmental Cadmium Toxicity on Rice, Mouse and Human Urine by Mass Spectrometry-Based Omics Analysis

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Abstract

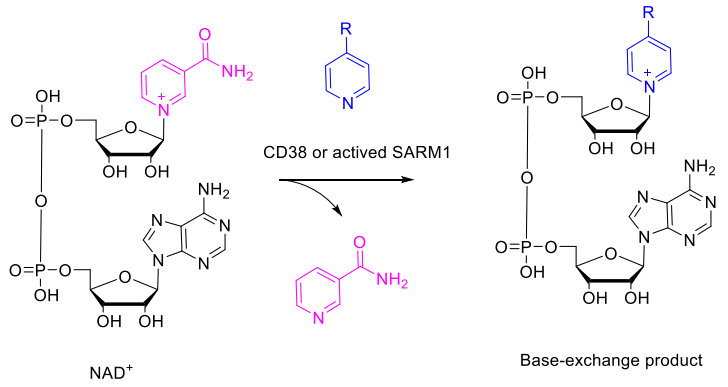
Cadmium (Cd) is a toxic environmental pollutant that has detrimental effects on plants, animals and human-beings. Mass spectrometry (MS)-based omics analysis has been widely applied in providing massive information associated with environmental pollution. The selection and breeding of rice varieties with low-cadmium accumulation is one of the most economical and ecological methods to reduce cadmium exposure. And exploring the multi-system organ failure caused by cadmium is the first step to understand its ill-health effects. In this study, two contrasting indica rice grains under cadmium stress were subjected to mass spectrometry-based metabolomics analysis for the first time. Then the systematic metabolomics and lipidomic characterizations on female ICR mice tissues under cadmium exposure was firstly conducted. Several representative lipids on the mouse liver were visualized by AP-MALDI MSI. Finally, a metabolomics investigation on urine from a cohort of 144 volunteers was conducted to explore sex-specific metabolic alteration and to screen biomarkers related to cadmium-induced nephrotoxicity. These insights could enhance knowledge in cadmium toxicity of public health and guide risk assessment in the future.

Design and Synthesis Small Molecule Probes of Detecting cyclic ADP-ribose synthases enzymic activity of SARM1 and CD38 via base-exchange activity reaction

HUANG Ke

Abstract

CD38 and Sterile alpha and TIR motif containing 1 (SARM1) are both cyclic ADP-ribose synthases (cADPRSs). They involve in multiple biological process by converting NAD^+ into ADP-ribose (ADPR) and cADPR. CD38 regulates Ca^{2+} channel via its enzymatic activity. A deeper understanding of its catalytic mechanism helps to better develop inhibitors for curing related diseases. SARM1 regulates axonal degeneration through its NAD metabolizing activity and is a prominent drug target for many neurological disorders. Here we designed and synthesized a series of fluorescent probes for studying catalytic mechanism of CD38 and imaging the activation of SARM1's enzymatic activity inside live cells. The strategy was based on our recent finding that the CD38 and activated SARM1 are a multi-functional enzyme catalyzing not only NAD hydrolysis but also the exchange of the nicotinamide of NAD with a base. A series of fluorescent probes were synthesized by conjugating the styryl derivatives to pyridine to serve as substrates for the base-exchange.



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Multiplex detection of foodborne pathogens by real-time loop-mediated isothermal amplification on a digital microfluidic chip

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Abstract

Rapid detection of foodborne pathogens is critical to assure food quality. In this study, a digital microfluidic (DMF) chip in combination with loop-mediated isothermal amplification (LAMP) was developed for multiplex detection of four common foodborne pathogens including Staphylococcus aureus, Listeria monocytogenes, Escherichia coli and Salmonella typhimurium. The DMF chip contains ten reaction chambers, on which primers targeting different genes were dehydrated, for simultaneous amplification in the volume of 2 μl per reaction. The limit of detection was 102 copies of genomic DNA per reaction for all four microorganisms. Using spiked milk for real food application, as low as 103 CFU/ml of the target bacteria were detected simultaneously in a single test. The proposed method was cost-effective and exhibited comparable sensitivity to the LAMP-based commercial kit but has advantages of simpler operation and shorter time. The DMF chip with dehydrated primers was ready to use in fields with good stability after storage at room temperature for 60 days, and was estimated to be stable for 106 days storing at room temperature, showing great potential for point-of-care (POC) testing of various foodborne pathogens.

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Title: Quantification of element contents in human hair with filter paper by LA-ICP-MS

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Abstract:

Human biomonitoring (HBM) is important in evaluating the exposure of different chemicals in human body. Blood is the most commonly used sample for determining the concentration of chemicals in the body. However, blood collection is invasive that poses risk of infection to an individual. Using non-invasive sample in HBM will not only avoid the main drawback of blood collection, but it also provides extra information compared with blood analysis. Hair is one of the commonly used non-invasive sample matrices in HBM. The disulfide bond in the keratin serves as an excellent binding site for different elements.

In the present study, Li, Mn, Cu, As, Sr, Y, Ba, Pb, U in hair were analyzed by laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS). Filter papers spiked with different concentration of elements were used to prepare a calibration curve for the quantification. This method had been widely applied to different sample matrices but not hair. It provides a simple and rapid quantification method for elemental analysis in hair. A novel sample preparation method of hair CRM pellet for method validation was developed. The filter paper quantified value was compared with the acid digestion result. The correlation of the two results were drawn by linear regression with coefficient of determination larger than 0.95. After applying the correction factor, the recovery of all elements ranged from 90 – 110%. The present study showed that filter paper is a potential calibration medium for hair elemental analysis using LA-ICP-MS.

Tracking the biodistribution and biotransformation of cerium dioxide nanoparticles in vivo through an integrated inductively coupled plasma-mass spectrometry-based analysis strategy

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Abstract

In order to understand the biological fate of cerium dioxide nanoparticles (CeO_2 NPs) in organisms, two key aspects we must address are biodistribution and biotransformation. Herein, we devised an integrated inductively coupled plasma-mass spectrometry (ICP-MS)-based analytical method that can track both the biodistribution and biotransformation of CeO_2 NPs, and we applied this method to investigate the biotransformation of single intraperitoneally administered CeO_2 NPs in major organs of mice (liver, spleen, kidney and thymus). It was found that CeO_2 NP biotransformation was organ-specific. CeO_2 NPs were barely transformed in thymus; the fact that Ce concentration in that organ first increased then decreased further indicated that the thymus was a "holding station" in CeO_2 NP translocation. Dissolution of CeO_2 NPs was observed in the kidney, liver and spleen. Around 50% of CeO_2 NPs were dissolved in kidney on Day 1, while the remaining CeO_2 NPs barely transformed in the following days. In liver and kidney, the dissolved Ce was believed to recrystallize on NPs $\geqslant$ 35nm in diameter, resulting in the agglomeration of NPs. On Day 90, CeO_2 NPs in the liver were still agglomerated while those in the kidney had separated. Increased pro-inflammatory response over time was reported the in the liver, suggesting a persistent and worsening inflammation induced by CeO_2 NPs. This inflammation is believed to be associated with CeO_2 NP biotransformation.

Title: Environmental emerging contaminants: their transformation chemistry and potential hazards

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Abstract

The contamination problems of emerging contaminants (ECs) are under concerns not only due to their ubiquitous occurrence, but also their ecotoxicity and potential health impacts to human. After entering to the environment, ECs will undergo transformation forming different kinds of transformation products (TPs) with enhanced toxicity. Yet, knowledge regarding the environmental fate, transformation pathway and toxicity impact of ECs and their TPs are scarce.

As a newly recognized class of ECs, UV filters are found widely occurred in aquatic bodies, sediments and bioaccumulated in aquatic living organisms. Several UV filters were reported to be potential endocrine disrupting and hazardous to the ecosystems and living organisms, such as benzophenone-3 (BP-3), avobenzone and UV-320. However, photostable UV filters are not easily transformed by photolysis, which led to persistence in aquatic systems with a tendency of absorbing to the soil and sediments. Apart from photolysis, MnO_2 degradation is one of the predominant natural attenuation processes which favors reactions with phenolic compounds like UV filters.

In this study, natural attenuation of UV filters by MnO_2 were studied, and the effect of pH change, different water constituents and sunscreens mixture were also evaluated. To understand the transformation mechanisms, TPs identification and transformation pathways were elucidated by high-resolution mass spectrometry. According to the experimental results, the water matrix constituent has greatly affected the MnO_2 degradation efficiencies. In sunscreen mixture, more complex TPs were formed by intermolecular radical coupling. *In silico* toxicity evaluation suggested that most of the TPs have higher ecotoxicity, while persistence and mobility prediction suggested an increased mobility after MnO_2 degradation. These results implied that the TPs of UV filters transformed by MnO_2 may result to greater detrimental effect due to changes of toxicity and physiochemical properties comparing to parent compounds.

A BODIPY-based fluorescent sensor for the detection of Pt^{2+} and Pt drugs

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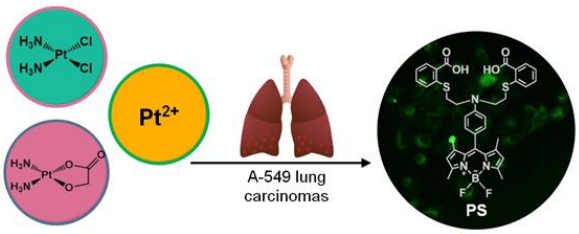
Abstract

A BODIPY-based fluorescent sensor **PS** with NO_4S_2 podand ligand was studied for selective detection of Pt^{2+} over 22 cations as well as selected platinum drugs in aqueous medium. The platinum sensor **PS** shows a 28-fold, 22-fold and 14-fold fluorescence turn-on enhancements to Pt^{2+}, cisplatin and nedaplatin, thereby employed to detect platinum drugs in A-549 human lung cancer cells. The development of **PS** can potentially use as an analytical and imaging tool for Pt drugs, enhancing the research and improvement for platinum chemotherapy in the future.



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Serum Amyloid protein 1 is associated with platelet-tumor cell interaction and its function on tumorigenesis and metastasis

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Abstract

Serum Amyloid A 1 (SAA1) is a type of acute phase protein, whose expression level can be elevated by 1000 folds during acute phase response in human body. Sequencing of SAA1 proteins showed that SAA1 contain the YIGSDKYFHARGNY amino acid sequence, which enables the binding between SAA1 protein and several integrin receptors, including integrin αIIbβ3 and αV[1]. Previous studies in our lab on SAA1 protein isoforms show that SAA1 may perform inhibitory effect on Epithelial-mesenchymal transition (EMT) in Esophageal squamous cell carcinoma (ESCC) via the interaction with integrin receptor αV. On the other hand, integrin αIIbβ3 is also one of potential target of SAA1, which is mainly expressed on platelet membrane and plays crucial role for the platelet activation in circulation system. Several researches indicated the activated platelets can interact with tumor cell and contribute to metastasis of tumor cell[2]. Although people reported that SAA1 expression is suppressed in ESCC tissue, whether the SAA1 expression is related platelet-tumor interaction remain unknown. Therefore, this research project aims to study the relationship between SAA1 and platelet-tumor interaction. And we would like to further investigate how this interaction may interfere the metastasis process of ESCC.

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"Barcode" Cell Biosensor for Rapid, Convenient and Resource-independent Antimicrobial Susceptibility Testing

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Abstract

In recent years many rapid antimicrobial susceptibility testing (AST) methods have been proposed to reduce the misuse of antimicrobials in clinical settings, as to combat against antimicrobial resistance (AMR) and preserve the effectivity of remaining antimicrobials. Nonetheless, few methods are available for studying and combating environmental AMR, which arises from causes such as agricultural activities, industrial discharges, and human wastes, and requires frequent survey of large number of samples. Most of the novel clinical AST methods realized thus far have variety of drawbacks for this purpose, e.g., they are costly and require microscopic analysis and expensive instrumentation, rendering them unsuitable for resource-limited and large-sample amount conditions. A more reasonable strategy is to routinely perform tests onsite, and send any sample suspected to have strong drug resistance to advanced tests. Thus, a convenient and cost-efficient AST method that can rapidly screen a large number of samples at resource-limited condition is required for the study of environmental AMR. Herein, we developed a novel "barcode" cell biosensor based on an adaptive linear filter array as a fully-automatic and microscope-free method for counting very small volume of cells, which concentrates suspended cells into microbars through the filtration effect of nanochannels at the channel sides. The nanochannels are conveniently formed by the roof collapse effect of an elastomer. We combined this biosensor with an on-chip culture that takes much less time than standard methods, thereby realizing a low-cost and high-throughput platform for portable AST, from which results can be obtained through a cell phone. Our "barcode" cell biosensor has shown enormous potential for the study of environmental AST samples due to its microscopy-free analysis, affordability, portability, high throughput, and user-friendliness, making it a powerful weapon in the fight against AMR.

A suspending-droplet mode paper-based microfluidic platform for low-cost, rapid, and convenient detection of lead(II) ions in liquid solution

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Abstract

A paper-based microfluidic device based on unconventional principle was developed and used to detect lead ions through a two-step process including heated incubation and subsequent mixing. The device was made by generating a superhydrophobic pattern, which defines channel and reservoir barriers, on a water-impermeable paper substrate, followed by loading and drying the reagents in the defined reservoirs. Different from the conventional paper-based devices that are made of water-permeable paper, the as-prepared device holds water drops in discrete reservoirs, and the water drops will not move unless the device is titled along the direction of the predefined channels. In this way, the liquid samples applied onto the device are handled as individual drops and could be stored, transported, and mixed on demand. Different from the conventional paper-based devices that use capillary force to drive liquid, our new device uses wetting and gravity as driving force. We name this operation principle suspending-droplet mode paper-based device (SD-μPAD). The use of a Teflon contact-printing stamp makes the production of such devices rapid, cost efficient, and mass productive. Utilizing a G-quadruplex-based luminescence switch-on assay, we demonstrated rapid, convenient, highly sensitive, and low cost detection of lead(II) ions in water samples, using a custom made battery-powered portable device, and a smart phone as the detector.

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Full-hydrogel Microfluidic Platform for Rapid, High-throughput Antimicrobial Susceptibility Testing

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Abstract

Using antimicrobial susceptibility test (AST) as an example, this work demonstrates a practical method to fabricate microfluidic chips entirely from polypropylene (PP), and the benefits for potential commercial use. Primarily caused by the misuse and abuse of antibiotics, antimicrobial resistance (AMR) is a major threat to modern medicine. AST is a promising technique to help with the optimal use of antibiotics for reducing AMR. However, current phenotypic ASTs suffer from long turnaround time, while genotypic ASTs suffer from low reliability, and both are unaffordable for routine use. New microfluidic based AST methods are rapid, but still unreliable, as well as costly due to the PDMS chip material. Herein, we demonstrate a convenient method to fabricate whole-PP microfluidic chips with high resolution and fidelity[1]. Unlike PDMS chips, the whole-PP chips showed better reliability due to its inertness, are solvent-compatible and can be conveniently reused and recycled, which largely decreases the cost and is environmental-friendly. We specially designed 3D chambers that allow for quick cell loading without valving/liquid exchange; this new hydrodynamic design satisfies the shear stress requirement for on-chip bacteria culture, which, compared to reported designs for similar purposes, allows for simpler, more rapid, and high-throughput operation. Our system allows for reliable tracking of individual cells and acquisition of AST results within 1-3 hours, which is among the group of fastest phenotypic methods. The PP chips are more reliable and affordable than PDMS chips, providing a practical solution to improve current culture-based AST and benefiting the fight against AMR through helping doctors prescribe effective, narrow-spectrum antibiotics; they will also be broadly useful for other applications wherein a reliable, solvent resistant, anti-fouling, and affordable microfluidic chip is needed.

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Development of Advanced Photodynamic Molecular Beacons with Multiple Controls for Targeted Photodynamic Therapy

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Abstract

Photodynamic therapy (PDT) is an established treatment modality for various superficial and localized cancers.[1] The therapeutic outcome can be enhanced by conjugating the photosensitizers with tumor-targeting ligands and/or controlling their photoactivities via tumor-associated stimuli. Photodynamic molecular beacons (PMBs), which are quenched by various mechanisms in the native form, can be activated in terms of fluorescence and reactive oxygen species generation upon interactions with cancer-related stimuli.[2] We report herein two dual activatable PMBs, which contains two or three glutathione (GSH)-cleavable 2,4-dinitrobenzenesulfonate (DNBS)-substituted zinc(II) phthalocyanine (ZnPc) units connected by one or two cathepsin B-cleavable peptide GFLG linker(s). The photosensitizing properties of these systems will only be fully activated in the presence of both GSH and cathepsin B, as demonstrated in phosphate-buffered saline and inside a range of cancer cells.[3] The trimeric ZnPc-based PMB has been further conjugated with a cyclic MYIEALDKYA peptide, which exhibits strong and selective binding affinity toward the epidermal growth factor receptor overexpressed in cancer cells.[4] Its photobiological properties are also reported in the presentation.

This work was supported by a grant from the Research Grants Council of the Hong Kong Special Administrative Region (Project No. 11303517).

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Structural studies of bacterial cell division proteins FtsZ and FtsA

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Abstract

The wild-type FtsZ and FtsA proteins of gram-positive Bacillus subtilis and Staphylococcus aureus were successfully overexpressed and purified. The purity of proteins was confirmed by SDS-PAGE analysis and the experimental mass of proteins identified by UPLC-ESI-QTof-MS analysis is consistent with the theoretical ones. Moreover, the results of circular dichroism spectrometer showed that the proteins acquire secondary structure in solution, other than SaFtsZ which is most likely unfolded during protein isolation. The unfolded behavior of intact SaFtsZ was also confirmed by the global Hydrogen Deuterium Exchange-Mass Spectrometry (HDX-MS) analysis showing no significant deuteration compared with the folded SaFtsA. In addition, the linear sequence coverage by online pepsin digestion reproducibly achieved at least 70% in the peptide maps of our protein samples. Thus, it is desirable to undergo the local HDX-MS analysis for the peptides of FtsZ and FtsA itself, as well as the study of protein-protein interaction between FtsZ and FtsA.

A serum metabolomics study on the therapeutic effects of *Ligustri Lucidi Fructus* on calcium deficiency in aged female rats using GC-TOF/MS and UPLC-Orbitrap/MS

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Abstract

Ligustri Lucidi Fructus (LLF, Nüzhenzi in Chinese) is the dried ripen fruit of *Ligustrum lucidum* Ait. (Oleaceae family). It was first documented in the famous ancient Chinese Materia Medica, Shennong Bencaojing (Anonymous, ca. 200 BC), and has been widely used for treatment of rheumatic bone and osteoporotic bone pain. Previous study showed that LLF extract as well as the two active triterpenoids constituents of LLF--oleanolic acid (OA) and ursolic acid (UA) could promote the calcium absorption and regulate the vitamin D metabolism[1]. In this study, a serum metabolomics analysis using GC-TOF/MS and UPLC-Orbitrap/MS was conducted to acquire the metabolic profiles of aged female rats received different treatment, including high calcium diet, medium calcium diet, LLF, OA and OA/UA. Our metabolomics study revealed the metabolic changes induced by calcium deficiency and the interventions of LLF. The results provided important information to evaluate and compare the holistic therapeutic effect of calcium supplement and FLL in improving bone properties.

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Mass spectrometry-based untargeted foodomics approach for authentication of organic origins of water spinach

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The global trends of organic vegetables' consumption are rapidly increasing because of raising demand for healthier food and concerns on environmental sustainability. Water spinach (Ipomoea aquatica) is one of the common leaf vegetables in Asia. In this work, the samples of organic and conventional water spinaches were collected from two traditional cultivation methods: the dryland method (GS, organic n= 15, conventional n=15) and the wetland method (WS, organic n= 14, conventional n=10). The study has used an ultra-high performance liquid chromatography-Orbitrap-mass spectrometry (UPLC-Orbitrap-MS) based untargeted foodomics approach, with both hydrophilic interaction liquid chromatography (HILIC) and C18 analytical platforms. In HILIC platform, a series of primary metabolites, including amino acids, tricarboxylic acids, sugar acids and sugar-phosphates, and secondary metabolites, such as terpenes, glucosinolates, flavonoids and alkaloids, were shown the significant difference of change in relative abundance between the organic and conventional water spinach in both traditional cultivation methods. In C18 platform, the organic and conventional water spinaches (both GS and WS) were differentiated by the major lipid classes, monogalactosyl diacylglycerols (MGDG), digalactosyl diacylglycerols (DGDG) and sulfoquinovosyl diacylglycerols (SQDG), in the membrane of plastids [1] and other lipid metabolites including phospholipids (GPL), diacylglycerols (DG), ceramide (Cer) and carotenoids.

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Metabolomics study of anti-osteoporotic effect of Epimerising Folium base on UPLC-Orbitrap-MS

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Abstract:

Osteoporosis is a systemic bone disease characterized by low bone mass and reduced bone mineral density and leads to aggravate bone fragility and risk of fracture [1]. Estrogen is commonly used to treat osteoporosis but the side effect is a huge concern. Icariin (ICA), a flavonoid isolated from *Epimerising Folium* (Chinese name as Yinyanghuo), has been reported to use as anti-osteoporosis [2]. This study aim at examining the anti-osteoporosis effect and the metabolic pathway of ICA on ovariectomized (OVX) rat serum compare with traditional estrogen replacement therapy and metabolite changes based on UPLC-Orbitrap metabolomics analysis. 94 metabolites in negative ESI mode and 47 metabolites in positive ESI mode which are VIP>1.0 are identified. The result shows that ICA have anti-osteoporosis effect but have different metabolic pathway from estrogen. Carnitine, arginine and citrulline shows high contribution to ICA model in multi-variance analyze and all these pathway is related to bone formation. On the other hands, different metabolic pathway show high contribution in estrogen model. Therefore, it believes the side effect of ICA is different from estrogen but similar in anti-osteoporosis effect.

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Metabolomics analysis of mice serum for parental exposure to $PM_{2.5}$

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Abstract

Parental exposure to fine particulate matter ($PM_{2.5}$) is associated with increased risk of neurodevelopmental disorder in offspring. However, the impact of parental $PM_{2.5}$ exposure on the metabolic change in parental mice has not been fully examined. This study investigated the effects of parental exposure to $PM_{2.5}$ on the serum metabolites profile and identified potential biomarkers. Pregnant mice were subjected to concentrated $PM_{2.5}$ or filtered air exposure with instillation during gestation. Their serum were analyzed by ultra performance liquid chromatography- orbitrap mass spectrometry (UPLC-Orbitrap/MS). Partial Least-Squares Discriminant Analysis (PLS-DA) and heatmap analysis were performed to discover potential biomarkers for further pathway analysis.

Structural dynamic study of FtsB/L protein complexation by Hydrogen-deuterium Exchange Mass Spectrometry

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Abstract

Divisome is a group of proteins responsible for bacterial cytokinesis. This multi-protein complex synthesizes the septal peptidoglycan (sPG) that separates two new daughter cells at the poles during cell division.[1] The divisome formation is based on a hierarchical protein order, including the essential FtsBL sub-complex that regulates the PG synthase.[2] However, limited information regarding the structure and conformational dynamic due to its' trans-membrane property. Here, we employ Hydrogen-Deuterium Exchange Mass Spectrometry to determent the conformation behavior of FtsB and FtsL in the free state and after complexation. FtsB is an unstructured protein with a membrane-embedded helix. The interaction with FtsL would induce a periplasmic helix in FtsB and stiffen both proteins. This rigidity enhancement orientates the constriction control domains (CCDs) that may be curial for the regulatory mechanism in the divisome. On the other hand, the flexibility of the FtsB C-terminal is reduced that could facilitate the interaction with other divisomal proteins.

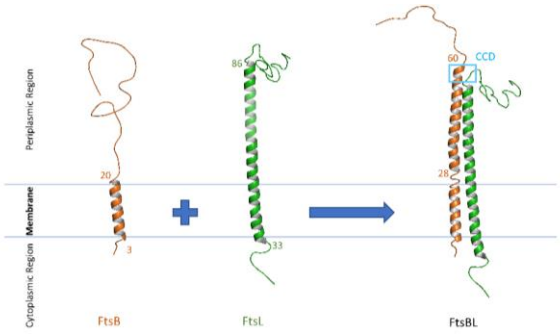

Figure. The dynamic change of FtsB and FtsL upon complexation

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A study of the conformational change of lipid II flipping enzyme MurJ

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Abstract

At present, the global situation of drug-resistant bacteria is serious, and the development of novel antibiotics is imminent.[1] Protein MurJ is widely distributed among different bacterial species, and its structure is relatively conservative. It is essential for bacterial viability and reproduction, as its depletion can cause an accumulation of lipid II at the cytoplasm following by bacterial shape distortion and cell lysis.[2] Therefore, it has become a popular potential antibiotic target.[3] Hydrogen-deuterium exchange is a chemical reaction in which covalently bonded hydrogen atoms are replaced by deuterium atoms. This method has been used in recent years to study membrane protein dynamics, although it has been used to characterize soluble proteins for decades.[4] HDX-MS can provide very useful information, including the conformation changes after binding, protein folding and unfolding pathways.[5] So far, we have designed some recombinant plasmids, and MurJ proteins from *Escherichia coli* and *Thermosipho africanus* have been expressed. Purified proteins identification have confirmed by mass spectrometry.

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Investigation of Peptide Stability for Data Storage

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Abstract

Peptides have wide applications in medicine and biotechnology, and have recently been developed as a medium for data storage.[1] However, limited knowledge has been available about the stability and storage duration of peptides. In this project, 10 18-mer peptides that were used for data storage in our previous study[1] have been chosen to test their stabilities with different elevated temperatures. The peptides were quantitatively analyzed using mass spectrometry, and the data were used to determine the kinetic decay rate (k) and activation energy (E_a) according to the Arrhenius equation. The results showed that the E_a values of most peptides were within a range of 52 ± 15 kJ/mol, while a much higher E_a value was obtained for one of the peptides, which might be related to a much more stable structure. The half-life of the peptides at different temperatures were obtained, with the average value of more than 10 years at -20°C.

This work was supported by Hong Kong Research Grant Council (Research Impact Fund Grant No. R5013-19F)

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Assembly-enhanced Differentiation of Leucine, Isoleucine and Allo-isoleucine in Ion Mobility Mass Spectrometry

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Abstract:

Isomerism is widely observed in natural and synthesized products, can lead to significant differences in the physical and chemical properties of isomers. Leucine (Leu), isoleucine (Ile) and allo-isoleucine (allo-Ile), the easily isomerized amino acids in nature, have only slight differences in their side chains, making their differentiation challenging. Ion mobility mass spectrometry (IM-MS) is an emerging technique for differentiation of isomers, yet differentiation of these three isomers directly is still difficult.[1]

In this study, by optimizing the ESI conditions, additive metal ions and their concentration ratios with the amino acids, we have been able to observe the assemblies of Leu, Ile or allo-Ile up to hepta-copper bound dodecamers. It was found that the difference of the isomer assemblies in drift time and collision cross sections (CCSs) in IM-MS become larger with the increased number of the assembled amino acids, indicating that the isomeric differences could be accumulated and amplified in the assembly process.

The combination of IM-MS, MS/MS and computational modelling have been employed to obtain the structure information of the assembly ions. The preliminary results showed that the assemblies might be formed with the alkyl chains of amino acids protruded outwards and the slight differences between the alkyl chains could be accumulated to eventually cause significant differences. Further study on the analogue compounds confirmed the enhanced differentiation of isomers. These results suggested that assembly could be employed to enhance differentiation of isomers in IM-MS.

This work was supported by Research Grants Council (grant No.15304020) and National Natural Science Foundation of China (Grant No. 81874306).

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Rapid Authentication of Red Wine by Matrix-assisted Laser Desorption/Ionization Mass Spectrometry and Direct Analysis in Real Time Mass Spectrometry

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Abstract

Red wine is one of the most popular alcoholic beverages all over the world, and counterfeit of red wine has been a severe problem in many countries. Authentication of red wine regarding their origins, vintage years, grape types etc. has thus become an important issue. In this study, we report a rapid, simple and high throughput approach for determination of red wine by combining matrix-assisted laser desorption/ionization mass spectrometry (MALDI-MS) and direct analysis in real time mass spectrometry (DART-MS), two techniques that can analyze red wine samples with no or little sample pretreatment. A chemometrics method, orthogonal partial least squares discrimination analysis (OPLS-DS), was employed to generate reliable models based on the spectral results and screen out potential markers. The approach was successfully performed on 535 wine samples from 8 countries with good classification correct rates. Compared to using only one single technique, combination of MALDI-MS and DART-MS allowed detection of more compounds, and higher fitting and predictive results. The satisfactory differentiation results of grape cultivars and vintage years verified the robustness of the approach, which will be further validated with more samples for authentication of other features, e.g., brands and manufacturing techniques.

Data Storage Using Peptide Sequences

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Abstract

Humankind is generating digital data at an exponential rate, but the current storage devices require large physical spaces and have limited longevity. We have developed a novel method that uses peptide sequences for data storage, which can offer high storage density and long storage duration.[1] We chose the optimal constituent amino acids and peptide lengths to facilitate peptide synthesis and sequencing, designed address and error-correction codes to protect data integrity, optimized the LC-MS/MS analytical protocol and developed a software to effectively recover peptide sequences from the tandem mass spectra. This method was successfully demonstrated by storing and retrieving a bilingual text file, as well as an audio file of the music 'Silent Night', with 40 and 511 peptides respectively. These peptides were also carried into space by the Long March-5B rocket, exposing to microgravity and cosmic radiation. After returning to the Earth, the data stored in these peptides could be retrieved correctly, proving the feasibility of this method for space missions.

This work was supported by Research Grants Council Research Impact Fund (Grant No. R5013-19F).

Reference:

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Data Storage and Retrieval using Peptides and MALDI-MS

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Abstract

With the exponentially increasing data, the current data storage devices may be insufficient for data storage in the future. Data storage in molecules would be a potential alternative. In this study, we aim to establish a method for high throughput analysis of data-bearing peptides. Matrix-assisted laser desorption/ionization mass spectrometry (MALDI-MS) was used for rapid peptide detection and tandem mass spectrometry (MS/MS) was used for peptide sequencing to read the stored data. We used peptide sequences which carried encoded information of two datasets from our group's previous study[1] to test the sequencing results using MALDI-MS/MS. By optimizing the analytical protocol and developing a program for spectral analysis and assignment of peptide sequences, 94.53% amino acids from a text file with 40 18-mer data-bearing peptides and 79.66% amino acids from the music file Silent Night with 511 18-mer data-bearing peptides could be correctly identified. The program finished the peptide sequencing in 5 minutes.

This work was supported by Research Grants Council Research Impact Fund (Grant No. R5013-19F)

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An integrative strategy for target profiling of electrophilic compounds

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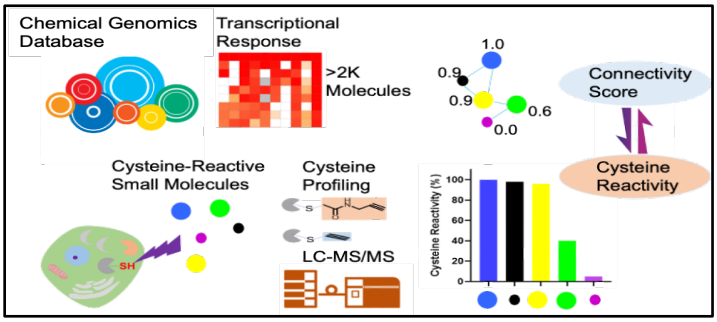
Abstract

Target profiling is important for elucidating the mode of action of druggable small molecules. Several popular methods for target profiling of bioactive compounds have been developed in recent decades, including chemical proteomic approach, genomic method, and bioinformatic prediction. Despite successful endeavors to identify target of small bioactive molecules on an individual basis, there is still lack of a systematic strategy to study a group of structure-unrelated compounds without any prior knowledge so far. Here, we provided a platform that allows parallel target profiling of electrophilic compounds with similar transcriptome perturbations. First, based on the genome-wide transcriptional expression profiles in the chemical genomics platform, five electrophilic compounds with varied transcriptome levels were selected. Next, an optimized cysteine profiling approach with enhanced complementary ability was employed to map reactive cysteines. Our result demonstrated that the cysteine reactivity of electrophilic compounds correlated with their perturbations on transcriptome levels. We anticipate this strategy to provide a more efficient way to screen potential common targets of electrophilic compounds, and to find broad application in drug discovery.



Repurposing Fabric Masks as a Dosimeter for Estimating Human Exposure to Airborne Polycyclic Aromatic Hydrocarbons

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Abstract

Polycyclic aromatic hydrocarbons (PAHs) are a class of carcinogen generated in natural and anthropogenic activities. Exposure to airborne PAHs via inhalation have been affecting human health in both occupational and general public settings. To estimate exposure risks through inhalation, methods utilizing active air pumping coupling sorbent tubes, as well as passive sampling were applied currently.[1-4] Yet, these traditional methods were either expensive or time-consuming. Hereby, we have demonstrated that ordinary fabric mask can be an efficient airborne PAH trapper, with collection efficiency up to 75%, thus being able to eliminate associated cancer risks, apart from the ordinary purpose of blocking aerosol-borne pathogens. Furthermore, it is capable to serve as a novel, convenient and quantitative sampling media, which gives reliable estimate for airborne PAHs exposure down to individual level, in a variety of occupational, indoor and outdoor environments.

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Preparation and surface conjugation of lead-free perovskite nanocrystals for biosensing applications

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Abstract

Lead halide perovskite nanocrystals have been widely studied due to their favorable optical properties but their biological applications are limited due to the presence of toxic lead ions. It is promising to replace lead with other elements such as Bi, Sn, or Sb to solve the toxicity issue. In this work, lead-free perovskite nanocrystals were synthesized using the ligand-assisted re-precipitation (LARP) method. The surface of $Cs_3Bi_2Br_9$ and $CsPbBr_3$ nanocrystals (NCs) was functionalized with either cellulose acetate (CA), glutamine, biotin, and chitosan. The synthesized $Cs_3Bi_2Br_9$ NCs gave blue emission with a maximum at 434 nm, and a PLQY of 4.23 %. In the case of $CsPbBr_3$ a green emission was observed with a maximum at 509 nm. Bathochromic shifts were observed with the change of concentration of CA from 3% w/w to 15% w/w. Currently, we are working to improve the water stability of these lead-free perovskites to enable their use in bioanalysis.

Desktop Injection Molded Centrifugal Microfluidics for Infectious Disease Diagnostics Using Integrated Optical pH Sensors

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Abstract

Infectious diseases are responsible for morbidity and mortality worldwide. Infectious agents proliferate and mutate rapidly, making it important to monitor them, but a lack of scalable and convenient multiplexed diagnostic technologies makes this challenging. A centrifugal microfluidic chip and detection methods were developed that permit rapid point-of-care multiplexed diagnostics. The chips were fabricated using a novel variothermal desktop injection molding method. Rapid heating and cooling of the molds enabled the use of a compact injection molding machine, which makes injection molding accessible in resource limited settings and ensures that prototyped designs are scalable. 100 µm wide microchannels were formed into polystyrene parts with high-fidelity along with other features up to 1.4 mm in height. Each part was produced in under one minute and sealed using double-sided adhesive and an acrylic disc. The chip design incorporated a novel central fluidic mechanism for sample loading using passive overflow valves. The chips featured 15 fluidically separated reaction chambers which can handle multiple diagnostic reverse transcription loop-mediated isothermal amplification (RT-LAMP) assays simultaneously. Fluorescein isothiocyanate covalently coupled to poly 2-hydroxymethylacrylate served as an optical pH sensor and was used to generate readouts in minimally buffered RT-LAMP reactions and yielded results in 30 minutes. The acidification associated with positive LAMP reactions is registered as a 30% decrease in fluorescence by the optical pH sensors deposited into reaction chambers using drop-casting. This technology should provide a means by which public health officials, medical practitioners, and even home users can monitor various infection agents, including viruses, bacteria, and fungi among others.

A Novel Method to Fabricate Teflon Chip for Organic Applications

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Abstract

Microfluidic chips made of fluoropolymers, such as polytetrafluoroethylene (PTFE), perfluoroalkoxy alkane (PFA), and fluorinated ethylene propylene (FEP), show potential merits in organic synthesis owing to their low surface energy, weak small molecule adsorption and excellent solvent resistance. Typical fabrication methods involve the bonding of two Teflon plates; however, high chemical inertness and high melting point of Teflon impose difficulties on the integration of separate parts and the harsh fabrication conditions can cause easy deformation of microfluidic channels. Herein, we proposed a simple and novel method to manufacture whole Teflon microfluidic chips. A metallic microstructure made of nickel was constructed by electroless deposition on the inner walls of PDMS microchannels. After detached from the PDMS mold, the metallic mold was placed onto the FEP sheet. One-step baking process was employed to make a FEP microfluidic chip with embedded nickel microchannels. The nickel was then sacrificed to obtain a whole FEP microfluidic chip without heat embossing while preserving the geometry of the original PDMS microchip. The whole FEP microfluidic chips are suitable for different organic applications, such as photochemistry and organic synthesis because of its high transparency, superior organic solvent compatibility and controllable fluid flows.

Temporal variation of fine particulate matter over 10 years (2008 -2017) in Hong Kong

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Abstract

Air quality control was one of the important concerns on environmental protection. The Hong Kong government monitored and regulated the emissions sources of fine particulate matter ($PM_{2.5}$), which is a typical air pollutant influencing the human health and environment, for over a decade. Changes of annual averaged $PM_{2.5}$ in Hong Kong were widely investigated[1,2,3] and yet a higher resolution temporal variation of $PM_{2.5}$ is needed. In this study, monthly averaged $PM_{2.5}$ from 2008 to 2017 at an urban site Tsuen Wan were analyzed by removing the seasonality (i.e. any repeating cycle) with seasonal and trend decomposition by LOESS method (STL), followed by quantifying the trend component with the general least square and autoregressive moving average model (GLS-ARMA). The $PM_{2.5}$ was found continuously declined with 1.5 $\mu gm^{-3}yr^{-1}$ reduction rate. Composition of $PM_{2.5}$ was notability changed with less elemental carbon (EC) and more organic matter (OM) in the latter years. The major component SO_4^{2-} (-0.36 $\mu gm^{-3}yr^{-1}$) decreased the most, compared with NO_3^- (-0.17 $\mu gm^{-3}yr^{-1}$), organic carbon (-0.18 $\mu gm^{-3}yr^{-1}$) as well as EC (-0.16 $\mu gm^{-3}yr^{-1}$). Trace elements were also studies and found more influenced by the changes of sources origin. Particularly, the shipping fuel exhaust V only significantly dropped after 2015, the implement year of marine emissions control.

Acknowledgement

We thank Hong Kong Environmental Protection Department for logistic support and making available certain PM data. This work is partially supported by the Environment and Conservation Fund (ECF 99/2017).

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Ambient Measurements of Heterogeneous Ozone Oxidation Rates of Oleic, Elaidic, and Linoleic Acid using a Relative Rate Constant Approach in an Urban Environment

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Long-chain unsaturated fatty acids (uFAs), such as oleic acid, undergo rapid degradation via heterogeneous reactions with atmospheric oxidants upon emission. The oxidation mechanism and kinetics have been extensively studied in laboratory experiments. However, quantitative knowledge of degradation rates under real-world atmospheric conditions is scarce. We obtained the nighttime decay rates of three cooking-related uFAs using a relative rate approach applied to bihourly-measured data in urban Shanghai. The estimated lifetime of oleic acid was 6 h under conditions of ~12 ppb ozone and 60-100% relative humidity encountered at our urban location or an inferred ~2 h at a higher ozone level of ~40 ppb. The decay rates of elaidic and linoleic acid are determined to be 0.62 and 1.37 that of oleic acid, respectively. This work provides the first kinetic data pertaining to real-world conditions. They are valuable for constraining the modeling of heterogeneous aging of ambient organic aerosols.

Hourly Organic Tracer-based Source Apportionment of $PM_{2.5}$ before and during the Covid-19 lockdown: A Case Study in Suburban Shanghai

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ABSTRACT:

During the Covid-19 outbreak, lockdown measures were implemented to suppress human activities and associated emissions, leading to distinct atmospheric pollution characteristics during the restriction period. Here, we present online measurements of $PM_{2.5}$ major components and organic molecular markers in suburban Shanghai before (28 Dec. 2019 to 23 Jan. 2020) and during (24 Jan. to 9 Feb. 2020) the lockdown. The NO_x levels declined sharply by 59% from 75 to 31 μg m^{-3} during the lockdown, while O_3, rose two times higher to 83 μg m^{-3}. The $PM_{2.5}$ dropped from 64 to 49 μg m^{-3} (-24%). Nitrate, sulfate, and organics were the predominant species, showing reductions of 58%, 17% and 13%, respectively. Positive matrix factorization (PMF) analysis identifies fourteen factors, including five secondary sources, i.e., sulfate-rich, nitrate-rich, SOA_I (anthropogenic secondary organic aerosols (SOA)), SOA_II (associated with later generation products of organic oxidation) and SOA_III (biogenic SOA)), and nine primary sources. The combined secondary sources contributed to 76% and 63% (43 and 21 μg m^{-3}) of $PM_{2.5}$, respectively, among which the reductions in nitrate-rich (62%) and sulfate-rich (-14%) were prominent. The contributions from coal combustion and biomass burning remained significant, while large reductions (>80%) in primary sources associated with industrial, cooking, and vehicle emissions were observed. Backward trajectories analysis confirmed that regional transport played an important role in $PM_{2.5}$ pollution. Previous studies reported that the restriction during the Covid-19 resulted in enhanced secondary sulfate and SOA formation due to the increasing oxidation capacity, offsetting the substantial reduction of primary emissions in urban areas. While we observed decreased secondary inorganic and SOA formation despite the overall elevated oxidizing capacity in suburban areas, revealing the different mechanisms driving the responses of secondary inorganic and organic formation process to the changes in primary precursors under different atmospheric conditions.

Keywords: Covid-19, organic molecular tracers, source apportionment, regional transport

ACKNOWLEDGMENT:

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Construction of diverse peptide structural architectures via chemoselective peptide ligation

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Abstract

A facile synthetic strategy for constructing diverse peptide structural architectures via chemoselective peptide ligation has been developed. The key advancement involved is to utilize the benzofuran moiety as the peptide salicylaldehyde ester surrogate, and hydroxyl lysine building block or Dap-Ser / Lys-Ser dipeptide as the hydroxyl amino functionality for our in-house Ser/Thr ligation which we previously developed for protein chemical synthesis and head-to-tail peptide cyclization[1-3]. Apart from side chain-to-side chain cyclic peptides, three classes of structural motifs have been successfully synthesized with native peptidic linkages at the ligation sites, including Class I: branched and bridged peptides, Class II: tailed cyclic peptides and Class III: bridged cyclic peptides and bicyclic peptides. These results have demonstrated the flexibility of the chemical ligation approach to construct diverse peptide structural architectures. We anticipate that this strategy will provide an alternative strategic opportunity for synthetic peptide development. It also serves as an inspiration for the structural design of protein-protein interactions (PPIs) inhibitors with new modalities.

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Lambda exonuclease based directed evolution of DNA-Encoded Chemical Libraries

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ABSTRACT:

DNA-encoded chemical libraries (DELs) represent a promising ultrahigh-throughput technology platform for pharmaceutical hit discovery, lead expansion in Chemical Biological research[1]. So far, most DELs were assembled and encoded with double-stranded oligonucleotide[2, 3]. Nonetheless, dsDNA format has its limitation especially when applied in solution selection and it appears that single-stranded tags might be more versatile and flexible, benefit from the facile and fast annealing with chemically custom-built complementary DNA, allowing for the construction of DNA-photo crosslinking conjugates[4, 5], dual-pharmacophore ESAC libraries[6] and Interaction-dependent PCR[7]. In this study, we present an accessible methodology for straightforward generation of high yield ssDNA scaffolds utilized in DEL, achieved by virtue of lambda exonuclease digestion without the need of new library synthesis or any other sophisticated manipulation. Furthermore, based on this approach, we enabled a powerful application to the execution of covalent affinity-based selection towards either immobilized protein or even live cell membrane protein.

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Extracellular Catecholamines Sensing by Streptavidin-Biotin Strategy

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Abstract

Catecholamines are important in many physiological and behavioral processes like emotion and motor control.[1-4] It was reported that abnormal level of catecholamines is associated with neurodegenerative diseases.[1-7] Parkinson's disease, for instance, is characterized by a significant reduction of dopamine level in the brain.[5-7] In this work, we report the development of an extracellular catecholamines detection method featuring streptavidin-biotin binding. An N_3S-Cu^{II} complex, attached on a glass surface, is developed as a selective catecholamine trigger to release a caged biotin.[8-9] Streptavidin-Cy5 was then introduced to conjugate to the released biotin to produce a fluorescent response. Level of extracellular catecholamines can then be revealed by fluorescence imaging of the bound Cy5 on the surface.

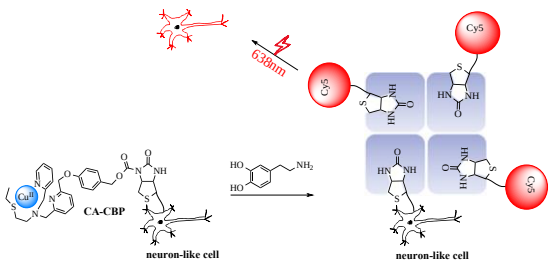

Fig. 1. Schematic illustration of streptavidin-biotin Controlled Binding Probe (**CA-CBP)** for extracellular catecholamines imaging.

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Bismuth-Siderophore-Antibiotic Conjugate against Antimicrobial Resistance

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Pathogenic bacteria scavenge ferric iron from the host for survival and proliferation using small-molecular chelators, siderophores. Siderophore-antibiotic conjugates, also called sideromycins, which were designed based on a "Trojan Horse" strategy wherein features enabled active uptake to bypass the Gram-negative cell wall, have been expected to be an efficient weapon for multidrug resistant strains caused infections in the clinic[1,2]. Cefiderocol, a cephalosporin sideromycin drug for Gram-negative bacterial infections, was approved by FDA recently.[3] Herein, the combination of bismuth(III) and cefiderocol is introduced to enhance the antimicrobial activity against *P. aeruginosa*. The MIC of cefiderocol can be reduced 64-fold after combination with bismuth(III) drugs, indicative of a synergy between sideromycin and bismuth compounds against Pseudomonas aeruginosa strains. The uptake competition between iron(III) and bismuth(III) is considered as one of the reasons to this synergistic effect. We also characterized the 1:1 molar-ratio complexation between bismuth(III) and cefiderocol by a variety of biophysical techniques.

We thank the Research Grants Council (RGC) and Innovative Technology Commission of Hong Kong, the University of Hong Kong and Norman & Celia Yip Foundation for financial support.

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Linker Matters in terms of RNA Localization Study

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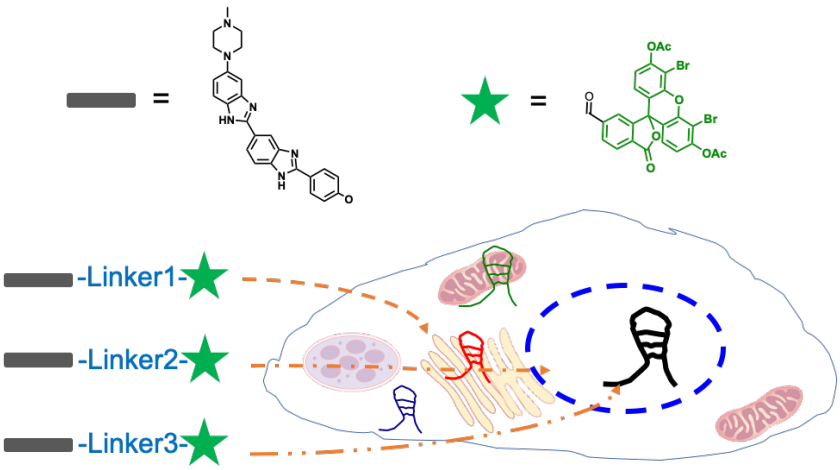
Abstract

RNAs play vital roles in cell survival. Rising evidences suggest RNAs need to be at certain locations inside cells during specific times to execute corresponding biological functions.[1] To assay cellular RNA localizations on a transcriptome-wide level unbiasedly, we developed a light-mediated RNA proximity labelling method, which was extended to protein tagging.[2] A series of singlet oxygen generator were designed and synthesized. Their capability to label adjacent biomolecules through spatially-restricted oxidation under visible light was validated using fluorescence confocal microscopy. The result suggested that careful molecular design is crucial to control the localization of small molecules in living cells, thus leading to more accurate RNA localization studies.



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Selection of DNA-encoded library for novel cell-penetrating peptides discovery

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Abstract

Cell penetrating peptides (CPPs) offer great potential to deliver therapeutic molecules to previously inaccessible intracellular targets[1]. DNA-encoded chemical libraries (DELs) have come of age and emerged to become a powerful technology platform for ligand discovery in biomedical research and drug discovery. Here, we propose to discover novel cell penetrating peptides by screening DELs. We reason that the potential cell-penetrating peptide - DNA conjugate can enter into cells, differentiating from the regular peptides, which stay outsides of cells.

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The reintroduction of ampicillin: ampicillin-siderophore conjugates have selectively antibacterial activity against *P.aeruginosa*

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Abstract

Nowadays, the prevalence of multi-drug bacterial resistance is increasing and inevitable, which makes that enhancing the efficacy of known antibiotics and the synthesis of new antibiotics with new target become an urgent need. Ampicillin, the first generation of broad spectrum antibiotics, is almost not used soely because of the rapid spread of beta-lactamase and the appearance of ampicillin resistance with extremely high frequencies.[1] Here, the method through conjugating ampicillin with a siderophore to improve the efficacy of antibiotic, which is also described as "Trojan-horse" strategy, is introduced. [2] In this strategy, siderophore-antibiotic conjugates are transported into bacterial cell via iron uptake system with the release of antibiotics, thereby resulting to increasing the concentration of antibiotics in bacterial cell. [3] The ampicillin sideromycin (**2CA**) demonstrated extremely potent antibacterial activity against *Pseudomonas aeruginosa* Pao1 (MIC=1 $\mu g \cdot mL^{-1}$), while it almost brings no cytotoxicity to the human cancer cell. This study is beneficial to ameliorate poor transportation of ampicillin related to decreasing number of porins and bring possibility to revive those conventional and outdated antibiotics.

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DNA-encoded chemical libraries for macrocycle ligand discovery

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Abstract

Macrocycles have drawn a great attention in drug discovery because of their unique structural features which are beneficial in targeting traditionally undruggable targets such as protein-protein interactions (PPI)[1]. Discovering new macrocycle drugs is difficult due to complicated cyclized structure and hard to synthesis. Therefore, most of them are the derivatives of natural products[2]. Since there is a great need to develop an effective way to accelerate macrocycle ligand discovery, we employ DNA-encoded library (DEL) with target-guided strategy to efficiently synthesis structurally diverse linear precursors of macrocycle and screen them against challenging protein targets. Unlike previous macrocycle DELs, our approach does not require to cyclize the molecules before screening but make use of the target-guided strategy to promote the cyclisation while binding to the targets. This approach addressed the problems from previous macrocycle DELs such as low cyclisation yield and the presence of the linear precursors impurity[3]. In our library design, we introduce a reactive group in every molecule which can be cyclized under the target template and then produce a capturable group. Therefore, we can identify which molecule is cyclized by the protein after separating the cyclized members out and decoding the DNA sequence. Our method does not only accelerate the identification of macrocycle ligands, but also can encoded the cyclisation events.

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Structural Studies of the Ligand/target Interaction of a Novo Anti-cancer Drug Candidate dhMotC and its Target Human ISOC1

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Abstract

Dihydromotuporamine C (dhMotC), a member of motuporamines, particularly exhibits significant inhibitory effect on cancer cell migration with little cytotoxicity. Recently, it has been identified by our group that the human isochorismatase domain-containing protein 1 (hISOC1) is the cellular target of dhMotC. However, the interaction mechanism of dhMotC and hISOC1 is still unclear. Here we determined the tertiary structure of apo-form hISOC1 (2.5 Å) and complex-form dhMotC/hISOC1 (2.0 Å) by X-ray crystallography. The structure reveals that hISOC1 is a homo-tetramer and the binding pocket for dhMotC locates at the interface of every two monomers. The hydrophobic interaction by the macrocyclic structure of dhMotC and the hydrophobic residues in the pocket mainly contributes to the ligand binding.

Target identification and mechanism studies of Dihydromotuporamine C

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Abstract

There are two core movements in combatting human diseases: identifying the pathology of human diseases formation on the molecular level and finding the potential healing agents to cure them. Bioactive small molecules provide a rich pool of versatile and powerful tools for biomedical research in both aspects. However, the chemical structures of small molecules do not directly reveal their modes of action. In this respect, target identification of the bioactive compound is an essential step to illuminate the underlying molecular mechanism and provide rationales for developing novel therapeutic strategies.

Dihydromotuporamine C (dhMotC), a derivative of Motuporamines, which were isolated from Xestospongia exigua, shows anti-invasion and anti-angiogenesis biological activities, whereas its underlying molecular mechanism in the cell has not been investigated thoroughly. Therefore, identify the target proteins of dhMotC and study the following in-depth molecular mechanism is crucial and may contribute to better understanding cancer development and promote anti-cancer drug discovery.

By applying the DNA-programmed photoaffinity labeling (DPAL) approach, we discovered and verified that protein A to be one of the cellular targets of dhMotC. However, the protein A is not well studied so far. We uncovered that protein A is closely related to cell invasion phenotypically by promoting the activations of MMP2 and plasmin. Hence, dhMotC may inhibit cell invasion by suppressing protein A. Moreover, we investigated protein A involved in-depth cellular pathways and revealed that protein A could stimulate HSP27 phosphorylation through the p38 pathway and suppress SQSTM1 ubiquitination by inhibiting TRIM21.

Development of the next generation of DNA-encoded dynamic libraries

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Abstract

Fragment-based drug discovery has attracted attention and become of great importance in the past decades. However, the evolution of fragments to lead compounds remains to be a highly challenging process that requires much effort. Here, we report a strategy to address this limitation and release a full ligand in the end from a large-scale dynamic library through DEL selection. DNA encoded library (DEL) has also emerged as a powerful tool in the pharmaceutical area. Introducing DNA encoding to a traditional dynamic library can achieve large library size and screen against biological targets in pmol scale. To demonstrate the generality and performance of this approach, a three-million-member DNA-encoded dynamic library has been prepared and selected against various protein targets.

Selection of triangular DNA-encoded glycan library against hemagglutinin of influenza

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Abstract: Influenza viruses use the surface protein hemagglutinin, to bind glycan structures containing terminal sialic acids on the membrane of host cells, which is the molecular mechanism underlying viral infection of hosts.[1] Therefore, compounds that can inhibit hemagglutinin-glycan interactions are expected to be effective agents to inhibit viral entry. However, due to the fact that viral hemagglutinin trimers bind to multiple sialic acid-containing glycan simultaneously, mono-valent inhibitors have been proved to be ineffective in blocking sialic acid binding.[2] In order to address this issue, we designed novel triangular DNA-encoded glycan libraries that can display three glycan ligands simultaneously, matching the three sialic-acid-binding sites on the hemagglutinin trimer and thereby realizing high affinity and selectivity.[3-5] Compound selected from the first generation library shows hemagglutination inhibition activity toward hemagglutinin H7 with an inhibitory constant of K_i = 1 μM. Our second generation library with expanded ligand diversity have been prepared to screen for more compounds that have the potential to facilitate the development of novel anti-influenza drugs.

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Tracking Vanadyl-associated Proteomes in the Premature Aging Disease: Hutchinson Gilford Progeria Syndrome

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Vanadium is a transition element capable of forming various compounds and functioning as an anion or a cation. It exists in +2, +3, +4, and +5 oxidation states, with the tetravalent and pentavalent form being the common oxidation stations in biological systems. [1] Multiple beneficial effects of vanadium have been observed, including anti-cancer, anti-diabetic, anti-hypercholesterolemic activity, cardioprotective and neuroprotective [1], but little is known about the effects of vanadium compounds on aging. Interestingly, we show vanadyl compounds to extend the lifespan of *Lamin A$^{G609G/G609G}$* mice by 15-20%.

In this work, a new strategy was developed by integration of fluorescent imaging with high throughput proteomic analysis to mine endogenous VO^{2+}-binding proteins at proteome wide scale in live wildtype and *Lamin A$^{G609G/G609G}$* MEFs using the vanadyl-chelated fluorescent probe, **VO-*TRACER***. [2,3] We previously demonstrated that this class of fluorescence probes can readily entered cells and track intracellular proteins of interest (POI) [4,5]. Seven putative protein targets of vanadyl ions in living *Lamin A$^{G609G/G609G}$* MEFs and eleven protein targets in living wildtype MEFs are subsequently identified. These proteins are predominantly located at endoplasmic reticulum (ER). The binding of vanadyl ions with selected identified proteins is further confirmed by cellular thermal shift assay. The identified proteins positively correlate to ER stress, confirming that vanadyl might exert its effect at ER. VO-Ohpic is found to downregulate the GRP78, PDIA1 and CHOP protein levels with decrease in the cell ratio of apoptosis, an increase ER Ca^{2+} levels, alleviation of the overloaded mitochondrial calcium and the decreased mitochondrial membrane potential during senescence. Moreover, the effect of VO-Ohpic on postponing premature senescence is not observed in *Lamin A $^{G609G/G609G}$* MEFs upon pretreatment with azoramide. Our study provides important information for further exploration of biological and pharmacological aspects of vanadyl-based metallodrugs.

We thank the RGC and ITF of Hong Kong SAR, Norman & Celia Yip Foundation, and the University of Hong Kong for support.

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Bismuth(III) compounds as inhibitors of nsp14-nsp10 complex of SARS-CoV-2

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Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has posed an unprecedented threat to public health globally. SARS-CoV-2 open reading frames (ORF) 1a and 1b encode 16 non-structural proteins (nsps) which are closely related to virus replication and transcription.[1] Among these nsps, nsp14 functions as an exoribonuclease (ExoN) and S-adenosyl methionine-dependent (guanine-N7) methyl transferase (MTase), and the exoribonuclease activity of nsp14 was stimulated by its critical co-factor nsp10.[2] Due to its important functions in virus replication and transcription, nsp14-nsp10 complex will be an attractive target for anti-SARS-CoV-2 drugs.

Bismuth metallodrugs have a long tradition in antimicrobial medicine for the treatment of *Helicobacter pylori* infection and various gastrointestinal disorder.[3] Herein, we focused on the dual enzymatic activity of SARS-CoV-2 nsp14-nsp10 complex and found that bismuth(III) compounds including ranitidine bismuth citrate, are effective inhibitors of the complex both on its ExoN activity and MTase activity. The activity of bismuth(III) compounds against SARS-CoV-2 nsp14-nsp10 complex is attributed to their ability to displace zinc(II) ions from the zinc-finger motifs by bismuth(III) ions. Our study demonstrates a highly potential of bismuth(III) compounds as anti-SARS-CoV-2 drugs.

This work was supported by the Research Grants Council (RGC), ITF of Hong Kong SAR and the University of Hong Kong.

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Enhancing antimicrobial activity of bismuth(III) against multidrug-resistant bacteria using hinokitiol and its derivatives

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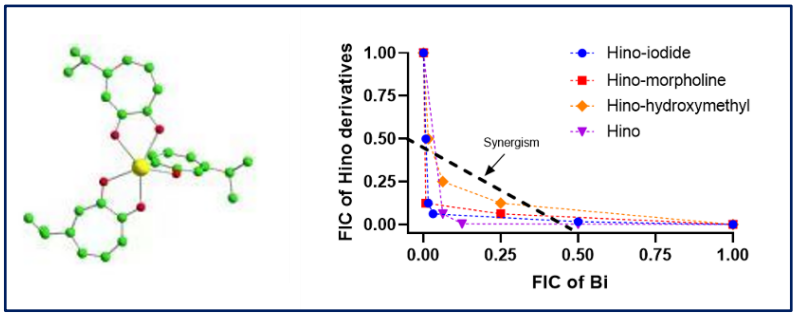
Hinokitiol, a molecule naturally isolated from essential oil of cypress tree, exhibits anti-microbial, anti-fungal, anti-inflammatory, and anti-viral activity, therefore has been widely applied in industry.[1] Moreover, due to its metal-chelating property, it is also called a metallophore, which can form metal complexes.[2]

In this study, we proposed that hinokitiol chelates with bismuth(III), forming a complex which shows antimicrobial activity. A series of thujaplicins derivatives (i.e., hinokitiol and tropolone-related) were synthesized and the combination of bismuth with these ligands are examined against six *Staphylococcus aureus* strains, including MRSA strains. Most of the combinations exhibit synergism (FIC values of less than 0.5) upon treating bacterial strains. We also find out that the antimicrobial activity of bismuth ions with these ligands correlates with on the lipophilicity of the ligands. Detailed antimicrobial activities of these complexes *in vitro* and *in vivo* will be discussed.



This work was supported by the Research Grants Council (RGC) and Innovative Technology Commission of Hong Kong, the University of Hong Kong (URC and Norman & Celia Yip Foundation).

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Gold-based Agents Effectively Inhibit B1 and B2 Subclass of Metallo-β-lactamase

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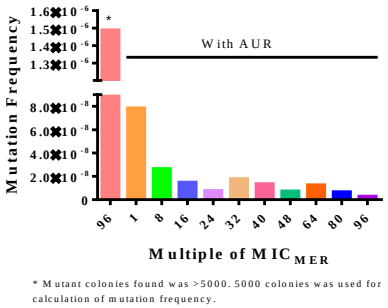
Antimicrobial resistance (AMR) has been spotlighted as one of the top threats to global health. Metallo-β-lactamase (MBLs) production accounts for resistance to β-lactam antibiotics including penicillins and carbapenems.[1]

Previously, we discovered that Bi(III)-based drugs serve as effective inhibitors to B1 subclass MBLs.[2] In this study, we demonstrated Au(I)-based agents including auranofin (AUR), as broad-spectrum inhibitors of MBLs including B1 subclass MBLs (e.g., NDM-1$^+$)[3], and B2 subclass MBLs (e.g., CphA$^+$ and Sfh-I$^+$). Enzymatic assays showed all studied MBLs were strongly inhibited when Au(I) is present in a dose-dependent manner, with the displacement of Zn(II) with Au(I) in their active sites. AUR functioned synergistically with meropenem (MER), reducing the minimum inhibitory concentration (MIC) of MER by 64-folds against NDM-1$^+$ and Sfh-I$^+$ bacteria whereas 16-folds against CphA$^+$ bacteria. The respective bacterial loads were also extraordinarily declined within 24 hours. Furthermore, MER-AUR co-treatment produced a notable reduction in bacterial load in CphA$^+$ bacteria-infected mammalian cells, simultaneously enhanced cell viability by over 14-folds. The antimicrobial activity of the co-treatment was further elucidated by murine peritonitis infection model, with impressive minimizing in CphA$^+$ *Aeromonas Sobria* loading in mouse spleen and kidney in comparison to antibiotic alone. We conclude that AUR along with related Au(I) drugs as broad-spectrum inhibitors of MBLs would largely broaden the therapeutic options in treating the infections caused by multidrug-resistant superbugs.

We thank the Research Grants Council (RGC) and Innovative Technology Commission of Hong Kong, the University of Hong Kong and Norman & Celia Yip Foundation for financial support.



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Auranofin targets GAPDH (Glyceraldehyde 3-phosphate dehydrogenase) in ovarian cancer cells

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Repurposing drugs for new therapeutic utilizations have become an extremely effective approach for many diseases since the discovery and development of new drugs is a drawn-out process with expensive costs and high failure rates.[1] Auranofin, an FDA-approved drug used for rheumatoid arthritis, is now being examined for many other therapeutic utilizations, especially for cancer treatment.[2] However, the molecular modes of action underlying its anticancer properties still remain obscure.

Herein, by utilizing on-line coupling of column-type gel electrophoresis with inductively coupled plasma mass spectrometry (GE-ICP-MS),[3-5] four gold-binding proteins were identified for the first time in A2780 human ovarian cancer cells upon treatment with auranofin. Among the identified proteins, GAPDH (glyceraldehyde-3-phosphate dehydrogenase), an important enzyme involved in glycolysis pathway, was preliminarily validated to be a potential target of auranofin both *in vitro* and *in cellulo*. Auranofin dose-dependently inhibited the enzymatic activity of GAPDH and suppressed glycolytic metabolism in A2780 cells. Furthermore, the knockdown of GAPDH effectively elevated the viability of A2780 cells after auranofin treatment, confirming that reducing GAPDH expression level confers resistance to auranofin in A2780 cells. We conclude that GAPDH is a target of auranofin, providing new information for further understanding its modes of action.

This work was support by the Research Grants Council (RGC) of Hong Kong and the University of Hong Kong (Norman & Celia Yip Foundation, and fellowship to XHX).

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Bi(III)-proteome in *S. aureus*: Uncovering the Molecular Mechanisms of Bismuth Drugs in Pathogens

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Metallomics and metalloproteomics are new frontier interdisciplinary fields of research addressing the entirety of metals and metalloids and their roles, uptake, storage and transport essential for protein functions in organisms, especially in cells and tissues.[1-3] Bismuth drugs have been used for the treatment of *H. pylori* associated gastrointestinal diseases for a long period of time, and have recently been found serve as a class of novel and potent inhibitors of metallo-β-lactamase e.g. NDM-1.[4]

We found that the antimicrobial activities of colloidal bismuth subcitrate (CBS) against *S. aureus* were significantly enhanced upon the addition of hinokitiol through an increase in the cellular uptake of Bi(III). To further figure out the molecular mechanisms of CBS-Hino, GE-ICP-MS system and LC-GE-ICP-MS were applied to uncover bismuth-proteome in *S. aureus*. Compared with GE-ICP-MS, LC-GE-ICP-MS system has better separating resolution and higher sensitivity, resulting in more bismuth-binding proteins to be identified. The Bi(III)-proteome consists of DNA-directed RNA polymerase, chaperone protein DnaK, glucose-6-phosphate isomerase, elongation factor Tu, and glyceraldehyde-3-phosphate dehydrogenase. Some of the bismuth-binding proteins were involved in the glycolysis pathway, indicative of disruption of glucose metabolic process in *S. aureus* by the metallodrug. More bio assay will be carried out to validate these protein targets.

We thank the Research Grants Council (R7070-18, 17308921P) and Innovative Technology Commission of Hong Kong, the University of Hong Kong and Norman & Celia Yip Foundation for financial support.

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Multiplex Metal-Detection based Assay (MMDA) platform for COVID-19 diagnosis and identification of disease severity biomarkers

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The ongoing Coronavirus Disease 2019 (COVID-19) pandemic caused by the novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) poses a huge threat to public health worldwide.[1-3] Accurate diagnosis and understanding of the antibody response is essential for the control of this highly transmissible disease.[4] Herein, by using metal-tagged antibodies as reporting probes, we developed a novel multiplex metal-detection based assay (MMDA) platform for serologic profiling of anti-SARS-CoV-2 antibodies including anti-SARS-CoV-2-spike (S) and -nucleocapsid (N) IgA, IgM, and IgG. The MMDA platform exhibits significantly higher sensitivity and specificity than ELISA for the detection of anti-SARS-CoV-2 antibodies. We classified patients into different subgroups based on distinct antibody landscape through in-depth analysis of multiplex data by high dimensional data exploration/visualization tool (tSNE) and machine learning algorithms. We unbiasedly identified the anti-SARS-CoV-2-N IgG and IgA as the most potently induced types of antibodies for COVID-19 diagnosis, and anti-SARS-CoV-2-S IgA as a biomarker for disease severity stratification. MMDA represents a useful platform not only for the diagnosis and disease severity stratification for the ongoing COVID-19 pandemic, but also for vaccine selection and development.

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Attributes of the [4Fe4S] Clusters in Archaean Species *Sulfolobus Solfataricus*

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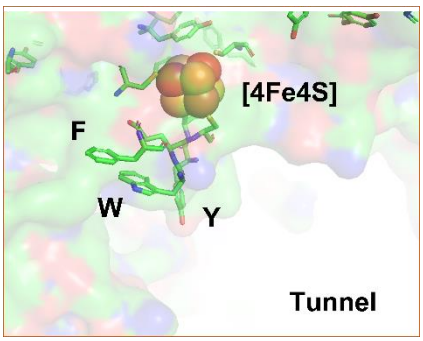
Abstract

Iron sulfur clusters are ubiquitous protein cofactor found participating in vital biochemical redox reactions, such as energy metabolism, nitrogen fixation and DNA repairment[1-3]. Toroidal decamer complex of *Sulfolobus Solfataricus* Cas4 (Sso0001) was revealed containing Mn^{2+} and [4Fe4S] as cofactors. Mutation of manganese coordinating residues had shown interfered binding between protein and DNA substrate, while mutation of [4Fe4S] coordinating cysteines showed loss of affinity between protein and DNA[4]. Aromatic residues of vicinity to [4Fe4S] in Sso0001 were identified and mutated for cluster electron signal transduction investigation. Residues mutated of possible electron signal transduction path between [4Fe4S] and DNA binding region in Sso0001 showed altered nuclease activity to single stranded DNA substrate. Single amino acid substitution of semi-conserved Phe residue showed uplifted nuclease activity, while substitution of conserved Trp and Tyr residues showed attenuated DNA digestion. Besides, W186A and Y190A mutants give chunkier digested DNA products than wild type and F184A mutants, showing retained nuclease activity in the mutants. A possible charge transfer pathway was described between [4Fe4S] and bound DNA herein, with mutation of putative aromatic residues pathing the pathway proving the hypothesis.



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Oral delivery of therapeutic bismuth drug together with N-acetylcysteine as a pan anti-coronavirus strategy

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Abstract

SARS CoV-2 is the causative agent of the outbreak of COVID-19 pandemic. Development of drug therapies against COVID-19 is of paramount to contain its spread and save lives. We previously demonstrated a bismuth drug as a promising anti-SARS-CoV-2 agent (1). However, the efficacy of bismuth drugs *via* an oral route to treat COVID-19 might not be sufficient owing to its low absorption. Here we report that chemical stability and pharmacokinetics profile of a bismuth drug, colloidal bismuth subcitrate (CBS) could be improved by a thiol-containing drug, N-acetylcysteine (NAC). NAC served to increase the peak blood concentration of bismuth and appeared at prolonged absorption time, resulting in a significant elevation in metal exposure. Importantly, combination of CBS and NAC broadly suppresses the replication of coronaviruses including SARS-CoV-2 *via* binding and functionally inactivation of multiple crucial cysteine protease, *i.e.*, papain-like protease, chymotrypsin-like main protease and helicase. Oral co-administration of CBS and NAC reduced viral loads in the lung and mitigated virus-associated pneumonia in a hamster model of SARS-CoV-2 pathogenesis. The co-administration of CBS and NAC offers a general strategy for combatting this and future coronavirus diseases.

We thank the Research Grants Council (RGC) of Hong Kong and Norman & Celia Yip Foundation for financial support

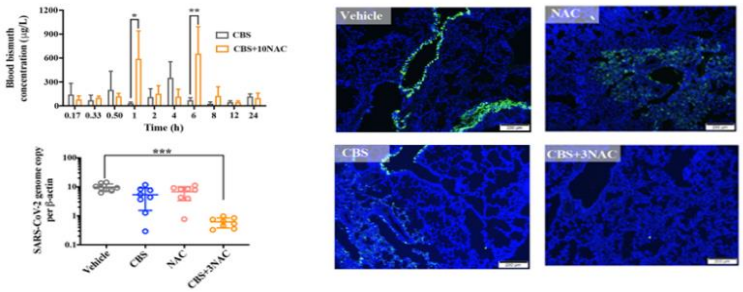

Figure 1. Pharmacokinetic profile of CBS and CBS+NAC (Upper left) and Viral N protein distribution in lung tissues section from groups of hamsters (Bottom left and right)

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The preparation of Brevilin A (BA) analogues and two generations of probes for target identification

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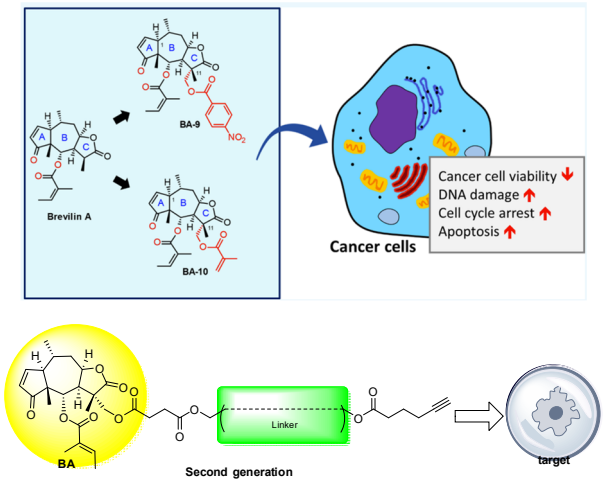
Abstract

Cancer is the second leading cause of death globally and this burden continues to increase. Therefore, there is a clear and urgent need for novel drugs with increased efficacy for the treatment of different cancers.[1] Here, we designed and synthesized a small library of 12 novel BA derivatives and evaluated the biological anticancer effects of the compounds in various cancer cell lines. The results of this structure–activity relationship study demonstrated that our BA derivatives BA-9 and BA-10 possessed significantly improved anticancer activity toward lung, colon, and breast cancer cell lines. BA-9 and BA-10 could more effectively reduce cancer cell viability and induce DNA damage, cell-cycle arrest, and apoptosis when compared with BA.[2] Target identification is important step for study further. So, we designed first generation of probes according to structure–activity relationship study, but we found that the biological activities drop significantly. Then we prepare the second genration and the biological activities can be maintained to about 60%.



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Characterization of the structure and the morphology of zein-based nanoparticles with gum arabic

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Abstract

Encapsulation is one of the most convenient ways to increase the solubility of hydrophobic compounds and enhance the protection of sensitive compounds. The development of natural and edible encapsulation systems is a challenge. This study explored the effects of different amounts of gum arabic (GA) on the structure and morphology of zein nanoparticles (NPs) and the protective effect of the formed NPs on rutin. ZG and ZWG NPs are prepared by different methods and have a series of mass ratios of zein to GA. The results of dynamic light scattering (DLS) and scanning electron microscopy (SEM) found that the average size of ZG and ZWG NPs is larger than that of zein NPs, and excessive GA will significantly increase the particle size of the NPs. The result of zeta potential changed from positive of zein NPs to negative of ZG and ZWG NPs, confirming the interaction between GA molecules and the surface of zein NPs. The results of thermogravimetric analysis (TGA) indicate that ZWG NPs are more likely to have a core-shell structure. Release studies have shown that rutin encapsulated in ZG and ZWG NPs releases less than 15% of rutin in simulated gastric juice in 2 hours, which proves the protective effect of ZG and ZWG NPs on rutin.[1] These results can be used to design controlled-release drug and nutrient delivery systems.

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Palladium-catalyzed Enantioselective and Regioselective Ring Opening Hydrophosphinylation of Methylenecyclopropanes

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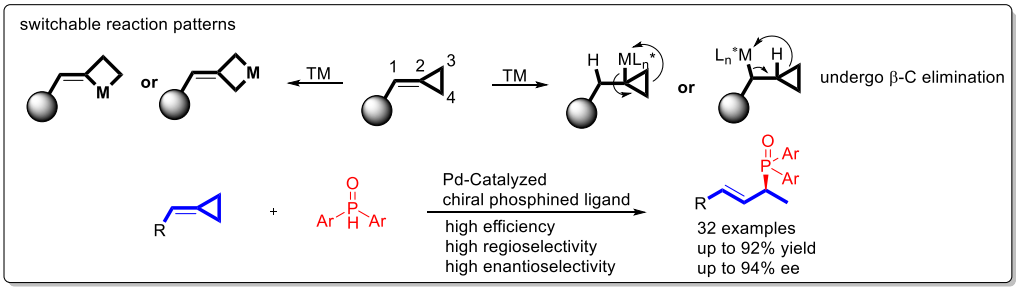
Abstract

Methylenecyclopropanes (MCPs), a type of versatile but readily accessible synthon in organic synthesis, can proceed diverse addition reactions and ring-opening/expansion reactions triggered by transition metal due to the inherent high strain ring force (40 kcal/mol).[1] On the other hand, organophosphorus compounds are a type of privileged molecules widely applied in the field of organic catalysis, pharmaceuticals, multifunctional materials and agricultural chemistry. [2] Recently, the construction of chiral organophosphorus compounds via asymmetric catalysis has attracted substantial interests.[3, 4] Herein, we disclosed the Pd-catalyzed hydrophosphinylation reaction of MCPs, wherein the cleavage of MCPs proximal C-C bond occurs regioselectively and affords desired allylic phosphine oxides enantioselectively.



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Bladder Cancer Photodynamic Therapeutic Agent with Off-On Magnetic Resonance Imaging Enhancement

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Abstract

Bladder cancer is the fourth most common malignancy in males. It is usually considered as one, unaggressive and noninvasive tumors but recur and commit patients to long-term invasive surveillance, or the other, aggressive and invasive tumors with high disease-specific mortality. [1] Due to the overexpression of $\alpha_V\beta_3$-integrin specifically in the neovasculature of bladder cancer, this integrin has become attractive target for both molecular imaging and PDT treatment of bladder cancer.

In this study[2], a series of specific $\alpha_V\beta_3$-integrin-targeting porphyrinato-gadolinium complexes Gd-PEG-R^n (n=1–3) was designed and synthesized as both PDT agents and MRI contrast agents for bladder cancer. In vitro and vivo studies was conducted to investigate the potential of those complexes as specific theranostic agents. The result shows Gd-PEG-R^3 is indeed effective for PDT bladder cancer treatment and serves as a moderately efficient off-on MRI contrast agent. The PDT capability of Gd-PEG-R^3 comes from i) its large specificity due to the inclusion of a carefully chosen targeting peptide; ii) it features great water solubility (R^3 substituent); iii) it has high photo-cytotoxicity while remaining non-cytotoxic in dark (PTI = 199.0) and in normal cells. The compound also exhibits "off-on" responsive relaxivity where its low initial T1 relaxivity can increase by over 17 times upon $\alpha_V\beta_3$ binding. In conclusion, Gd-PEG-R^3 is a potential $\alpha_V\beta_3$-integrin-specific theranostic agent for curing bladder cancer.

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Structure engineering of porphyrin-based hole transporting materials for stable and high-performance perovskite solar cells

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Abstract

Perovskite solar cells (PSCs) are a new type of organic-inorganic thin-film solar cells developed from dyesensitized solar cells. Due to its high efficiency, low cost and easy preparation characteristics, perovskite solar cells have attracted the research interest of a huge number of scientific researchers and have achieved very significant achievements. From 2009 to the present, its light conversion efficiency has increased from 3.8% [1] Increased to 25.5% [2]. However, hole transport materials like Spiro-OMeTAD which was used mostly in perovskite solar cell often needed doping to increase its mobility, and this would decrease its stability, which was unfavorable for its scalable application. Herein, four porphyrin-based hole transport materials (HTM) were designed, synthesized, and used in perovskite solar cell. Compared with traditional HTM Spiro-OMeTAD, they were more convenient to synthesize and non-doped. They got a comparable power conversion efficiency of 18.12%, which is just slightly lower than Spiro-based device (19.71%). At the same time, the device of based on these four new HTM could remain at least 80% of their efficiency after 31 days under ambient environment, while Spiro based device degraded to 54% of its original efficiency.

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An Iridium Complex Conjugated Zinc Porphyrin for Cocatalyst-Free Photocatalytic Hydrogen Evolution by Synergistic AIE and FRET

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Abstract

Because of the limited amount of fossil fuel storage, and the more and more serious greenhouse effect, the development of sustainable energy has become an important issue for human beings.(1) Photocatalytic hydrogen evolution (PHE), in which hydrogen gas is produced by solar irradiation, is a good clean renewable energy source.(2) Recently, much effort has been paid on discovering effective PHE catalysts, where TiO_2, graphitic carbon nitride, and covalent organic framework are often discussed. On the other hand, small organic molecules, such as transition metal complexes and organic dyes, also have good potential as photocatalysts. Here in, T-Ir complex was conjugated to porphyrin ring via an phenylene linkage to afford a new ZnP-T-Ir photosensitizer, which shows highly efficient cocatalyst-free PHE with a rate of 1.42 $mmolg^{-1}h^{-1}$. The higher rate of ZnP-T-Ir than ZnP-T could be ascribed to the conjugation of T-Ir conjugation with the synergistic effect of aggregation induced emission (AIE), aggregation caused quenching (ACQ) inhibition and Förster resonance energy transfer (FRET), which leads to efficient UV-visible light-harvesting with longer photoexcited electron lifetime, enhanced electron transfer rate from the photoexcited porphyrin to the proton and thereby water reduction in PHE.

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Specially Designed Chiral Carbazolyl-Derived Phosphine Ligands in Atroposelective Cross-Coupling for Axially Chiral Biaryls

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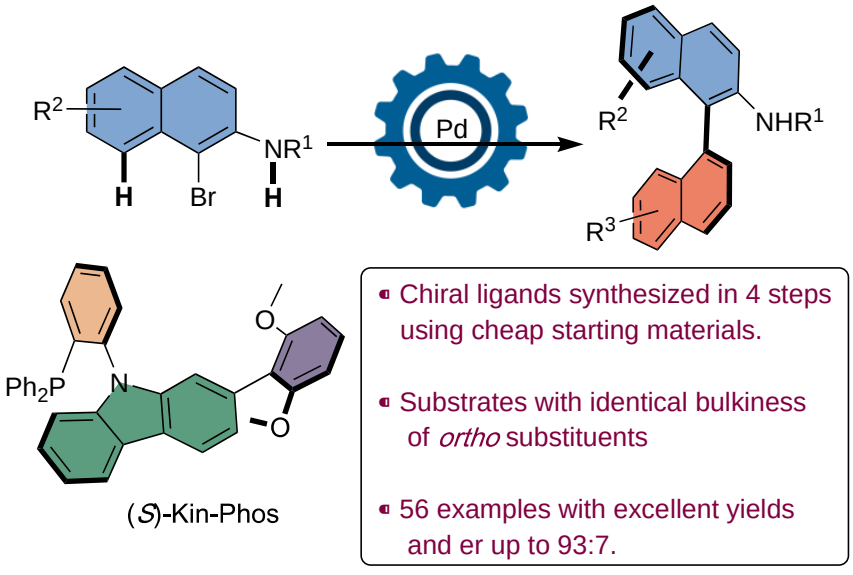
Abstract

The axially chiral 2-aminobinaphthalene is an important precursor to access various axially chiral biaryls via functional group interconversion. Among several reported methods, the hassle-free, versatile, and straightforward synthesis of this biaryl via enantioselective Suzuki-Miyaura cross-coupling remains challenging. Consequently, we have designed a series of useful and synthetically effortless chiral carbazolyl-derived monophosphine ligands, particularly Kin-Phos, to achieve the asymmetric cross-coupling reaction of a wide range of substrates in excellent yields and good enantioselectivities. Larger scale reactions are also feasible at a lower catalytic loading, showing the applicability of this reaction system in the pharmaceutical and chemical industry. DFT calculations revealed that the reductive elimination is the enantio-determining step for this reaction as the calculated percentage er matches with the experimental result.



Palladium-catalyzed Highly Regioselective Monoarylation of Arylhydrazines with Aryl Tosylates

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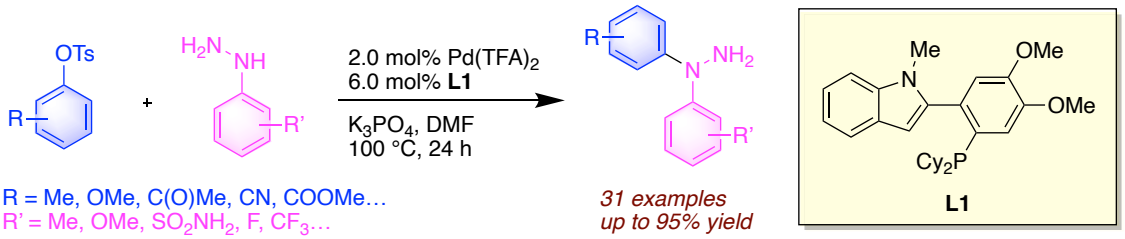
Abstract

Arylhydrazines are resourceful building blocks in synthetic organic chemistry. Traditional method for preparing *N,N*-diarylhydrazines is rather hash and lack of efficiency. Herein a palladium-catalyzed C–N bond coupling reaction between arylhydrazines and aryl tosylates for facile synthesis of unsymmetrical *N,N*-diarylhydrazines has been developed. Employing the catalyst system of $Pd(TFA)_2$ associated with the newly developed phosphine ligand **L1**, the monoarylation of arylhydrazine proceeds smoothly to afford desired products in good-to-excellent yields (up to 95%) with good functional group compatibility. This method provides an alternative synthetic pathway for accessing structurally diversified *N,N*-diarylhydrazines from simple and easily accessible coupling components.



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Metal-Free, Redox-Neutral Benzylic C-O cyclization: Facile Access to Dioxa[5]helicenes

Tianyi Liu and Fuk Yee Kwong*

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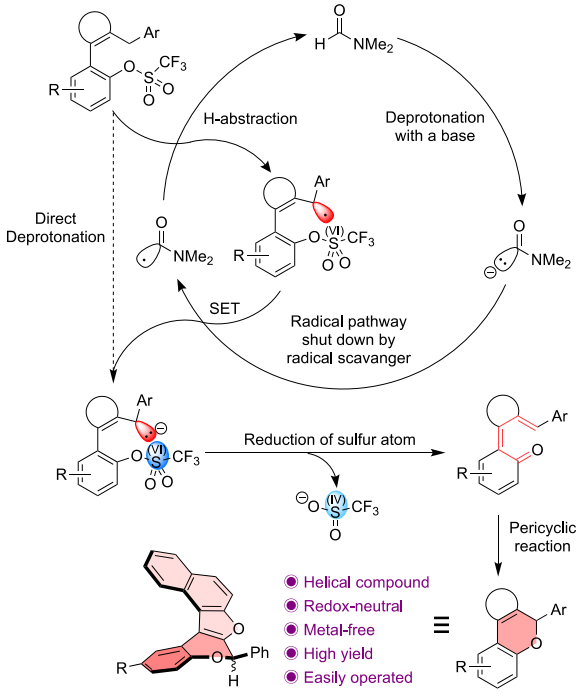
Abstract

A specially designed metal-free and redox-neutral benzylic C-O cyclization reaction via benzylic C-H activation is reported. A key feature of this reaction is the utilization of Tf anion as a leaving group to achieve the redox-neutral transformation. This method established the formation of a series of novel dioxa[5]helicenes. Employing a suitable base, the products could be obtained in good-to-excellent yields. Some of the sterically hindered helical compounds contain conformationally stable diastereomers within the NMR timescale. Bihelical compounds which are potentially useful in the material chemistry were also acquired using the method. Detailed mechanistic study which reviewed that quinone intermediate as the key intermediate to achieve the desired cyclization via oxa-6π-electrocyclization was carried out.



A Rational Ligand Design for Palladium-Catalyzed Miyaura Borylation of Highly Steric Hindered Aryl Chlorides

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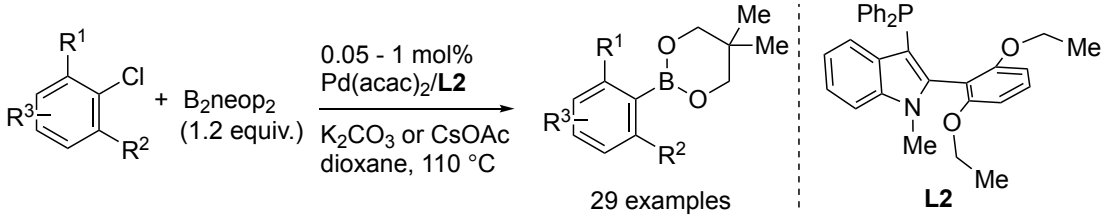
The development of transition metal catalyzed borylation on aryl halides became a major focus, especially the cheaper and broadly available aryl chlorides. Yet, the borylation employing extremely hindered electrophilic coupling partners have been a lasting challenge. Here we report the first general examples of palladium-catalyzed Miyaura borylation of steric hindered aryl chlorides. Key to success of this reaction relies on the distinctive tailor-made phosphine ligand in which it features of smaller phosphine head and larger remote steric bulk. This concept is on contrary, yet complementary to the existing characteristic of common phosphines, e.g. P*t*-Bu_3 or biaryl-PCy_2 and etc., where they consist of localized steric bulk at the phosphorous center. In fact, the smaller phosphine motif effectively allows coupling partner to approach Pd center at the initial stage. Our finding showed that even an extremely steric hindered 2,6-di-*iso*-propyl-substituted aryl chloride was applicable under this newly developed catalyst system. Nice functional group compatibility was observed under these reaction conditions and the catalyst loading down to 0.05 mol% Pd was able to be achieved for particular entry. The success of this ligand-enabled C–B bond formation is believed to offer unique fundamental knowledge in attaining catalyst establishments fit for other highly steric hindered cross-coupling reactions in relevance.

A rational ligand design fit for borylation of steric hindered ArCl in general



Pre-macrocyclization Strategy For the Synthesis of Heptagon-embedded Nanographenes by Scholl reaction

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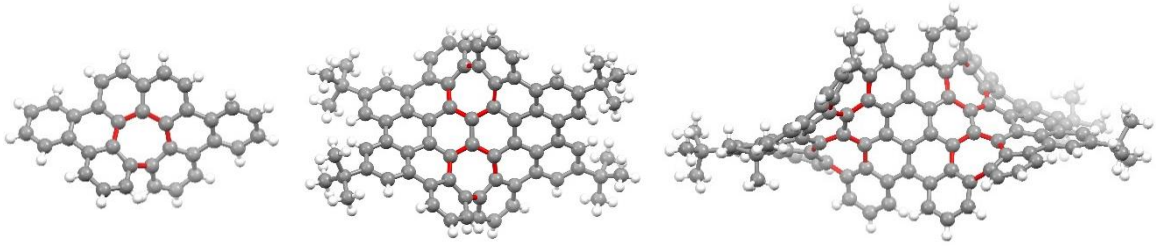
Abstract:

The capability of synthesizing polycyclic arenes containing seven- or eight-member rings is one of the important steps to achieve the imaginary negatively curved carbon allotropes.[1] This study presents a new synthetic strategy to construct heptagon-embedded nanocarbons. In this strategy, the key step is the formation of a macrocycle precursor containing a naphthalene moiety by Yamamoto reaction for the following Scholl reaction. By adopting this pre-macrocyclization strategy, three curved nanographenes, comprising one heptagon, two heptagons and four heptagons respectively, were successfully synthesized. As revealed by X-ray crystallography, the structure becomes more twisted when more heptagons are embedded into the molecule. The torsion angle of the molecule containing four heptagons reaches 172 degrees.



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Synthesis and Properties of Acenes Containing Pyrene and Biphenylene

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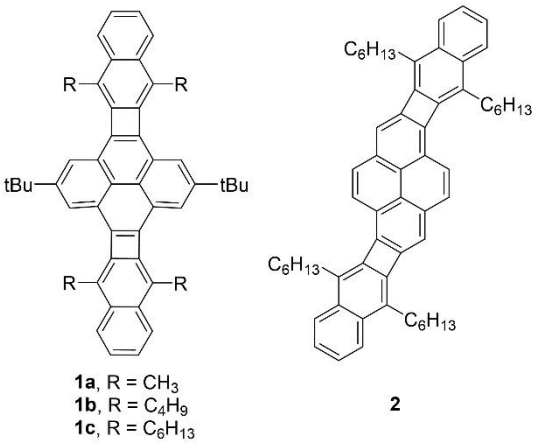
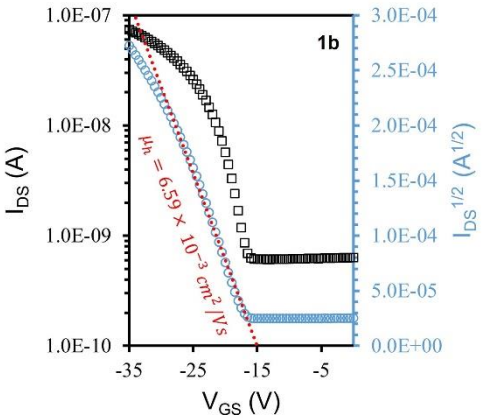
Abstract

Herein we report the synthesis, crystal structures and electronic properties of new derivatives of acenes **1a-c** and **2**, containing pyrene and biphenylene moieties. It is found that the π–π stacking of **1a-c** in single crystals can be modified by alkyl substituting groups of different lengths. All of these compounds have one dimensional arrangement in the solid state. It's noticed that **1b** with good packing and good solubility has been applied as p type semiconductor and the mobility is 6.59×10^{-3} $cm^2/(V\ s)$.



1a, R = CH_3
1b, R = C_4H_9
1c, R = C_6H_{13}

2



Ultrathin Hexabenzoperylene-based Gas Sensors

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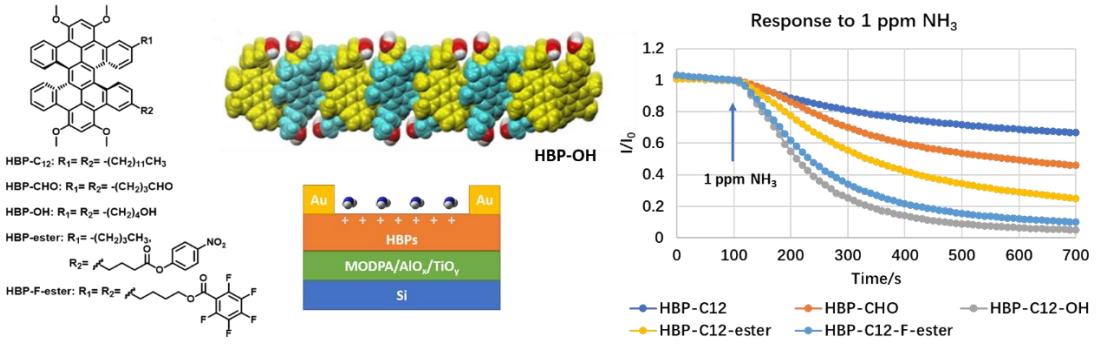
Abstract

One promising aspect where organic field effect transistors (OFETs) based gas sensors outperform their inorganic counterparts is that sensitive and selective sensing can be easily achieved through various molecule design and a series of device fabricating strategies. Our group has discovered a general platform molecule hexabenzoperylene (HBP) for chemical and biological sensing. With various functional groups linked to the end of alkyl chains in HBPs, the unusual π-π stacking of the solid state can be reserved and a semiconducting nanosheet can still be produced by self-assembling.[1,2] In this study, we expanded the application field of HBP to gas sensors. By fabricating ultrathin HBP films and introducing functional groups, sensitivity to amines or nitrogen dioxide was significantly improved. Quantitative and highly sensitive detection of 0.01 -100 ppm ammonia and 1-100 ppm nitrogen dioxide can be measured, and a series of amines can be distinguished with a sensor array containing five HBP sensors.



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Synthesis of Three Heptagons Embedded Polycyclic Hydrocarbons

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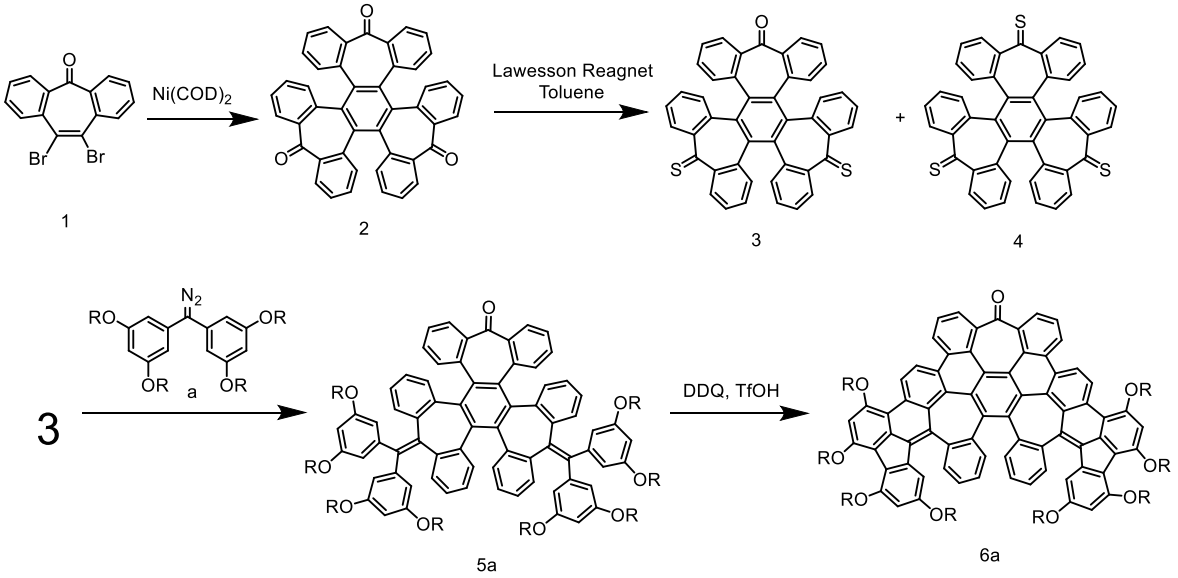
Abstract

Introducing 7- or 8-membered rings into hexagonal lattice of carbon atoms give negatively curved polycyclic hydrocarbons which serve as important building blocks in negatively curved Mackay crystals, which are theoretically proposed but yet to be synthesized.[1] Here, we present the synthesis of three heptagons embedded polycyclic hydrocarbons. In the synthesis route, three dibenzosuberenone moieties are successfully fused together around one benzene ring via Ni-mediated Yamamoto coupling reaction. Following extensions using Barton-Kellogg reaction between thioketone compounds and corresponding diazo compounds successfully give a series of overcrowded alkene molecules. Finally, partially fused compound 6a and small amount of fully fused PAHs are successfully synthesized by Scholl reaction with carefully placing the activating groups.



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Strategic synthesis of shape-persistent supramolecular boxes and cages

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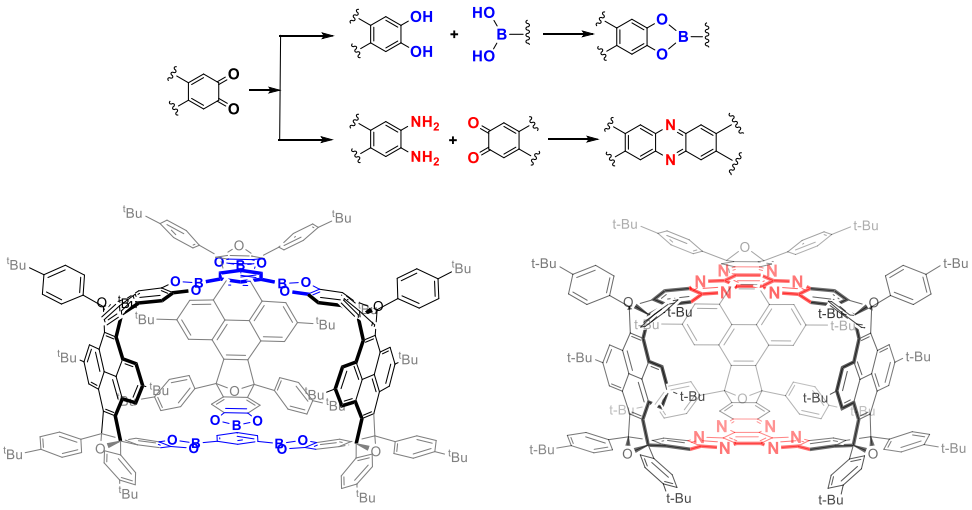
Abstract

Supramolecular cages with well-defined cavity have drawn considerate attention in a wide range of applications including molecular separations, purification, and catalysis.[1] In the past decades, organic chemists have been able to synthesize a wide range of cages using different methods including imine or boronic acid condensation, alkyne metathesis, and self-assembly. Generally, synthesizing these desired architectures requires well-defined precursors with rigid structure and reasonable geometric attributes necessary for a target structure. Herein, we report the synthesis and characterization of a family of shape-persistent supramolecular boxes and cages using C-shaped building block[2] by imine and boronic acid condensation. As monitored with fluorescence spectroscopy, one of these cages exhibits binds C_{60} with association constants as high as 2.4×10^{6} M^{-1}.



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Relation of Non-ideal Performance in Organic Field-Effect Transistors with Substrate Dielectrics

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Abstract

Non-linear "kinks" are common in the transfer curves of high-mobility organic field-effect transistors (OFET), which causes unreliable mobility extraction, and complicates device performance evaluations. To examine the origin of the double-slope nonideality, we fabricated bottom-gate top-contact OFETs using thin films of tetraazapentacene derivatives produced from solution processes. Both ideal and double-slope transfer curves were successfully reproduced on these films., managed by simply altering dielectric substrates of the OFETs. From our experiments, high-κ dielectrics with lower scanning voltages generally produces near-ideal results, while low-κ dielectrics and high scanning voltage raises occurrence of double-slope phenomenon. In addition, the "after-kink" mobility of double-slope devices were similar to the near-ideal devices, while the mobility before the kinks were 2 ~ 4 times higher. The results indicates that double-slope transfer curves would extrapolate overestimated mobilities, and demonstrates possible relation between strength of in-channel electric fields and nonidealities in OFETs.

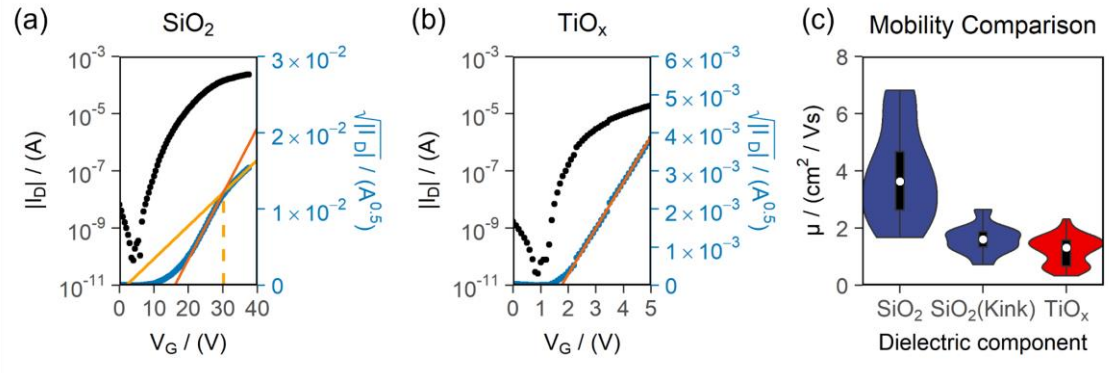

Figure 1: Examples of (a) double-slope transfer curve and (b) near-ideal transfer curve TIPS-TAP semiconductor layers, using CDPA/AlO_y/SiO_2/Si (low-κ) and CDPA/AlO_y/TiO_x/Si (high-κ) as dielectric layers, respectively. (c) Comparison of before-kink and after kink field-effect mobility with mobility in near-ideal devices.

Charging a Negatively Curved Nanographene and Its Covalent Network

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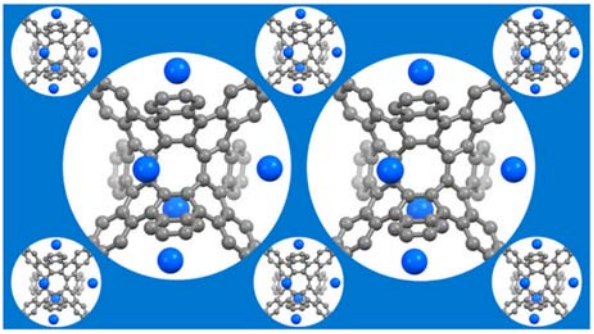
Abstract

This study explores a bottom-up approach toward negatively curved carbon allotropes from octabenzo[8]circulene, a negatively curved nanographene.[1,2] Stepwise chemical reduction reactions of octabenzo[8]circulene with alkali metals lead to a unique highly reduced hydrocarbon pentaanion, which is revealed by X-ray crystallography suggesting a local view for the reduction and alkali metal intercalation processes of negatively curved carbon allotropes. Polymerization of the tetrabromo derivative of octabenzo[8]circulene by the nickel-mediated Yamamoto coupling reaction results in a new type of porous carbon-rich material, which consists of a covalent network of negatively curved nanographenes.[3] It has a specific surface area of 732 $m^2\ g^{-1}$ and functions as anode material for lithium-ion batteries exhibiting a maximum capacity of 830 $mAh \cdot g^{-1}$ at a current density of 100 $mA \cdot g^{-1}$. These results indicate that this covalent network presents the key structural and functional features of negatively curved carbon allotropes.



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Diboration of Alkenes and Alkynes with a Carborane-Fused Four-Membered Boracycle Bearing an Electron-Precise B-B Bond

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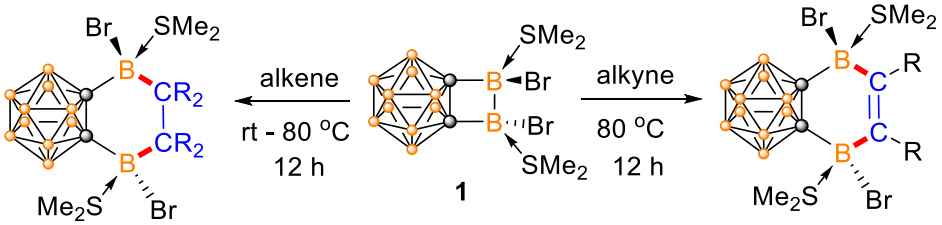
Abstract

Small ring compounds are fascinating molecules and have been used as valuable compounds in organic synthesis.[1-4] In this study, a carborane-fused four-membered boracycle bearing an electron precise B-B bond, 1,2-[BBrSMe$_2$]$_2$-*o*-C$_2$B$_{10}$H$_{10}$, was synthesized via the reaction of 1,2-Li$_2$-*o*-carborane with B$_2$Br$_4$(SMe$_2$)$_2$. This novel boracycle can be used as a "strain-release" compound to achieve diboration of alkenes and alkynes, leading to the generation of ring-expansion products. Interestingly, when bis(trimethylsilyl) acetylene was employed, an allene-functionalized six-membered boracycle was obtained. Moreover, DFT calculations were conducted to shed light on the reaction mechanism.



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Ligand-Accelerated Pd-Catalyzed Regioselective Cage B(4,5,8,10,12)-Penta-Arylation of o-Carboranes via Five-Fold Iterative B−H Activation

Peng Zhou, Jie Zhang, Shimeng Li, and Zuowei Xie*

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Abstract

A ligand-accelerated carboxy-guided one-pot palladium-catalyzed regioselective five-fold iterative cage B−H arylation of 9-COOH-*o*-carboranes with aryl iodides has been developed, leading to the synthesis of 4,5,8,10,12-Ar_5-9-COOH-*o*-carboranes in good to high yields with excellent regioselectivity. Late-stage functionalization of the resultant penta-arylated products via the transformation of the carboxylic acid group and cage CH vertices were also achieved. Control experiments showed that N-acetyl-L-valine ligand could significantly accelerate the reaction rate and drive the penta-arylation to completion. The roles of the ligand as supported by the density functional theory (DFT) calculations are (1) to stabilize the transition state, so as to lower the BH activation barrier, (2) to improve the catalyst lifetime, and (3) to act as an internal proton acceptor, facilitating the Pd-B bond-forming process. Accordingly, a reaction mechanism is proposed to account for the catalytic penta-arylation of 9-COOH-*o*-carboranes, where the carboxy group controls the regioselectivity.

Title of Poster: Synthesis of Thieno[3,2-b]thiophene-based Functional Organic Photosensitizers for Dye-sensitized Solar Cells and Photocatalytic Water Splitting

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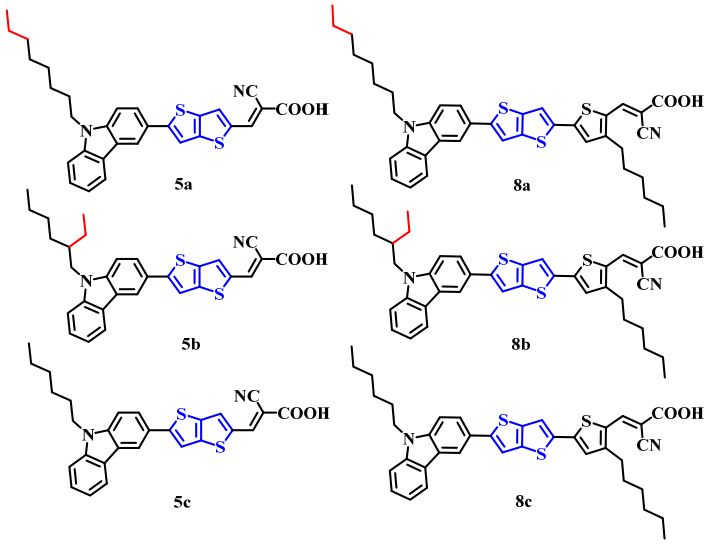
Abstract

Photocatalytic hydrogen evolution (PHE) and dye-sensitized solar cells (DSSCs) have been in the limelight as sustainable and environmental-friendly energy sources, especially the metal-free organic or organometallic ones with low toxicities. The main challenges upheld by solar-to-hydrogen energy conversion efficiency include having longer wavelength photons, higher photocatalytic activities and stability. Several functional thieno[3,2-b]thiophene-based organic dyes with different electron-donating moieties and π-linkers were synthesized and characterized. Their photophysical and electrochemical properties, and photocatalytic and photovoltaic abilities were investigated.



The introduction of alkyl chain engineering and extended π-conjugation could effectively enhance the efficiency in both photocatalytic hydrogen production and dye-sensitized solar cells (DSSCs) from the experimental results, with the decent hydrogen turnover number (TON) of 5170 over 48 hours in PHE and 5.25% power conversion efficiency (PCE) in DSSCs[1].

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Visible-Light Controlled Hierarchical Supramolecular Assembly of Donor-Acceptor Stenhouse Adducts Amphiphiles

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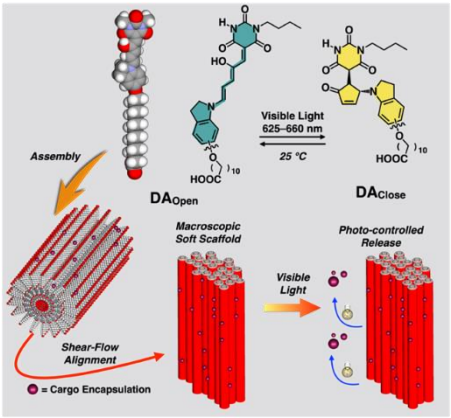
Abstract

The supramolecular transformations at multiple length-scale of vast majority of photoresponsive molecular amphiphiles in aqueous media are driven by high energy and bio-damaging UV-light[1]. Here we present the visible-light controlled hierarchical supramolecular assembly of donor-acceptor Stenhouse adducts[2] amphiphiles (DA) in aqueous media. We find that the DAs show excellent photoswitchability in organic and photoresponsiveness in aqueous media by visible-light, and to provide supramolecular assembly transformation at microscopic length-scale. Moreover, the significant geometrical transformation of DAs destabilize the macroscopic soft scaffold of the obtained DAs, demonstrating controlled release of fluorophore from the scaffolds and providing opportunities for future soft functional materials.



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Atomically precise Zn-Cu metal ensembles as SOD mimics for synergistic cancer therapy

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Abstract

Superoxide dismutase (SOD) are metalloproteins, which contribute to reducing oxidative damage[1], and other applications related to oxidative stress like cancer therapy. However, native SOD enzyme cannot be directly used as a therapeutic agent because of its short half-life, antigenicity, and low cell permeability[2]. To design SOD mimics with high stability, we propose a novel and modular assembly pathway to synthesise Zn-Cu active pairs in ZSM-5 (Zn-Cu-Z) as an effective SOD mimic. The motif of Zn-Cu-Z was confirmed by techniques like synchrotron XRD, X-ray absorption spectroscopy, and MALDI-TOF mass spectroscopy. Zn-Cu-Z shows an excellent catalytic performance as a SOD mimic with the IC_{50} value of 0.093μM, which is comparing to native enzyme (*cf.* IC_{50} = 0.0147μM[3]). Interestingly, Zn-Cu-Z enhances the performance of typical cancer drugs (e.g., Sorafenib) in *in vitro* study. We reveal that Zn-Cu-Z can regulate the cellular concentration of H_2O_2 by reacting the superoxide radical generated from the oxidative stress from cancer cells when sorafenib is applied[4].

In brief, the synthesis of Zn-Cu-Z can effectively mimic the active site of the native Cu-Zn SOD enzyme successfully and can play a key role in synergistic cancer therapy.

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General Chemoselective Suzuki−Miyaura Coupling of Polyhalogenated Aryl Triflates Enabled by an Alkyl-Heteroaryl-Based Phosphine Ligand

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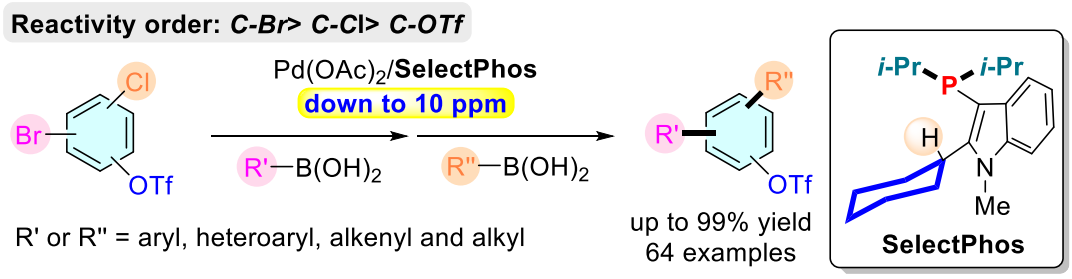
Abstract

A Pd-catalyzed chemoselective Suzuki−Miyaura coupling of polyhalogenated aryl triflates with the reactivity order of C−Cl > C−OTf has been reported using a Pd/SelectPhos catalyst. The methine hydrogen and the steric hindrance offered by the conceptually new design of the alkyl bottom ring of SelectPhos were found to be key factors for the reactivity and chemoselectivity. A wide range of polyhalogenated (hetero)aryl triflates successfully coupled with (hetero)aryl, alkenyl, and alkylboronic acids to obtain the desired coupling products with excellent chemoselectivity and yields. The chemoselectivity was independent of substrates and the relative positioning of the competing reaction sites. The reaction could be conducted on a gram scale, and at parts per million levels of Pd catalyst (e.g. 10 ppm) smoothly.



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Chiral Cyclometalated Oxazoline Gold(III) Complex-Catalyzed Asymmetric Carboalkoxylation of Alkynes

Aries Kwok-Heung Chan, Jia-Jun Jiang, Jian-Fang Cui, Bin Yang, and Man-Kin Wong*

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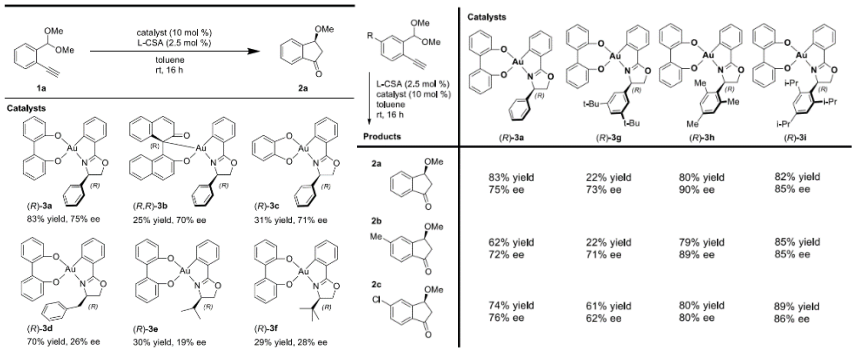
Abstract

Gold catalysis has received significant attention in organic transformations in the past decades owing to its excellent selectivity and outstanding reactivity under mild conditions. Introducing appropriate ligands to gold center overcame the low product turnovers resulted from instability of simple gold salts in catalysis. The efficient gold(I) catalysts have been widely developed for synthetic transformations. However, the development of gold(III) complex comes to a challenge due to the difficulty on balancing its catalytic reactivity and stability. Here we present chiral O,O′-chelated 4,4′-biphenol cyclometalated oxazoline gold(III) complex-catalyzed asymmetric carboalkoxylation of alkynes with an enantioselectivity of up to 90% ee. Considering that the sterically bulky substituents would be the origin of enantioselectivity, we set out to examine the catalytic activity of cyclometalated oxazoline gold(III) dichloride complexes to infer that the catalytic vacant site was generated by the detachment of the biphenol ligand.



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Development of some novel NDM-1 inhibitors

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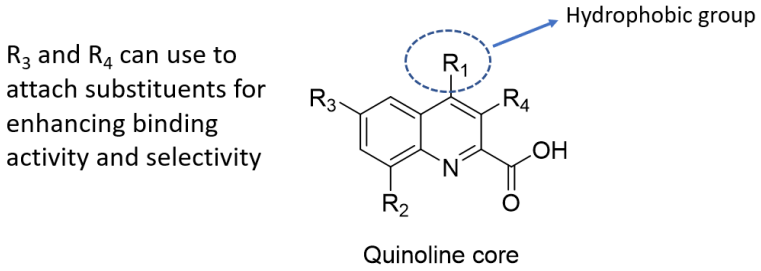
Abstract

The discovery of the antibacterial activities of penicillin and sulfonamide half of a century ago has brought us the weapons on combating bacteria. Scientists have also found out several new classes of antibiotics in the following decades.[1] However, resistances to corresponding antibiotics were quickly found out after the introduction of new antibiotics. The antibiotics resistance abilities in bacteria mainly come from the expression of varieties of β-lactamases. One of the most common and worrisome of class B β-lactamases is the New Delhi Metallo-β-lactamase-1 (NDM-1). NDM-1 has a broad-spectrum effect on all types of β-lactam antibiotics, including carbapenems.[2] Scientists have put intensive efforts in finding NDM-1 inhibitors. We have also developed some novel NDM-1 inhibitors based on quinoline. These inhibitors showed good MIC values when synergistically applied with meropenem.



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A fluorescent probe for the discrimination of oxidation states of palladium

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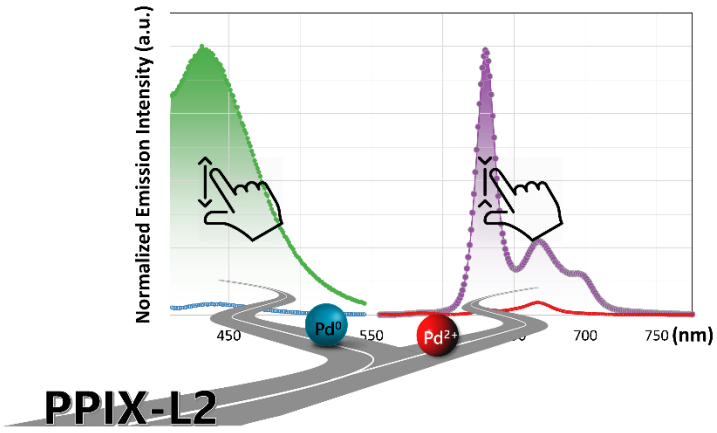
Abstract

Palladium-based catalysts are widely used in pharmaceutical industries, which can sometimes cause palladium contamination in pharmaceutical drug manufacture. It is important to separately quantify the different oxidation states of palladium (Pd^0 and Pd^{2+}) as they react with scavengers differently. Although palladium sensors have been under intense investigation, oxidation state differentiators are very rare. Here, we report a simple porphyrin–coumarin conjugate, **PPIX-L2**, that can selectively discriminate between the oxidation states of palladium, and with significantly improved detection sensitivity.[1]



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Title of Poster

Discovery of antibacterial inhibitors with benzamide skeleton targeting the Bacterial Cell Division Protein FtsZ

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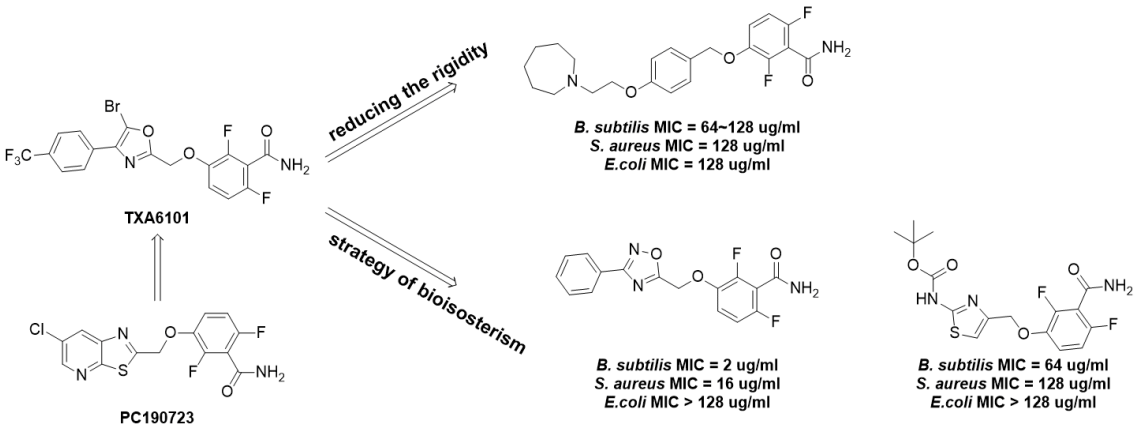
Abstract

With the rise of antibiotics resistance worldwide, it is necessary to develop new antibacterial agents with new mechanisms for killing the emerging antibiotic-resistant bacteria[1]. FtsZ is a new promising target for new antibiotics, which forms a Z-ring and then further regulates bacterial cell division. Here taking PC190723[2] as lead compound, this research aims to develop a novel class of benzamide-skeleton compounds which can inhibit FtsZ protein and kill bacteria, and to optimize their pharmacokinetics for the discovery of a drug candidate that can be used in clinical trials.



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Ruthenium-Catalyzed Intramolecular Arene C(sp^2)−H Amidation for Synthesis of 3,4-Dihydroquinolin-2(1*H*)-ones

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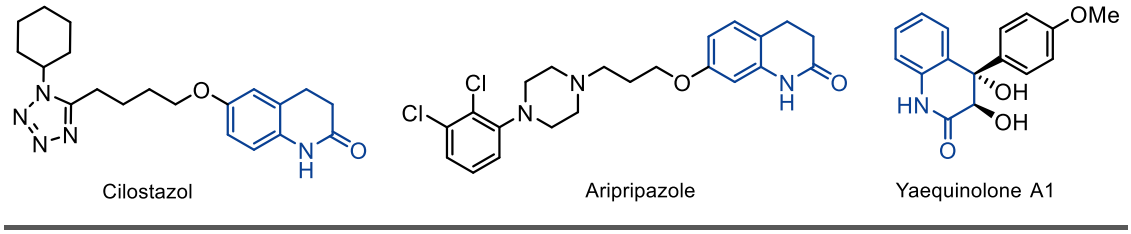
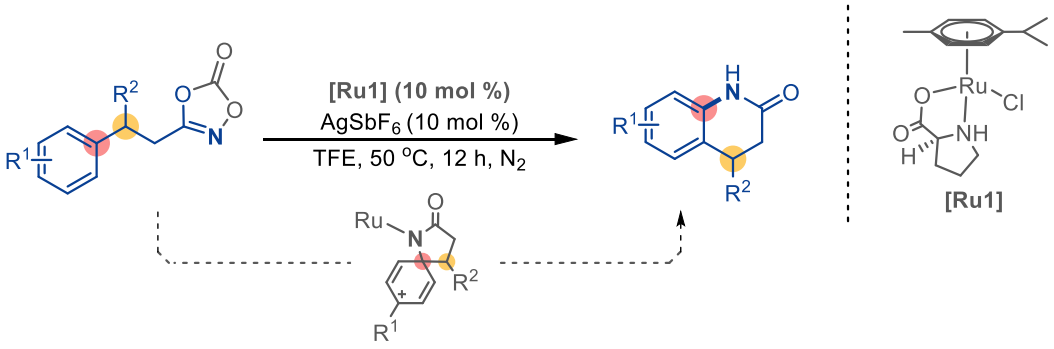
Abstract

3,4-Dihydroquinolin-2(1*H*)-ones are ubiquitous structural motifs in pharmaceutical and bioactive compounds[1] such as cilostazol, aripripazole and Yaequinolone A1. Further to our report on the ruthenium-catalyzed enantioselective intramolecular C(sp^3)–H amidation of dioxazolones for chiral γ-lactams synthesis,[2] we herein describe a highly chemo- and regioselective synthesis of 3,4-dihydroquinolin-2(1*H*)-ones involving formally regioselective C(sp^2)-H functionalization.[3] Unlike our earlier report, [Ru(p-cymene)(L-proline)Cl] was found to be an effective catalyst for the 3,4-dihydroquinolin-2(1*H*)-ones formation, whereas the analogous complexes with diphenylethylenediamine ligand exhibit poor catalytic activities. The reactions are likely to proceed through spirolactamization via electrophilic amidation at the arene.





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Solution-Processed, Inverted $AgBiS_2$ Nanocrystal Solar Cells

Dezhang Chen[†], Sunil B. Shivarudraiah[†], Pai Geng[†], Michael Ng[†], C.-H. Angus Li[†], Neha Tewari[†], Xinhui Zou[‡], Kam Sing Wong[‡], Jonathan E. Halpert[*†]

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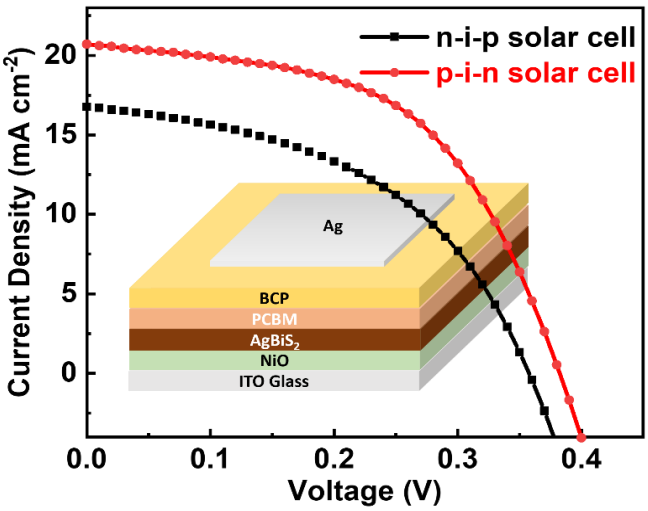
Abstract

$AgBiS_2$ nanocrystals are a promising non-toxic alternative to PbS, $CsPbI_3$ and CdS quantum dots for solution fabricated nanocrystal photovoltaics[1]. In this work, we have fabricated the first inverted (p–i–n) structure $AgBiS_2$ nanocrystal solar cell. We selected spray-coated NiO as the hole transporting material and used PCBM/BCP as electron transporting materials. Combining transient photocurrent and photovoltage measurements with femtosecond transient absorption spectroscopy, we investigated the charge collection process on metal-oxide / $AgBiS_2$ interfaces, and demonstrated that the NiO/$AgBiS_2$ NC junction in the p-i-n configuration is more efficient for charge carrier collection. The fabricated p–i–n solar cells exhibited a 4.3 % PCE, which was higher than conventional n–i–p solar cells fabricated using the same sample. Additionally, inverted devices showed an ultra-high short-circuit current (J_{sc}) over 21 mA/cm^2 and 0.4 V open-circuit voltage (V_{oc}), suggesting their potential for further improvements in efficiency and, eventually, for large scale production.



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Efficient and Spectrally Stable Sky-blue Perovskite Light-emitting Diode via Metal Doping.

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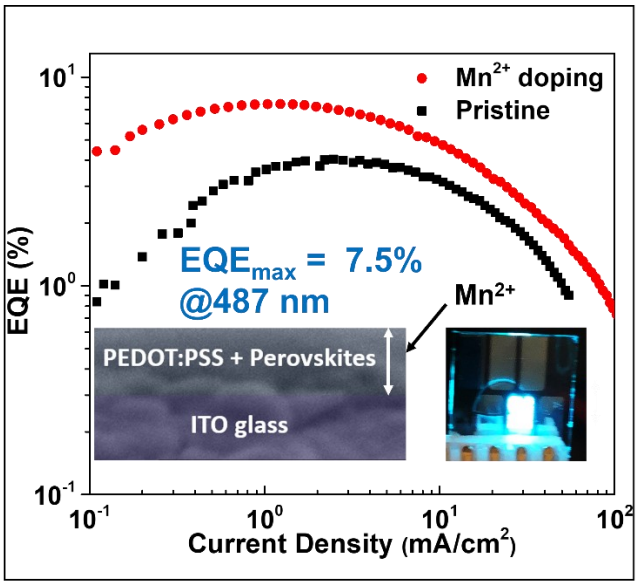
Abstract

Metal halide perovskites light-emitting diode (peLED) has attracted significant attention for its excellent photoluminescence and electroluminescence properties such as bright emission, high photoluminescent quantum yield (PLQY), narrow emission width and high carrier mobilities.[1] Recent years have seen improvement of overall external quantum efficiency (EQE%) surged from sub-1 to over 20% in the region of green, red and infra-red (IR).[2, 3] For practical application such as display technology, red, green and blue emitters are indispensable, therefore research into efficient and stable blue peLEDs are indispensable. Herein we report efficient and spectral stable quasi-2D based peLED via metal doping, the resulting device shown high EQE of 7.5% at 487 nm sky-blue and spectral stable up 9V without shifting EL peak. These results paved way for peLEDs become practical in display applications.



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Highly Efficient Lead-free Copper(I)-based Halides

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Abstract

Ternary metal halides, including perovskites, have become a popular field of study over the last decade. Many groups have attempted to replace the lead in lead-based perovskites with other metals while retaining similar optical and electronic properties. While there are several candidates for lead replacement, copper has become a favored candidate for replacing lead in the metal halide family because of its outstanding optoelectronic features, abundance, low price, and low environmental effect. A series of $A_mCu(I)_nX_{m+n}$ (A = K, Rb, and Cs; X = Cl, Br, and I) have been studied, the different compositions and structures enable them to exhibit bright emission in the spectrum region from deep-blue to yellow. Among them, $Cs_3Cu_2X_5$ (X = Cl and I) and A_2CuX_3 (A = K, Rb; X = Cl, Br) possess ~100% photoluminescence quantum yields (PLQYs) and electric driven $Cs_3Cu_2I_5$-based blue and $CsCu_2I_3$-based yellow LEDs were also fabricated. These results indicate that copper-based chlorides may have great potential for future display or lighting applications. Here we present copper(I)-based metal halides with excellent optical properties.

Photo-rechargeable Lead-free Perovskite Halide Lithium-ion Batteries

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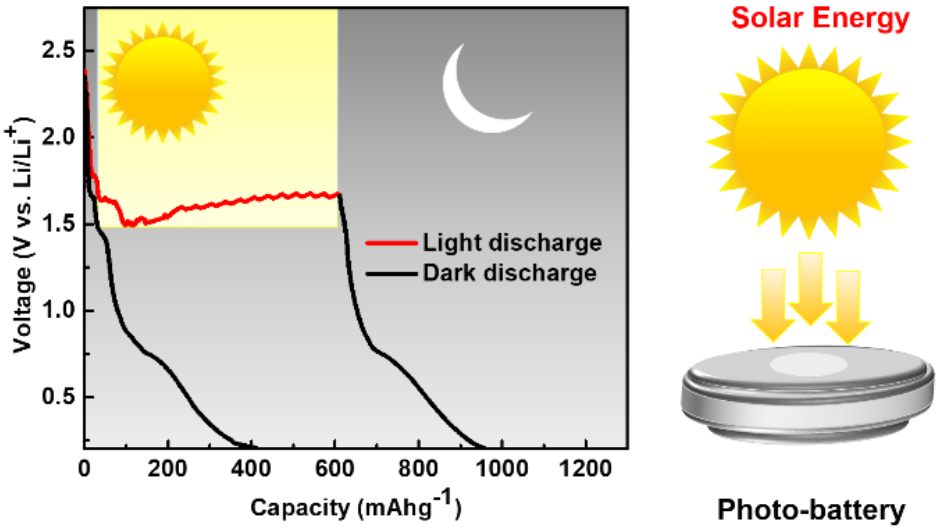
Materials that enable bifunctional operation in harvesting and storing energy are currently in high demand, due to their potential to efficiently use renewable solar energy.[1] Multi-field integration of solar cell and a battery can lead to ohmic losses and higher cost.[2] Here, we have reported a lead free all inorganic bismuth based perovskite halide as a potential electrode candidate for lithium ion batteries which can harvest energy under illumination without an external load, working as a photoelectrode. The electrode consists of cesium bismuth halide perovskite which also acts as a photoactive material that drives the light charging process by generation of electron hole pairs showing a 12 μA/cm^2 rise in the value of current and a photo conversion efficiency of 0.43 %, the highest first cycle efficiency reported for lithium ion photo-batteries. Further exploration in research and design can provide possibilities for an efficient energy storage system.



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Ring Closing Alkyne Metathesis Promoted by Robust d^2 Rhenium(V) Alkylidyne Complexes

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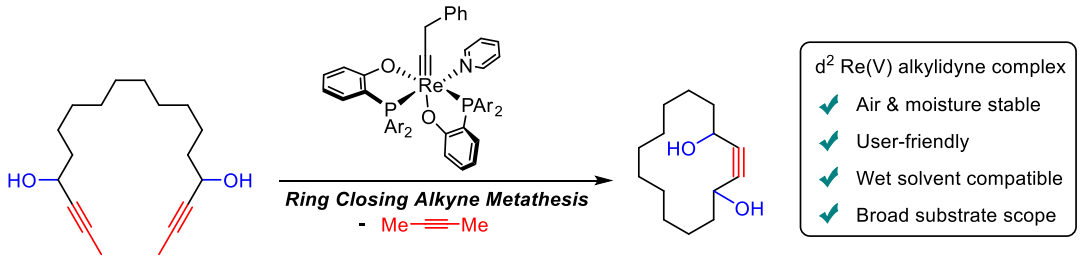
Abstract

Ring closing alkyne metathesis (RCAM), mediated by d^0 metal alkylidyne complexes, has shown promising applications in synthesis of nature products and functional materials.[1] However, traditional d^0 alkylidyne catalytic systems, suffering from drawbacks such as extremely air and moisture sensitive character and limited functional group compatibility, are hardly to be broadly used. More recently, with fine tuning of ligand combinations, a new d^2 Re(V) alkylidyne system has been developed to promote metathesis of internal alkynes, which is air and moisture stable and can tolerate a wide range of functional groups, including alcohols, amines and even carboxylic acids.[2] With robust d^2 Re(V) alkylidyne catalysts in hand, we are going to further explore their application in RCAM.

In this presentation, the first examples of d^2 Re(V) alkylidyne catalyzed ring closing alkyne metathesis reactions will be introduced. Macrolides with ring size ≥ 12 could be efficiently prepared by RCAM from diyne substrates. The catalytic system could tolerate tough substrates with functional groups like free alcohols, phenols, aldehydes, amines and amides. Most impressively, Re(V) alkylidyne catalysts are moisture stable so that catalytic RCAM could be carried out in water-containing solvents. Details of the studies will be described in the presentation.



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Beyond conformational control: effects of noncovalent interactions on molecular electronic properties of conjugated polymers

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Abstract

Noncovalent intramolecular interactions have been often used as conformational control to enhance the planarity of polymers or molecules and tune the electronic properties. However, it is little known if noncovalent interactions may further alter the electronic properties of polymers with high planarity through some mechanism other than the conformational control. Here, we studied the effects of various noncovalent interactions, including sulfur-nitrogen, sulfur-oxygen, sulfur-fluorine, oxygen-nitrogen, oxygen-fluorine, and nitrogen-fluorine, on the electronic properties of polymers with planar geometry using unconstrained and constrained density functional theory. We found that the sulfur-nitrogen intramolecular interaction may reduce the band gaps of coplanar polymers and enhance the charge transfer more obviously than other noncovalent interactions. Our findings are also consistent with the experimental data. For the first time, our study shows that the sulfur-nitrogen noncovalent interaction may directly affect the electronic structure of coplanar conjugated polymers beyond conformational control. Our work suggests a new mechanism to manipulate the electronic properties of polymers to design high-performance small-molecule-polymer and all-polymer solar cells.

Organocatalytic Asymmetric Formal Oxidative Coupling for the Construction of All-aryl Quaternary Stereocenters

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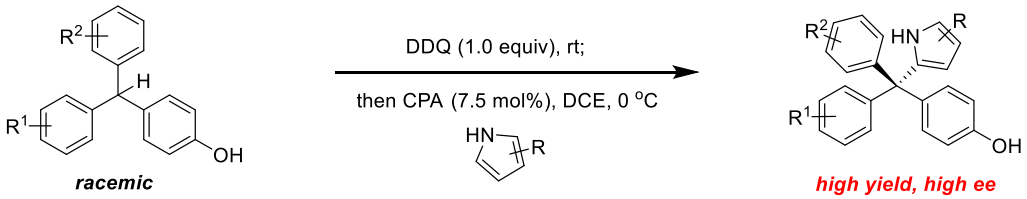
Abstract

Cross dehydrogenative coupling (CDC) have been well-known as a powerful tool to forge intermolecular C–C bonds from two C–H bonds without prefunctionalization. Specifically, the benzylic C–H bond is relatively prone to oxidation and thus it has evolved into a versatile arena for the implementation of this reaction, leading to efficient construction of various benzylic stereogenic centers, particularly in a wide range of 1,1-diarylalkanes. However, the establishment of tetraaryl-substituted carbon stereocenters by this method remains unknown.[1]

In this context, we have developed the first catalytic asymmetric formal cross dehydrogenative coupling for the efficient synthesis of enantioenriched chiral tetraarylmethanes, a challenging target in organic synthesis.[2] With DDQ as the superb oxidant and chiral phosphoric acid (CPA) as catalyst, intermolecular stereoselective C–C bond formation in an overwhelmingly crowded environment was enabled under mild conditions. *para*-Quinone methides bearing an *ortho*-directing group serve as the key intermediate. The chiral products synthesized by this approach have also been demonstrated as promising antiviral agents. Details of this reaction will be presented.



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A Mild Intermolecular Synthesis of Cyclopropane-Incorporated Tricyclic Skeleton: Unusual Reactivity of Isobenzopyryliums

Shuxuan Liu, Hui Qian, and Jianwei Sun*

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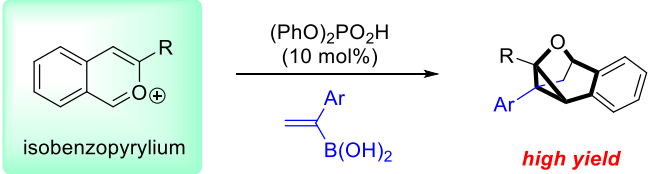
Abstract

Cyclopropane is a fascinating subunit widely present in natural products and biologically important molecules. Driven by strain release, cyclopropane-containing molecules also exhibit diverse chemical reactivity, enabling them to serve as versatile intermediates in the synthesis of complex molecules and other useful building blocks. Specifically, cyclopropanes embedded in a polycyclic bridged architecture have attracted substantial synthetic interests in the past few decades, not only because of their biological relevance, but also owing to the endless possibilities to manipulate such spring-loaded cyclic systems for strategic construction of challenging structures. However, mild intermolecular convergent processes for the rapid assembly of cyclopropane remain scarce.

During our study of isobenzopyryliums, we discovered a new approach for the expedient access to such strained systems via convergent process between isobenzopyryliums and vinylboronic acids. With a simple phosphoric acid catalyst, multiple C-C bonds were formed sequentially to form a highly strained bridged cyclopropane system with high efficiency. This protocol does not involve the highly active carbenoid intermediates or strong conditions in order to overcome the disfavored kinetic and thermodynamic problems. Instead, the key cyclopropane ring was formed between the well-positioned nucleophile and electrophile in the adduct from the regioselective [4+2] cycloaddition. Thus, this unusual process also represents a new reactivity of the versatile isobenzopyryliums. The strained products are precursors to other useful synthetic building blocks. Details of this reaction including the mechanism will be presented.



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SPHENOL, A New Chiral Framework for Asymmetric Synthesis

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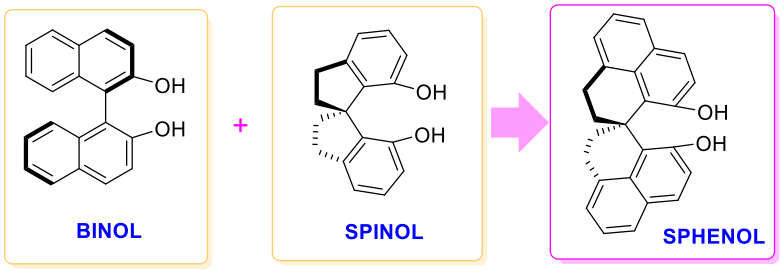
Abstract

Privileged chiral catalysts have found tremendous applications and thus immensely advanced asymmetric synthesis in the past few decades. However, truly privileged chiral frameworks are still extremely limited. Thus, the search and development of new versatile members remain in high demand but challenging. BINOL is one of the most widely exploited manmade privileged chiral frameworks in asymmetric synthesis. More recently, SPINOL has emerged as another superior chiral skeleton for its conformational rigidity and chemical robustness. While BINOL and SPINOL are both versatile, their properties and catalytic behaviors, including those of their derivatives, are sometimes complementary. For example, BINOL-based catalysts sometimes exhibit better catalytic activity, while the SPINOL-based ones often show better asymmetric induction capability. Therefore, a dilemma will be encountered when synergy cannot be achieved regarding these two features. In this context, we envisaged a new framework, which is tentatively named as SPHENOL (2,2',3,3'-tetrahydro-1,1'-spirobi[phenalene]-9,9'-diol). This new structure is expected to combine the advantages of BINOL and SPINOL. Moreover, the introduction of two substituents in the 3,3'-positions of naphthalene units is expected to allow tunable chirality of the C2-symmetric skeleton.

Herein we report the design, synthesis, and application of a new chiral framework, SPHENOL, which features combined advantages of BINOL and SPINOL. This unique feature enables SPHENOL to serve as an excellent platform for the development of new chiral ligands and catalysts. Its superior performance has been demonstrated in mechanistically unrelated reactions. These results clearly indicated the great potential of SPHENOL as a useful chiral framework. The details will be presented.



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Total synthesis of Hexacyclic Xanthone, F10

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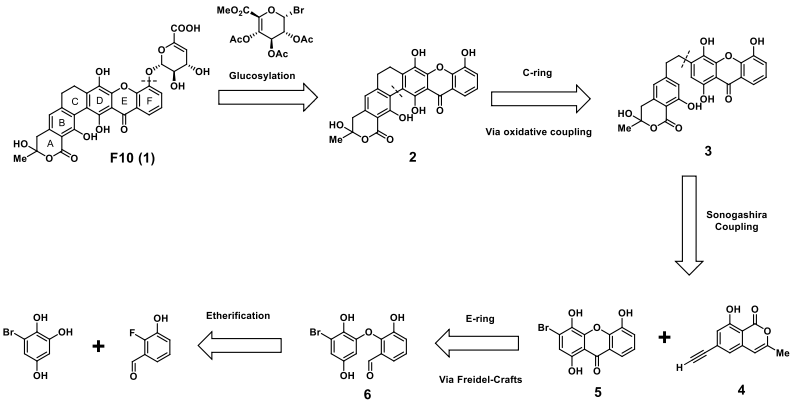
Abstract

Hexacyclic xanthone (F10), which was isolated from marine–derived *Streptomyces caelestis,* showed neuroprotective activity against HEK293T cells, especially by glutamate-induced excitotoxicity. The xanthone motif can find from many natural products with a variety of biological activities and different synthetic strategies were established to construct this motif[1]. In this project, we proposed a flexible strategy for the synthesis of F10 and related polycyclic xanthone natural products. As shown in the scheme, the glycosylation will be performed at the late stage due to pH and temperature-sensitive of glucose fragment. We envisioned that the polycyclic xanthone skeleton could be forged by intramolecular aryl oxidative coupling[2]. Sonogashira coupling will be used to assemble the substrate for oxidative coupling.



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Catalytic Asymmetric Alkynylation of 3,4-Dihydro-β-carbolinium Ions Enables Collective Total Syntheses of Indole Alkaloids

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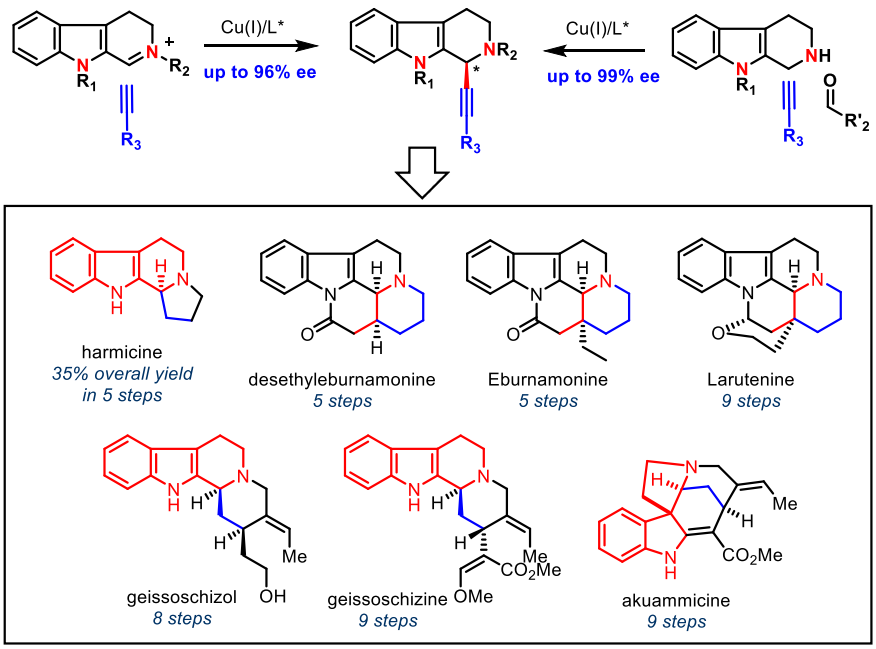
Abstract

Chiral tetrahydro-β-carboline (THβC) is not only a prevailing structural feature of many natural alkaloids but also a versatile synthetic precursor for a vast array of monoterpenoid indole alkaloids. Asymmetric synthesis of C1-alkynyl THβCs remains rarely explored and challenging. Herein, we describe the development of the two complementary approaches for the catalytic asymmetric alkynylation of tetrahydro-β-carbolines with up to 96% yield and 99% ee. The utility of chiral C1-alkynyl THβCs was demonstrated by the collective total syntheses of seven indole alkaloids: harmicine, eburnamonine, desethyleburnamonine, larutensine, geissoschizol, geissochizine, and akuammicine.



Fluorinated End-group Enables High-Performance All-Polymer Solar Cells with Near-infrared Absorption and Enhanced Device Efficiency over 14%.

Han Yu, Ha Kyung Kim, Zhenyu Qi, He Yan*

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Fluorination of end groups has been a great success in developing efficient small molecule acceptors. However, this strategy has not been applied to the development of polymer acceptors. Here, a dihalogenated end group modified by fluorine and bromine atoms simultaneously, namely IC-FBr, is first developed, then employed to construct a new polymer acceptor (named PYF-T) for all-polymer solar cells (all-PSCs). In comparison with its non-fluorinated counterpart (PY-T), PYF-T exhibits stronger and red-shifted absorption spectra, stronger molecular packing and higher electron mobility. Meanwhile, the fluorination on the end groups down-shifts the energy levels of PYF-T, which matches better with the donor polymer PM6, leading to efficient charge transfer and small voltage loss. As a result, an all-PSC based on PM6:PYF-T yields a higher power conversion efficiency (PCE) of 14.1% than that of PM6:PY-T (11.1%), which is among the highest values for all-PSCs reported to date. This work demonstrates the effectiveness of fluorination of end-groups in designing high-performance polymer acceptors, which paves the way toward developing more efficient and stable all-PSCs[1]

Reference

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Random polymerization strategy leads to a family of donor polymers enabling well-controlled morphology and multiple cases of high-performance organic solar cells

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Developing high-performance donor polymers is important for nonfullerene organic solar cells (NF-OSCs), as state-of-the-art nonfullerene acceptors can only perform well if they are coupled with a matching donor with suitable energy levels. However, there are very limited choices of donor polymers for NF-OSCs, and the most commonly used ones are polymers named PM6 and PM7, which suffer from several problems. First, the performance of these polymers (particularly PM7) relies on precise control of their molecular weights. Also, their optimal morphology is extremely sensitive to any structural modification. In this work, a family of donor polymers is developed based on a random polymerization strategy. These polymers can achieve well-controlled morphology and high-performance with a variety of chemical structures and molecular weights. The polymer donors are D–A1–D–A2-type random copolymers in which the D and A1 units are monomers originating from PM6 or PM7, while the A2 unit comprises an electron-deficient core flanked by two thiophene rings with branched alkyl chains. Consequently, multiple cases of highly efficient NF-OSCs are achieved with efficiencies between 16.0% and 17.1%. As the electron-deficient cores can be changed to many other structural units, the strategy can easily expand the choices of high-performance donor polymers for NF-OSCs.[1]

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Regio-Regular Polymer Acceptors Enabled by Determined Fluorination on End Groups for All-Polymer Solar Cells with 15.2% Efficiency

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Polymerization sites of small molecule acceptors (SMAs) play vital roles in determining device performance of all-polymer solar cells (all-PSCs). Different from our recent work about fluoro- and bromo- co-modified end group of IC-FBr (a mixture of IC-FBr1 and IC-FBr2), in this work, we synthesized and purified two regiospecific fluoro- and bromo-substituted end groups (IC-FBr-*o* &IC-FBr-*m*), which were then employed to construct two regio-regular polymer acceptors named PYF-T-*o* and PYF-T-*m*, respectively. In comparison with its isomeric counterparts named PYF-T-*m* with different conjugated coupling sites, PYF-T-*o* exhibits stronger and bathochromic absorption to achieve better photon harvesting. Meanwhile, PYF-T-*o* adopts more ordered inter-chain packing and suitable phase separation after blending with the donor polymer PM6, which resulted in suppressed charge recombination and efficient charge transport. Strikingly, we observed a dramatic performance difference between the two isomeric polymer acceptors PYF-T-*o* and PYF-T-*m*. While devices based on PM6:PYF-T-*o* can yield power conversion efficiency (PCE) of 15.2%, devices based on PM6:PYF-T-*m* only show poor efficiencies of 1.4%. This work demonstrates the success of configuration-unique fluorinated end groups in designing high-performance regular polymer acceptors, which provides guidelines towards developing all-PSCs with better efficiencies.[1]

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Chiral Spiroborate Anions derived from Naphthoic acid

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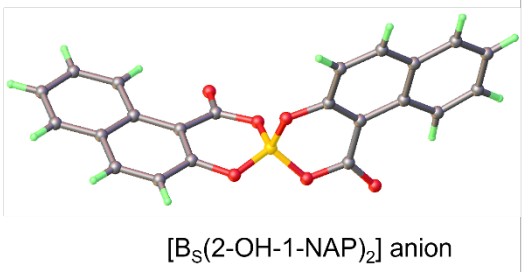
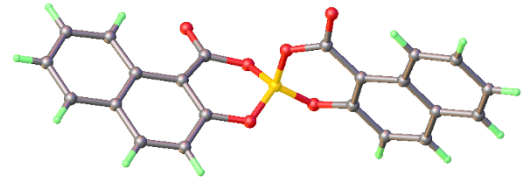
Abstract

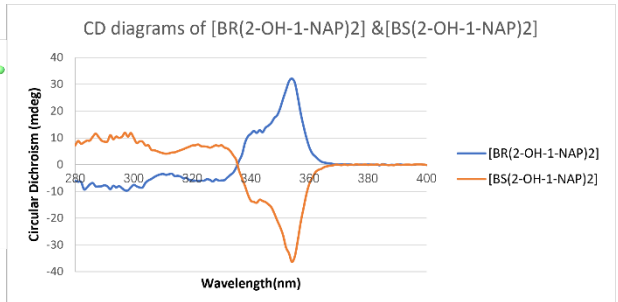
We have recently reported the isolation and enantiostability of the B-chiral bis(saliscylato)borate anions [$B_R(Sal)_2$] and [$B_S(Sal)_2$] (R and S subscripts indicate boron stereochemistry).[1] Then we expand the phenyl group of salicylic acid to naphthyl group of 1-hydroxyl-2-naphthoic acid, 2-hydroxyl-1-naphthoic acid and 3-hydroxyl-2-naphthoic acid. In the three systems, it indicates that the bis(2-hydroxyl-1-naphthlato)borate anions can be isolated in one-pot synthesis involving reaction of boric acid and 2-hydroxyl-1-naphthoic acids with the L/D-proline. Circular dichroism (CD) spectroscopy shows the B-based chirality is stable in polar aprotic solvent, such as DMF. Enantiopure 'conglomerate' salts with achiral counter-cations, such as [NBu4][B_R(2-OH-1-Nap)$_2$] and [NBu4][B_S(2-OH-1-Nap)$_2$] can be prepared by exchange, so these B-chiral anions may have good potential in metathesis-based resolutions.

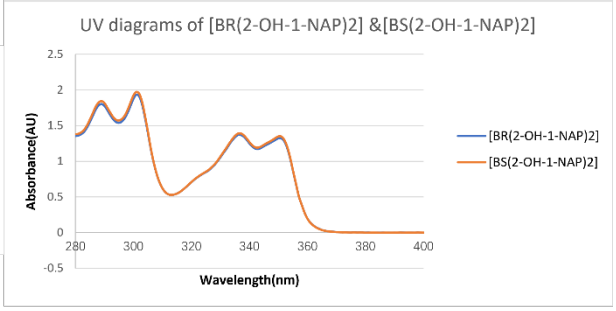


[B_S(2-OH-1-NAP)$_2$] anion



[B_R(2-OH-1-NAP)$_2$] anion





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Templating Polymorphism in 1:1 Pharmaceutical Cocrystals of 11-Azaartemisinin with substituted Salicylic Acids

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Abstract

In our previous research, we've obtained more than 20 cocrystal structures between 11-Azaartemisinin (11-Aza) and different substituted salicylic acids (SalA-Xs).[1] Small perturbations in the functional group of cocrystal coformers could result in drastic change in crystal structures, while the interaction between synthons might not have significant variation.[2] These different crystal structures could be regarded as "pseudo" polymorphs and we would try to create real polymorph *via* heteroseeding. Heteroseeding in solid solution was applied to recover the disappearing polymorph of caffeine : benzoic acid cocrystal before but it is yet managed to create a new polymorph.[3] Here in this report, more insight into the crystal structures of 11-Aza : SalA-X system would be provided. Also some successful polymorph obtained using pseudo polymorph as heteroseeding template would be discussed, showing the potential of templating polymorphism in cocrystal system.

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Cocrystals of 11 Azaartemisinin with Substituted Benzoic Acids and its derivatives.

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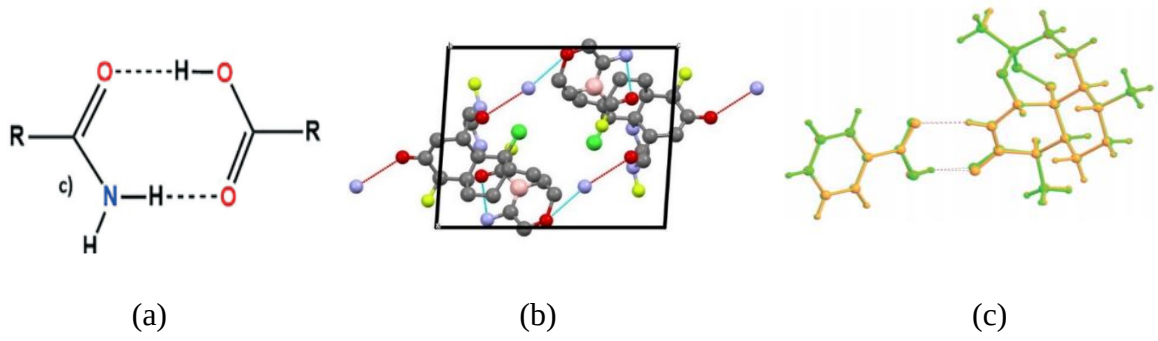
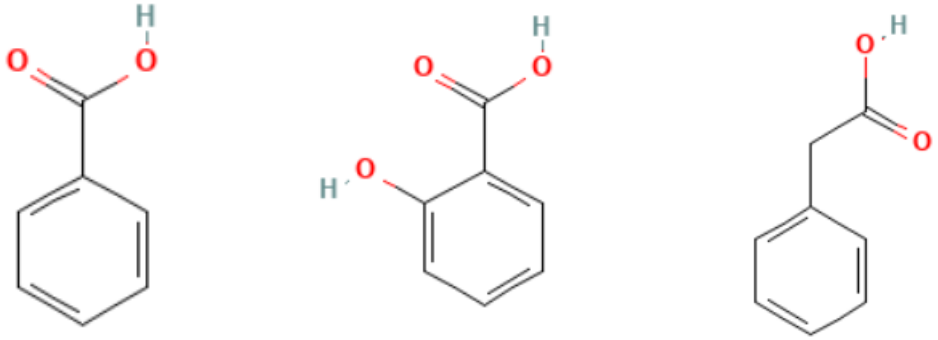
The formation of co-crystals[1], i.e., crystalline molecular complexes of two- or more neutral molecules, represents a potential route to achieve pharmaceutical materials with improved properties of interest. A preliminary batch of substituted variations of the cocrystal[2-4] between 11-azaartemisinin and substituted benzoic and a class of benzoic acid derivatives: salicylic and phenylacetic acids (11-Aza: BzA/SalA/PAA) using respective coformers were prepared. From prior literature[2], a molecular pair with retained synthon is present, these form 2-fold screw stacks with similar geometry. (Figure 1). The X-ray structures of three new 1:1 pharmaceutical cocrystals of 11-azaartemisinin (11-Aza) with bromo-substituted salicylic acids (5-BrSalA, 4-BrSalA and 3,5-Br_2SalA) are reported[5]. Cocrystal structures for various substituted benzoic and PAA[6] is investigated in this work, cocrystals of 11 Aza with substituted BzA, SalA and PAA is expected to follow trends from prior works. Future works concern the use of seeding using one form to induce another cocrystal to adopt the alternative arrangement.



(a) (b) (c)

Figure 1: Similarity between (a)hydrogen bond between amide:acid heterodimer, (b) 11Aza: 5BrSalA and (c) 11Aza:BzA cocrytals.



(a) (b) (c)

Figure 2: Molecular similarities for (a)BzA (b) SalA and (c)PAA.

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Synthesis, structures and application of cyclodextrin-based metal organic frameworks

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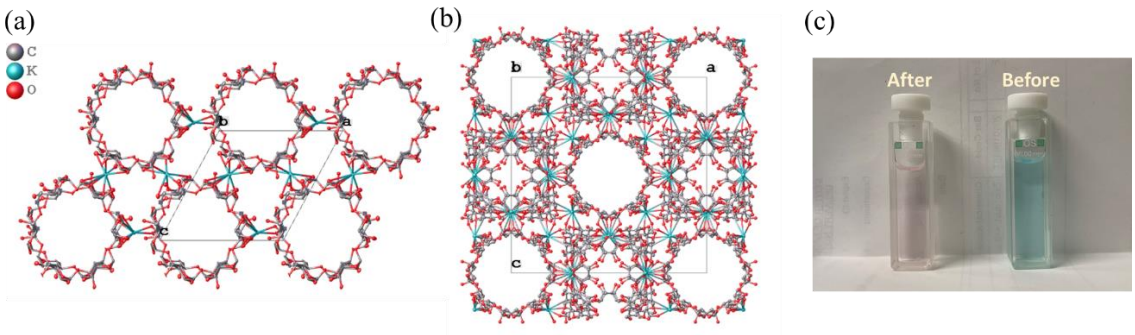
Abstract

Metal-organic frameworks (MOFs) are porous materials with a metal core and organic ligands that provide a variety of advantages (e.g., high surface area, controllable size, flexible network, and versatile functionalities). They are gaining in popularity and have a wide range of applications in gas storage, solvent absorption, catalysts, biosensors, etc.[1] Natural cyclodextrin molecules with six-, seven-, and eight-membered rings are employed as ligands because they are non-toxic, edible, and renewable. [2]



[(a) Packing diagram view along b-axis of α-CD-MOF (H atoms emitted); (b) View along b-axis of γ-CD-MOF; (c) After and before the absorption of methylene blue]

The vapor diffusion method was used to make the non-aqueous-solvent-stable CD-MOFs in this study. The α-CD contributes to monoclinic $P2_1$ crystals whilst the γ-CD as the ligand results in *I432* space group with a 3-D framework and 51.3% solvent-accessible void. The guest molecule absorption test of methylene blue in γ-CD-MOF is successful.

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Fine-Tuning of the Optical Output in a Dual Responsive Catenane Switch

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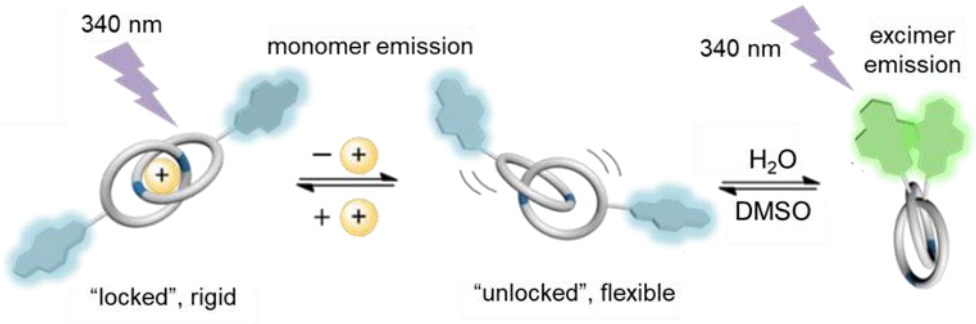
Abstract

A pyrene-functionalized dual responsive [2]catenane switch is reported.[1] The [2]catenane possesses a photophysical output that is correlated to its co-conformational changes, which can be fine-tuned by the combination of two orthogonal stimuli: cation binding and solvent polarity. Specifically, the cation binding is employed to "lock" the mechanical bond to prevent the pyrenes from approaching each other, while increasing the solvent polarity will strengthen the intramolecular pyrene-pyrene hydrophobic interactions such that the pyrenes will be brought closer in proximity. This work demonstrates the dual-responsive and fine-tunable properties of a [2]catenane switch which allow an elaborate and versatile control.



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Catenane-Coordinated Copper(I) Catalyzed Aerobic Coupling of *N*-Aryl Tetrahydroisoquinoline and Indole Derivatives

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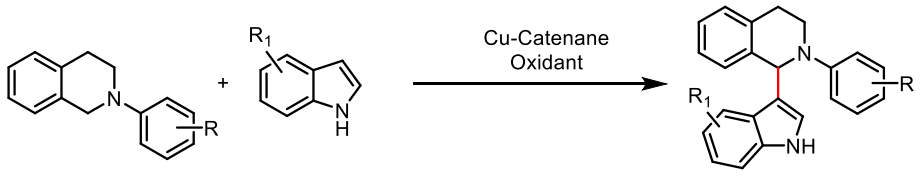
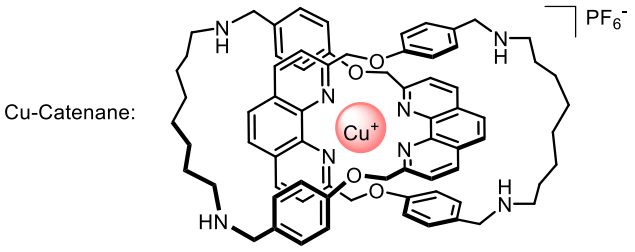
Abstract

Mechanically interlocked molecules (MIMs) have been used in catalysis due to the unique properties arising from mechanical bond. Our previous work have found that the interlocked catenane ligands provide kinetic stabilization to Cu(I) and offer a responsive copper coordination geometry, allowing the active site to be available briefly for cross dehydrogenative coupling (CDC).[1] Herein, we have utilized copper-[2]catenane as catalyst in the aerobic oxidative coupling between *N*-Aryl tetrahydroisoquinoline and indole with a broad substrate scope in good yields. Notably, other than O_2, H_2O_2 is also successfully employed as an oxidant, where it was rarely reported as an oxidant in this reaction.





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The synthesis of oxetan-2-yl enolsilanes and their (4 + 3) cycloaddition reactions

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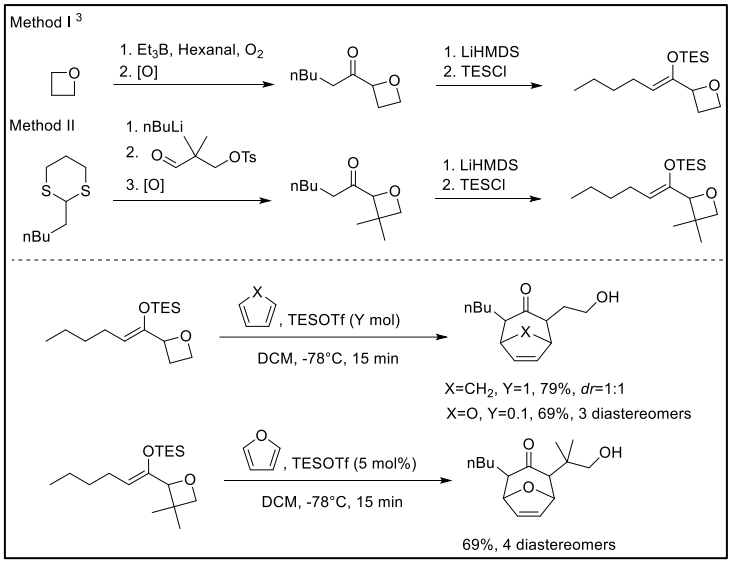
Abstract

The oxetane plays an important role in medicinal and synthetic chemistry and they are isosteres of some functional groups.[1] However, in comparison to epoxides, methods to synthesize oxetanes are quite limited, especially 2-substituted oxetanes because this introduces a stereocenter. Thus both the synthesis of oxetanes and the exploration of their applications in synthetic chemistry needs further exploration and study.[2]

To synthesize 2-acyloxetanes, we explored two methods I [3] and II. These were then converted to the corresponding enolsilanes. These were induced to undergo (4 + 3) cycloadditions to generate seven-membered carbocycles.[4] 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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Studies Toward the Total Synthesis of Tubingensin B

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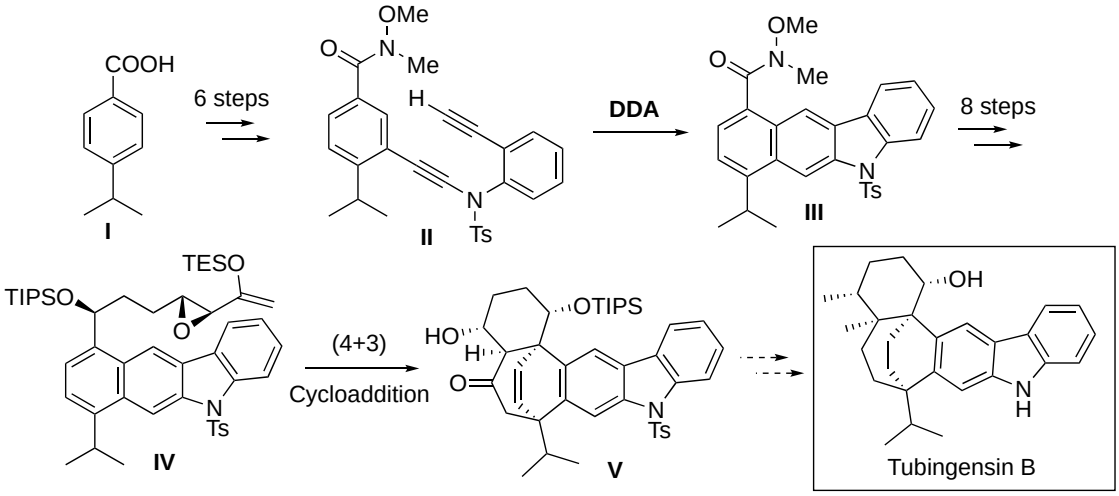
Abstract

Tubingensin B was isolated from the fungus *Aspergillus tubingensis* in 1989[1]. Five stereogenic centers involving three quaternary centers make the synthesis challenging. Garg's group has completed the first and the only total synthesis of Tubingensin B in 2017.[2]

Our synthesis began with a cheap substrate 4-isopropylbenzoic acid (**I**). And the Benzo[b]carbazole structure was assembled by a *Dehydro-Diels−Alder (DDA)* reaction.[3] Based on the studies of the dearomative intramolecular (4+3) cycloaddition of arenes[4], we have successfully applied the methodology to build the skeleton of Tubingensin B in one step. Currently, we are trying the remaining steps towards Tubingensin B.



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Studies Toward the Total Synthesis of Pseudolaric Acid B

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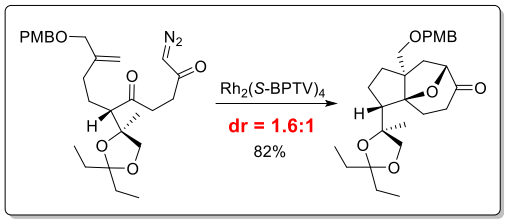
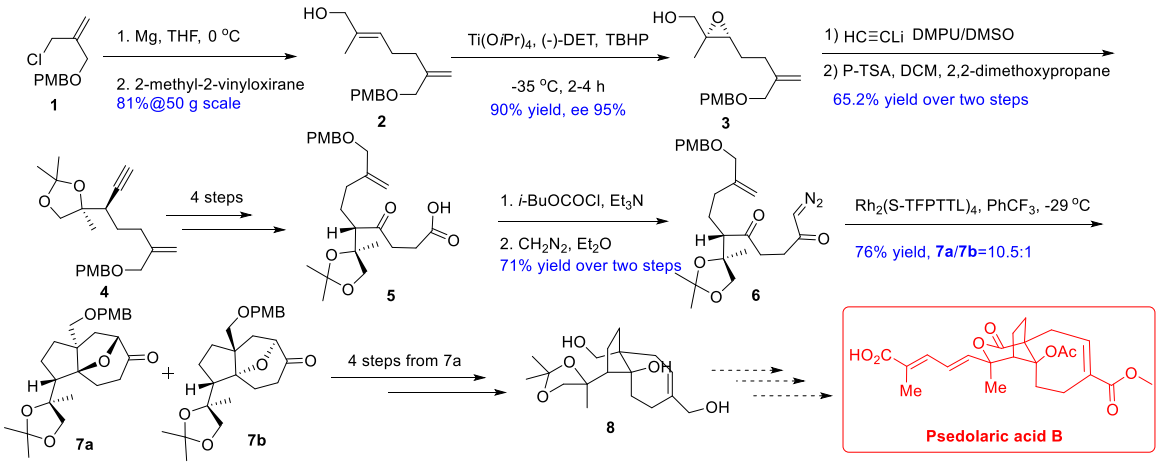
Abstract

Pseudolaric acids are a class of novel deterpenoids isolated from the root bark of Pseudolarix kaempferi Gordon in 1980's for the treatment of dermatological fungal infections[1,2]. Of them, pseudolaric acid B displays much higher activities than other pseudolaric acid members. Due to their remarkable biological activities and intriguing structural skeleton[3,4], the pseudolaric acids have attracted considerable attention around world. Our group reported the first total synthesis of PAA[5] (Scheme 1). However, the carbene cyclization cycloaddition cascade key step proceeded with a low diastereoselectivity (1.6:1). Our second-generation synthesis aims to improve the selectivity of the key step and the efficiency of synthetic route as well.



Scheme 1. Key step of the first generation total synthesis



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Copper-Catalyzed Enantioselective 1,2-Reduction of Cycloalkenones

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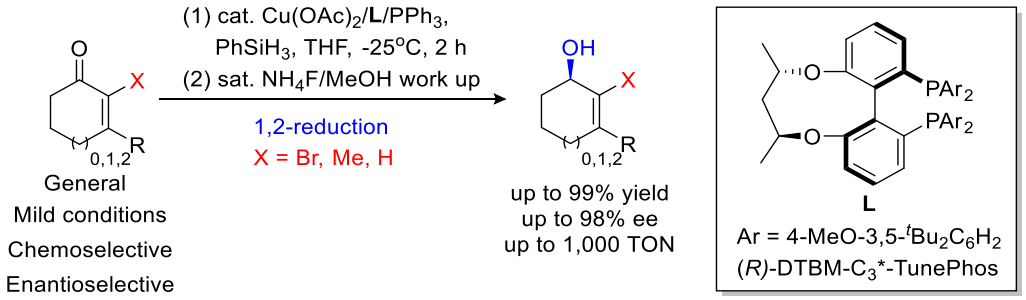
Abstract

We report an asymmetric 1,2-reduction of cyclic α, β-unsaturated ketones to access various enantiomerically enriched cyclic allylic alcohols under mild conditions, catalyzed by in situ generated copper hydride ligated with (R)-DTBM-C3*-TunePhos.[1] α-Brominated cycloalkenones were reduced with excellent enantioselectivities of up to 98% ee, while substrates that were without α-substituents were reduced chemoselectively, with moderate enantioselectivities.



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Intermolecular (4+3) cycloadditions with Epoxy Allylsilanes as Dienophiles

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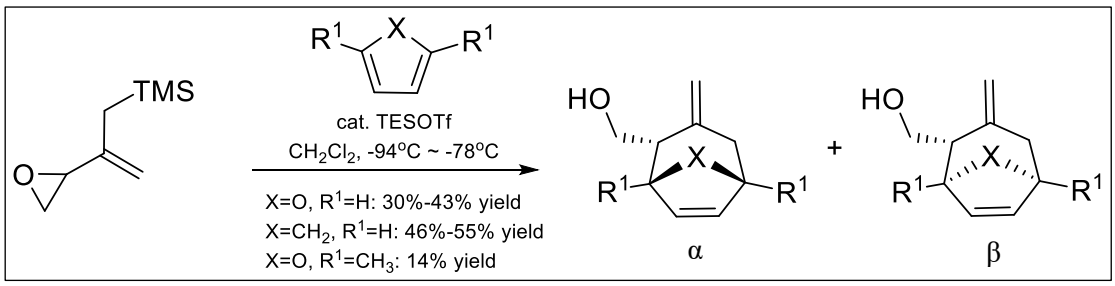
Abstract

Many bioactive natural products possess complex seven-membered carbocycles as their core structure, and yet, the assembly of the seven-membered framework is often a challenging task to organic chemists.[1] The (4+3) cycloaddition reaction is a strategy that has been widely used to construct seven-membered carbocycles.[2] Variations of the cycloaddition could be applicable to the synthesis of different natural products.[3] The synthesis of the dienophile precursor and the intermolecular (4+3) cycloadditions of epoxy allylsilanes with different dienes to provide methylenated cycloheptanes are presented. Treatment of epoxy allylsilanes with a catalytic amount of TESOTf results in the formation of (4+3) cycloadducts with moderate yields.



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Synthesis of Tertiary Alcohols and α-Tertiary Amines via Reductive Desymmetrization of Malonic Esters

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Abstract:

Expeditious and stereoselective construction of polyfunctionalized amines and alcohols are essential for accessing a plethora of complex structures of biological importance[1,2]. Amines and alcohols bonded to a chiral tertiary carbon are particularly attractive targets owing to their prevalence in natural products and pharmaceutical agents, yet their synthesis poses considerable synthetic challenges. While conventional approaches towards these tertiary motifs often hinge on the enantioselective addition to planar ketones and ketimines, desymmetric transformation of preformed and prochiral tertiary alcohols or α-tertiary amines with a pair of enantiotopic functional groups is rarely explored. Here, we report that oxygenated or aminated malonic esters can be readily hydrosilylated by chiral dinuclear zinc catalysts to give enantioenriched amine and alcohol derivatives. This approach employs disubstituted malonic esters that can be easily accessed from commercially available starting materials[3] and has enabled the synthesis of several classes of versatile building blocks, including α-disubstituted amino esters, malic acid derivatives, and α-tertiary heterocycles. The compatibility of the desymmetrization with amine, alcohol, and carbon substituents with a variety of electronic/steric properties and pendent functional groups have also allowed the diverse and rapid derivatization of these chiral products to bioactive molecules of higher complexity.

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A Desymmetrization/Rearrangement Approach to Chiral Amino Alcohols from Malonic Esters

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Abstract:

Amino acids and their derivatives are vital molecules in synthetic chemistry. They are fundamental building blocks for the synthesis of peptides and enzymes, as well as prevalent structural motifs in bioactive metabolites and pharmaceutical agents[1] . Particularly, efficient and stereoselective synthesis of non-canonical amino acid derivatives is increasingly sought after owing to their distinct properties from their proteinogenic counterparts and promising application potential in proteomics and biochemical research, such as alternating peptide conformation[2] , antitumor studies[3] , and serving as protein labels[4] . Here, we describe a modular and convenient access to chiral amino alcohols from easily available malonic esters through a sequence of reductive desymmetrization[5] and Curtius rearrangement. In our synthetic paradigm, monosubstituted malonic esters are enantioselectively hydrosilylated by using a dinuclear zinc catalyst with a pipecolinol-derived tetradentate ligand to give chiral β-hydroxyester motif. Subsequent acyl hydrazine formation and oxidation trigger a Curtius rearrangement and the resulting isocyanate intermediates are trapped by the internal primary alcohols to yield chiral oxazolidinones as masked amino alcohols. Overall, the desymmetrization-rearrangement approach allows an early and easy installation of the side chain of amino alcohols during the synthesis of monosubstituted malonic esters. This advantage, together with the high stereoselectivity of the reductive desymmetrization and the high stereospecificity of the rearrangement, would enable the synthesis of a large library of enantioenriched amino alcohol derivatives with distinct structural features and pendent functional groups.

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Mechano-responsive Hydrogel for Switching Protein Functions

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Abstract

Mechanical force is ubiquitous in a living body and known to play essential roles in many biological and biomolecular events.[1] Inspired by the biological mechano-sensing, we designed, as an artificial mechano-responsive tissue, a hydrogel that can switch off/on biomolecular functions in response to mechanical stress. The hydrogel consists of 2 segments: guanidinium ion (Gu^+)-appended molecular glue[2] and poly(*N*,*N*-dimethylacrylamide-*co*-2-acrylamido-2-methylpropane sulfonic acid) [poly(DMA-*co*-AMPS)], with covalent crosslinks between the poly(DMA-*co*-AMPS) segments. The molecular glue segment tightly adheres to proteins via multivalent salt-bridge and suppresses their functions.[3] Upon mechanical stress, the salt-bridges between molecular glue segments and proteins are preferentially dissociated, allowing the proteins to be liberated and retrieve their functions. As a proof-of-concept study, we demonstrated enzymatic activity switching of *β*-galactosidase with the mechano-responsive hydrogel.

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New synthetics method for carbapenem-based sideromycins

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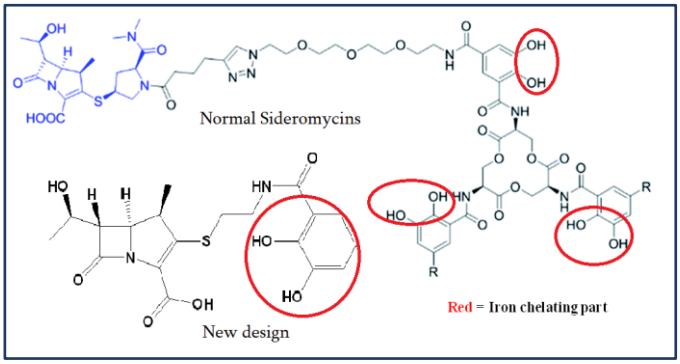
Highly resistance bacteria like carbapenem resistant Enterobacteriaceae can have fatality up to 50% since limited treatment options available[1] and it is spreading quickly worldwide so as others superbug like NDM-1 containing bacteria which already spready to more than 70% of the whole world in 2015[2]. An emerging treatment is to conjugate β-lactam antibiotics with siderophores[3-5] which are small molecules that bacteria synthesize to grab iron from host. These sideromycins like cefiderocol (approved by FDA in 2020)[6] can be actively transport into bacteria cell and bypass their defense system[7]. However, as β-lactam antibiotics and siderophores are very polar in nature[3], the conjugation also require multiple steps with HPLC purification.

In this poster, the highly effective and high yield synthetic route of simplified *E coli*. siderophore conjugation with carbapenem will be unraveled (*lower figure*), which may provide an approach for solving these problems.



Instead of starting from meropenem as starting material and enterobactin as starting material and conjugate by alkyne-azide click reaction[5], the benzyl protected 2,3-dihydroxybenzoic acid reacts with cysteamine directly through amide condensation, and then an enol-phosphate thiol exchange reaction take place to conjugate the siderophore with the carbapenem core, followed by palladium on carbon reduction to obtain the final compound. With the use of this method, large scale synthesis of carbapenem based sideromycins can be achieved.

We thank the Research Grants Council (RGC) and Innovative Technology Commission of Hong Kong, the University of Hong Kong and Norman & Celia Yip Foundation for financial support.

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Precisely Light Switched Micromotor by Phase Command in AC E-field

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The pursuit of artificial micromotors with high precision manipulation of direction and velocity requires sophisticated unsymmetric structure and individual external field control.[1] Here, we propose an innovative working mechanism that allows the swiftly-translational motion of forward and backward for an illuminated (pulse light, 50% duty cycle) bare silicon wire by phase (0-360°) modulation under AC E-field, along with speed variation at a specific frequency. Charge induced by visible light in silicon wire can construct natural unsymmetric engineering by the polarization of AC E-field, guiding the alignment performance and driving the chemical-powered migration by self-electrophoresis. Unlike previously developed micromotors strongly dependent on energy consumption to accelerate self-propulsion, linearly increase/decrease motion speed within working frequency (1KHz-100KHz) in our system makes it subtly flexible to adjust the movement.[2] Our work explores a new insight to replace the complex material design with multi-external field interplaying, further advancing the general application for non-decorated micromotors.

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Organic Self-Assembled Monolayers as Tunable Electrocatalytic Platforms

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Abstract

Gold electrode surface can be modified by organic self-assembled monolayers (SAMs) through robust Au-S bonding interaction.[1] The well-packed SAM on gold surface consists ligand chelation motif that can chelate with a variety of metal ions, such as copper (II) and nickel (II) ion, for metal-catalyzed electrochemical organic reactions. This heterogenous system aims at tuning the electron transfer rate from metal catalyst to substrate. It could control reaction pathways and hence selectively produce desirable products. In addition, the system also aims at increasing the turnover number and frequency of metal catalyst, which provides environmentally-friendly platform for electrochemical catalytic reactions.

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Scalable Transition Metal Nanoconstructs for Efficient and Selective Energy Catalysis

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Next-generation fuel cell technology is one of the key components of a future society powered by clean energy. Regarding the selection of renewable fuels for energy conversion, H_2O_2 is considered a sustainable power source in a direct hydrogen peroxide/hydrogen peroxide fuel cell (DPPFC). Typically, precious metals with outstanding activity and stability are hindered by their cost.[1] While metal oxides and complexes have been used for H_2O_2 reduction, they are rarely applied to H_2O_2 oxidation likely due to their limited robustness under operating environments.

Here, we developed a laser pyrolysis method to produce tantalum-based Ta/N/O nanomaterials as a new class of bifunctional catalysts performing prominent catalytic activities towards H_2O_2 oxidation and reduction for DPPFCs.[2] The exploratory work serves as a milestone for developing early transition metal materials for future energy catalysis and renewable power schemes.

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Nitrile-facilitated Proton Transfer for Enhanced Oxygen Reduction by Hybrid Electrocatalysts

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Abstract

Hybrid bilayer membranes (HBMs), comprised of a self-assembled monolayer (SAM) covered by a lipid membrane, have been developed recently to regulate the performance of HBM-embedded electrocatalysts.[1,2] However, up until now, no proton switch can be turned on in basic condition and off in acidic condition. This limitation is due to the mode of proton delivery used in HBMs. Here, we synthesized proton carriers bearing nitrile groups found in protonophores.[3] These nature-inspired proton carriers can facilitate transmembrane proton delivery to an HBM-supported Cu oxygen reduction reaction (ORR) catalyst under alkaline conditions. Our stimuli-responsive proton regulators can turn on the activity of the ORR catalyst on demand, thereby opening doors to investigate how proton transfer kinetics govern the performance of electrocatalysts for renewable energy conversion processes.

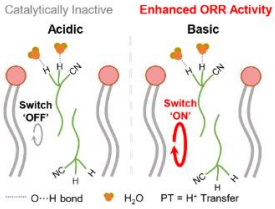

Figure 1. Cyano proton carrier regulates the activity of the ORR catalyst on demand.

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Enhancement of Oxygen Reduction Performance of Cu Complexes via Pulsed Laser Treatment

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A sustainable society requires advanced catalysis technology to achieve efficient green energy production and conversion. Because of its advantages of "zero emission", high energy density, and high energy conversion efficiency, hydrogen fuel cells have considerable application potential in high power demand areas, such as transportation and residential power supply. At present, the performance of hydrogen fuel cells is limited by the slow kinetics of the oxygen reduction reaction (ORR) occurring at the cathode as well as the high cost of catalyst materials made of precious metals. Therefore, it is necessary to find a low-cost, high-capacity, and high-performance catalyst of ORR.

Here, we aim to address two technological issues of ORR electrocatalysts, namely high overpotential and low scalability. Upon processing via a pulsed laser, the ORR overpotential of copper complexes can be improved by 0.05 V in alkaline solution (pH=13) while the H_2O selectivity can be enhanced by 21%. By adjusting pulsed laser parameters, screening liquid phase components, and changing ligands of the copper complexes, optimized copper-based ORR electrocatalysts can be obtained. The insights obtained from this study provide a pathway to enhance the activity and selectivity of non-precious metal catalysts as well as improve the scalability of catalysts through replacing conventional wet chemistry processes by dry pulsed laser treatment.

Structure-Activity Relationships of Novel Indoloquinoline Ligands and their Copper(II) Complexes as Anticancer Agents

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Indoloquinolines are naturally occurring alkaloids isolated from the species of West African Shrub, *Cryptolepis Sanguinolenta*. Their heterocyclic structures enabled them to exist in many derivatives including those that are only obtainable synthetically. Notably, the biological activity of the synthetic alkaloid, indolo-[2,3-*c*]-quinoline has been seldomly investigated. In this research, we report a series of novel indolo-[2,3-*c*]-quinoline-based ligands and their copper(II) complexes modified with Schiff bases and substituent groups. The synthesized compounds were characterized by ESI-mass spectrometry, ^{1}H and ^{13}C NMR spectroscopy, and single crystal -ray diffraction analysis. Both ligands and complexes demonstrated high cytotoxicity against breast cancer and normal human cell lines, ranging from nanomolar to low micromolar activity. The results revealed that the methylation of Schiff base groups and the position of the bromine substituent on the indoloquinoline backbone impact the cytotoxicity of the compounds. In general, the indolo-[2,3-*c*]-quinoline derivatives are twice as cytotoxic compared to the indolo-[3,2-*c*]-quinoline based compounds.

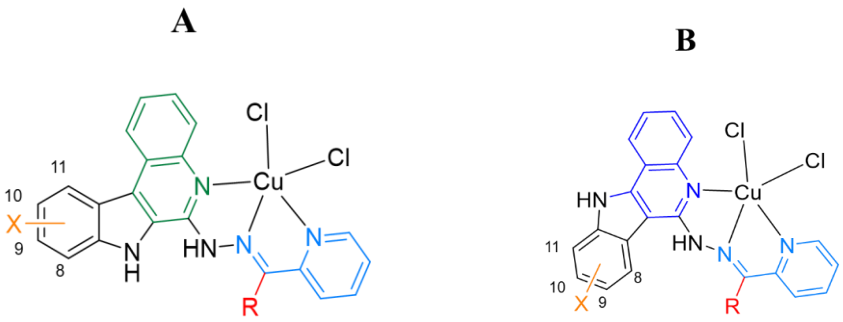

Fig.1., Structure (A) Cu(II) indolo-[2,3-*c*]-quinoline complex, Structure (B) Cu(II) indolo-[3,2-*c*]-quinoline complex

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A DFT study of Selective Alkane Halogenation by Non-heme Iron Catalysts: Evidence for [Fe^{V}(acacen)(oxo)(halide)] as an Active Intermediate

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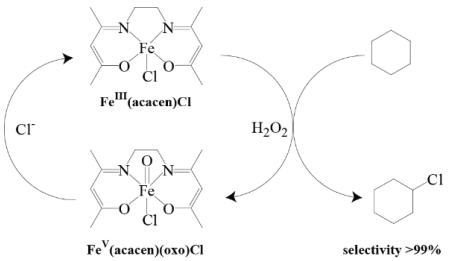
Abstract: DFT computations have been performed to gain insight into the mechanisms of the oxidative halogenation of alkanes with H_2O_2/CF_3COOH catalyzed by Fe^{III}(acacen)Cl (**1^{III}-Cl**) complex, giving haloalkanes. In our work, the catalytical oxidative halogenation mechanism includes four major parts, (i) formation of **trans-1^{V}-oxo-Cl**, (ii) HAT, (iii) chlorine atom rebound, and (iv) regeneration of **1^{III}-Cl**. The detailed characterization of the pathways allows us to have the following key mechanistic findings. The formation of the high-valent iron^{V}-oxo intermediate from the reaction between **1^{III}-Cl** and H_2O_2 is the rds with a barrier of 23.5 kcal mol^{-1} (**^{4}TS1** relative to ^{4}**INT1**) and is endergonic by 0.3 kcal/mol. Note that, experimentally the small kinetic isotope effect also suggested that the hydrogen atom transfer (HAT) step by the high valent iron-oxo intermediate is not the rds. The [Fe^{IV}(acacen)(OH)Cl···alkane radical] is found as a well-caged transition species in which the *trans*-effect from the hydroxyl group (O^{-}) elongates the iron-halide bond and hence increasing the chance of halogen rebound. The calculated kinetics and thermodynamic properties are in good agreement with the available experimental findings. We expect that this study could enrich the field of oxidative C-H activation.

Key words: Fe^{III}(acacen)Cl (**1^{III}-Cl**) complex, oxidative halogenation, HAT, DFT calculations



Modulation of Emission and Singlet Oxygen Photosensitization in Live Cells Utilizing Bioorthogonal Phosphorogenic Probes and Protein Tag Technology

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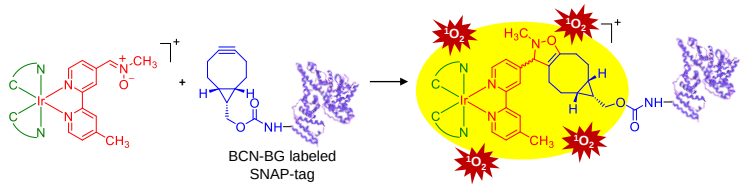
The self-labeling protein SNAP-tag is commonly used to study the expression and functions of proteins of interest (POI) in live cells. It undergoes a specific reaction with synthetic probes containing a benzylguanine (BG) moiety. Despite many substrates developed, photofunctional substrates that serve as both fluorogenic probes and singlet oxygen ($^1O_2$) photosensitizers have not been reported. Herein, we designed a new class of phosphorogenic iridium(III) nitrone complexes for this purpose. In this strategy, a strained alkyne-modified substrate BCN-BG was used to label SNAP-tag, which is then recognized by the iridium(III) nitrone complexes. These complexes were weakly emissive with negligible $^1O_2$ generation due to quenching of the nitrone moiety. However, they displayed significant emission enhancement upon reactions with the strained alkyne BCN-OH (*ca.* 7.2 – 47.1) and BCN-modified BSA (*ca.* 82.9 – 327.1). These reactions also resulted in efficient photoinduced $^1O_2$ generation (Φ_Δ up to 0.91) of the complexes. Confocal images revealed that CHO-K1 cells expressing organelle-specific SNAP-tag exhibited intense and long-lived emission only in presence of both BCN-BG and the complexes. MTT assays indicated that BCN-BG and SNAP-tag significantly increased the photocytotoxicity of the complexes, resulting in a photocytotoxicity index up to 115.9.



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

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

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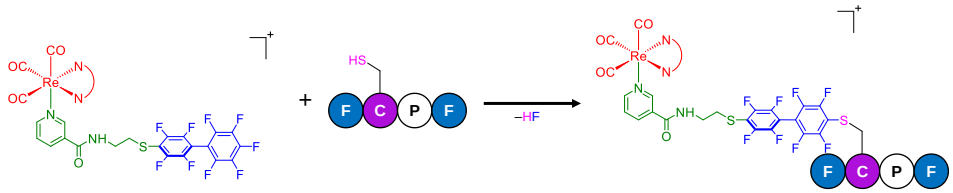
A four amino-acid sequence (FCPF, termed as "π-clamp") has been introduced for the site-specific cysteine labeling of peptides and proteins in aqueous media. This short sequence undergoes selective and rapid cysteine arylation with perfluorobiphenyl (PFBP) derivatives without the need of catalysts. In view of the rich photophysical and photochemical properties of rhenium(I) polypyridine complexes such as 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 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 that was responsive toward caspase-3/7 was developed for monitoring the activity of these enzymes in live cells.



We thank the funding support from the Hong Kong Research Grants Council (Project No. CityU 11302820, CityU 11300019, CityU 11300318, and T42-103/16-N).

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A Rhenium(I) Polypyridine Tetrazine Complex as Phosphorogenic Bioorthogonal Reagent for Release of Functional Payloads

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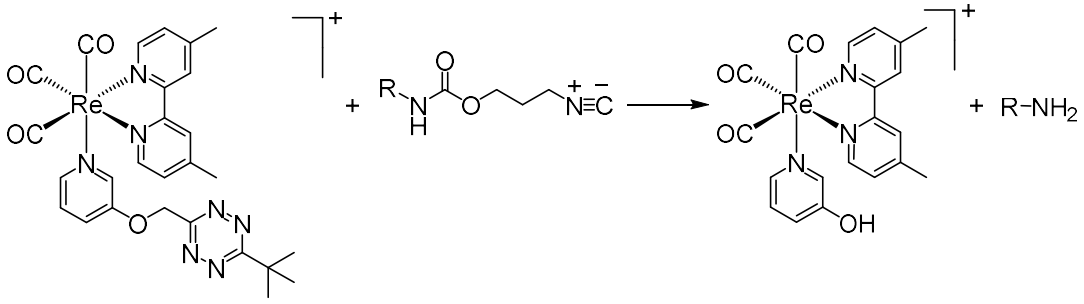
There has been growing interest in developing bioorthogonal cleavage reactions for targeted delivery of functional payloads, such as fluorophores and drugs, in living systems. The bioorthogonal chemistry of tetrazines and isonitriles has gained attention due to the structural compactness of the isonitrile group that minimizes perturbation to biological environments.[1] Based on our interest in photofunctional transition metal complexes as bioimaging reagents and photosensitizers for photodynamic therapy, a rhenium(I) polypyridine complex functionalized with a tetrazylmethyl group (**1**) was designed as a novel bioorthogonal turn-on reagent for triggering and monitoring the release of payloads. Upon reaction with an isonitrile derivative, the complex displayed substantial emission enhancement and lifetime extension. The reaction was monitored by HPLC analysis and showed near-quantitative release of the tetrazylmethyl-free complex. The high photoinduced singlet oxygen generation efficiency of the complex demonstrated its potential as a phototherapeutic reagent.



1
Emission off

1a
Emission on

Bioorthogonal Phosphorogenic Rhenium(I) Polypyridine Sydnone Complexes for Specific Lysosome Labeling

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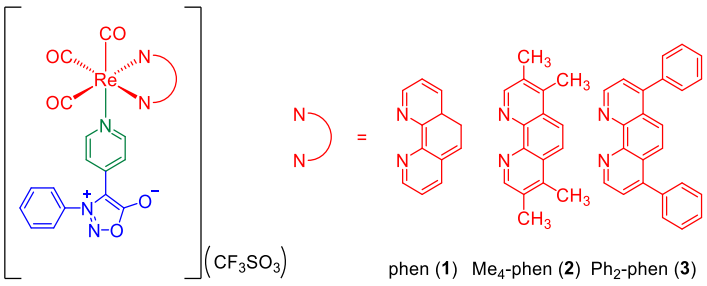
Abstract

Many novel bioorthogonal reactions have been developed for labeling, such as the strain-promoted sydnone-alkyne cycloaddition (SPSAC), but sydnone-based probes with phosphorogenicity have not been investigated to date. The synthesis, characterization, and photophysical properties of rhenium(I) polypyridine complexes containing a sydnone moiety as bioorthogonal phosphorogenic probes are reported. Their reactions with strained alkyne derivatives and the associated photophysical changes were examined. Upon SPSAC with bicyclo[6.1.0]non-4-yn-9-ylmethanol (BCN-OH), the complexes exhibited emission enhancement in the range of 8.8 to 17.3. Conjugation of the complexes with BCN-modified bovine serum albumin (BCN-BSA) led to the increase in emission enhancement to as high as 38.9 and extended lifetimes in the range of 1.80 to 4.71 μs. The bioorthogonal ligation of one of the complexes with a morpholine derivative induced specific lysosomal labeling in live cells (Pearson's Correlation Coefficient = 0.83).



We thank the Hong Kong Research Grants Council (Project No. CityU 11300019, CityU 11300318, CityU 11300017, and T42-103/16-N) and the Hong Kong Research Grants Council, National Natural Science Foundation of China (Project No. N_CityU113/15) for financial support.

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Bioorthogonal Control of the Phosphorescence and Singlet Oxygen Photosensitization Properties of Iridium(III) Tetrazine Complexes

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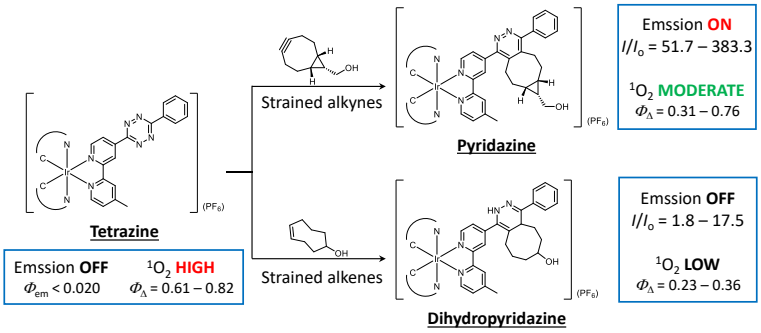
Tetrazine is a commonly used bioorthogonal functionality that quenches the emission of the appended fluorophores by different processes. It undergoes inverse electron-demand Diels–Alder (IEDDA) with dienophiles including strained alkynes and alkenes to give the corresponding pyridazine and dihydropyridazine products, respectively. The rich photophysical properties of iridium(III) polypyridine complexes have been exploited for biomolecular sensing and imaging applications. Their complexes usually display long-lived triplet excited states that render them excellent photosensitizers for singlet oxygen ($^1O_2$). Herein, we report a new class of iridium(III) tetrazine complexes that exhibit very different photophysical and photochemical behavior after reactions with strained dienophile derivatives. Based on the properties in the resulting derivatives, these complexes were utilized for the specific staining of organelles including lysosomes and endoplasmic reticulum of human cervical carcinoma HeLa cells. Furthermore, in combination with the HaloTag technology, the control of intracellular photocytotoxicity activity of the complexes was demonstrated with different strained dienophile derivatives.



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Utilization of Rhenium(I) Polypyridine Complexes Featuring a Dinitrophenylsulfonamide Moiety as Biothiol-selective Phosphorogenic Bioimaging Reagents and Photocytotoxic Agents

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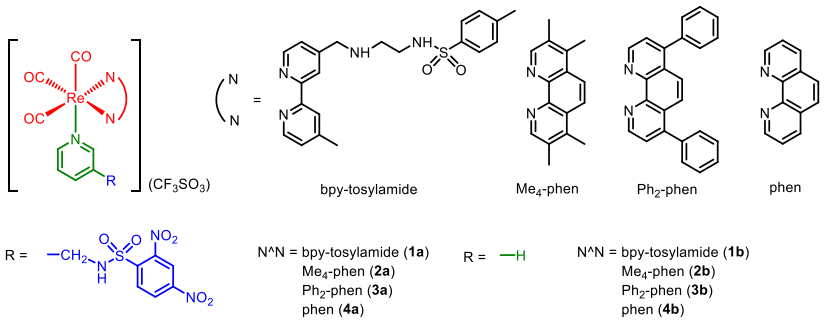
Glutathione (GSH) plays a crucial role in regulating redox homeostasis in living systems. Significant efforts have been devoted to the design of fluorescent probes for GSH in live cells. With our on-going interest in the development of luminescent transition metal complexes for bioimaging and photodynamic therapy (PDT), we functionalized rhenium(I) polypyridine complexes with a dinitrophenylsulfonamide moiety to afford a new class of GSH-responsive reagents. Upon reaction with GSH, these complexes displayed substantially increased emission intensity and enhanced singlet oxygen photosensitization capability. Additionally, conjugation of the complexes with a tosylamide unit led to endoplasmic reticulum-targeting ability. Our results showed that these complexes are promising GSH-sensitive reagents for bioimaging and organelle-targeted PDT applications.



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Luminogenic Iridium(III) Bis-tetrazine Complexes as Double-clicking Two-point Binders and Bioorthogonal Probes for Bioimaging and Photocytotoxic Applications

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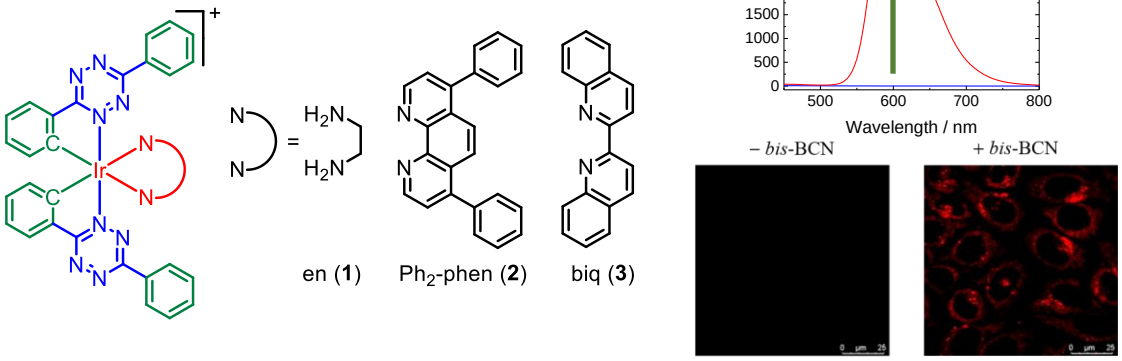
Luminogenic bioorthogonal probes have emerged as useful biological tools to selectively visualize biomolecules in complex cellular environments through "turn-on" emission. Recently, there has been much interest in the design of luminogenic bioorthogonal probes that rely on the efficient emission quenching effect and chemical reactivity of tetrazine derivatives. Herein, we report the synthesis, characterization, and photophysical studies of three novel luminogenic cyclometalated iridium(III) bis-tetrazine complexes. These complexes were utilized as luminogenic double-clicking two-point binders for the derivatives of a strained alkyne, bicyclo[6.1.0]non-4-yne (BCN). The cellular uptake efficiency, bioimaging capability, and (photo)cytotoxicity of the complexes were also studied by ICP-MS, confocal microscopy, and MTT assays, respectively.



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Tuning the Organelle Specificity and Cytotoxicity of Iridium(III) Photosensitizers for Enhanced Phototheranostic Applications

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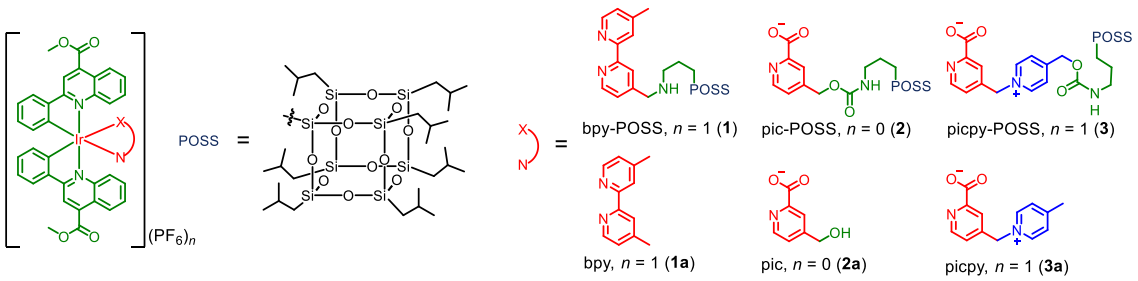
Three new molecular hybrids composed of a cyclometalated iridium(III) polypyridine core and a POSS unit $[Ir(pqe)_2(N\text{^}X)](PF_6)_n$ (N^X = bpy-POSS, n = 1 (**1**); pic-POSS, n = 0 (**2**); picpy-POSS, n = 1 (**3**)) and their POSS-free counterparts (N^X = bpy, n = 1 (**1a**); pic, n = 0 (**2a**); picpy, n = 1 (**3a**)) were synthesized and characterized. Upon photoexcitation, these complexes exhibited long-lived orange-red to deep red emission. The complexes displayed not only significant photoinduced $^1O_2$ generation but also efficient generation of $O_2^{\cdot-}$. Modification of the ancillary N^X ligand enables the complexes to be taken up by the cells via different internalization mechanisms and to target different cellular organelles. Additionally, the POSS complexes were found to be significantly less cytotoxic than their POSS-free counterparts in the dark. However, all the complexes showed substantially high cytotoxic activity upon photoirradiation. The bpy complexes **1** and **1a** demonstrated notable photocytotoxicity under hypoxic conditions. Cell death mechanism studies indicated that complex **1** predominantly induced apoptotic cell death upon photoirradiation, while the cells incubated with the complex **1a** underwent a mixed apoptotic and paraptotic pathway.



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Cα–Cβ Tyrosyl Bond Cleavage: Theoretical and Spectroscopic Investigation of theGeneration of α-Glycyl Radical Cations from Tyrosylglycylglycine

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Abstract

Mechanistic study of peptide radical cation has gained lot of attention due to its key intermediate's role in some neurodegenerative disorders. Herein, detailed exploration of single electron transfer dissociation of **$[Cu^{II}(dien)(YGG)]^{\bullet 2+}$** complex [dien = diethylenetriamine, YGG = Tyrosylglycylglycine] was accomplished. The **Cu^{II}** is reduced to **Cu^{I}** and formed **$(YGG)^{\bullet +}$** radical cation. The comprehensive analyses of the formation of **$(YGG)^{\bullet +}$** and its fragmentation pattern were carried out via mass spectrometry, infrared multiple photon dissociation (IRMPD) with the conjunction of density functional theory (DFT). Geometry optimizations and harmonic frequency analyses were performed at UB3LYP/6-311++G(d,p) level. Relative enthalpies at 0 K ($\Delta H0$) were evaluated with hybrid meta exchange-correlation functional at UM06-2X/6-311++G(d,p) level, which was also used for natural population analyses (NPAs) to obtain charge and spin densities. The MS/MS spectrum of **$[Cu^{II}(dien)(YGG)]^{\bullet 2+}$** showed that it can dissociate into two major products, odd electron peptide radical cation **$[YGG]^{\bullet +}$** at *m/z* 295 and reduced copper complex ion **$[Cu^{I}(dien)]^{+}$** at *m/z* 166. Furthermore, the product ion **$[YGG]^{\bullet +}$** undergoes dissociation. So, the m/z 278 **$[Z3\text{-}H]^{\bullet +}$** (breakage of N-Cα bond) appears which indicates the loss of NH_3. The m/z at 189 is arisen due to the loss of *p*-quinomethide by forming **$[G^{\bullet}GG]^{+}$** radical cation. Comparison between experimental and theoretical spectrum indicating that the experimental IRMPD spectrum is a mixture of at least three different conformers namely **A3 (**linear) **A5** (tyrosine ring O is H bonded with C-terminal) and **A6** (tyrosine ring O is attached with Cu-complex). Theoretical investigation shows that after dissociation of Cu-complex the lowest energy structure is α- structure the **$[Y\alpha^{\bullet}GG]^{+}$** (having unpair electron located on α-carbon and charge on 1st amide oxygen atom).

Keywords: Infrared multiple-photon dissociation; Density functional Theory; peptide radicalcation; action spectroscopy; mass spectrometry

Decomposition of Nitrous Oxide in Hydrated Cobalt(I) Clusters: A Theoretical Insightinto Mechanistic Roles of Ligand-binding Modes

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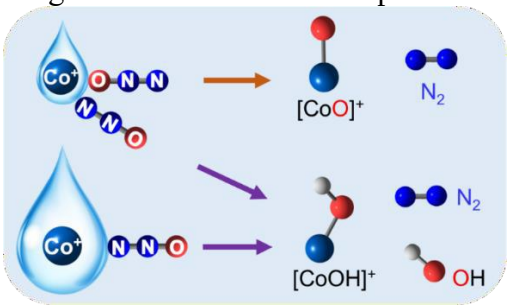
Abstract

Hydrated cobalt(I) cluster ions, $[Co(H_2O)_n]^+$, can decompose the inert nitrous oxide molecule,N_2O. Density functional theory suggests that N_2O can anchor to Co^+ of $[Co(N_2O)(H_2O)_n]^+$ through either O end-on (η^1–OL) or N end-on (η^1–NL) coordinate mode. The latter is thermodynamically more favorable resulting from a subtle π backdonation from Co^+ to N_2O. The N_2O decomposition involves two major processes: (1) redox reaction and (2) N–O bond dissociation. Initial activation of N_2O through an electron transfer from Co^+ to N_2O yields an anionic N_2O^-, which binds to the metal center of the formally $[Co^{2+}(N_2O^-)(H_2O)_n]$ also throughe either O end-on (η^1–O) or N end-on (η^1–N) mode and also be stabilized by water molecules through hydrogen bonding. From η^1–O, subsequent N–O bond dissociation to liberate N_2, producing $[CoO(H_2O)_n]^+$, is straightforward via a mechanism that is commonplace for typical metal-catalyzed N_2O decompositions. Unexpectedly, the N–O bond dissociation directly fromη^1–N is also possible and eliminates both N_2 and OH, explaining the formation of $[CoOH(H_2O)_n]^+$ as observed in a previous experimental study. Interestingly, formation of $[CoO(H_2O)_n]^+$ is kinetically controlled by the initial redox process between Co^+ and the O- bound N_2O, of which the activation barrier in large water clusters ($n \geq 14$) are higher than thatof the unexpected N–O bond dissociation



from the N-bound structure forming $[CoOH(H_2O)_n]^+$. This theoretical discovery implies that, in the present of water molecules, the metal-catalyzed N_2O decomposition starting from an O-bound metal complex is not mandatory.

Mechanistic insights on catalyzed CO_2 hydroboration by in situ generated NHC-borylsilylene

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Abstract

A novel unsymmetric NHC-disilyne complex was found to be capable of promoting CO_2 hydroboration by pinacolborane (HBpin). The underlying mechanism was explored theoretically with density functional theory (DFT) calculations at the M06-2X/def2-TZVP//M06-2X/DGDZVP level of theory. Reaction pathways involving either the intact di-silicon compound or dissociated mono-silicon species have been considered. Among investigated pathways, a NHC-borylsilylene was found to be the most probable catalytic species. This NHC-borylsilylene was able to mediate HBpin activation and sequential reduction of CO_2 down to MeOBpin. These results may provide mechanistic insights into low-oxidation state silicon catalysts used for CO_2 and carbonyl reduction reactions and facilitate development of such catalysts in the future.

Seeded synthesis of unconventional 2H-phase Pd alloy nanomaterials for highly efficient oxygen reduction

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Abstract

Phase engineering of nanomaterials (PEN) paves a new way to the rational design of highly efficient noble metal catalysts for various applications.[1] However, the controlled synthesis of noble metal-based alloy nanomaterials with unconventional crystal phases still remains a great challenge due to their thermodynamically unstable nature. Herein, we develop a robust and general seeded method to synthesize PdCu alloy nanoparticles with unconventional hexagonal close-packed (*hcp*, 2H type) phase and also tunable Cu contents. Moreover, galvanic replacement of Cu by Pt can be further conducted to prepare unconventional trimetallic 2H-PdCuPt nanomaterials. Impressively, 2H-$Pd_{67}Cu_{33}$ nanoparticles possess a high mass activity of 0.87 A mg^{-1}_{Pd} at 0.9 V (*vs.* reversible hydrogen electrode (RHE)) towards electrochemical oxygen reduction reaction (ORR) under alkaline condition, which is 2.5 times that of conventional face-centered cubic (*fcc*) $Pd_{69}Cu_{31}$ counterpart, revealing the important role of crystal phase on determining the ORR performance. After the incorporation of Pt, the obtained 2H-$Pd_{71}Cu_{22}Pt_7$ catalyst shows a significantly enhanced mass activity of 1.92 A mg^{-1}_{Pd+Pt} at 0.9 V (*vs.* RHE), which is 8.7 times that of the commercial Pd/C and 19.2 times that of commercial Pt/C, placing it among the best reported Pd-based ORR catalysts in alkaline electrolytes.

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Heterophase *fcc*-2H-*fcc* Au@Pd Nanorods for Highly Efficient Electrocatalytic Alcohol Oxidation

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Phase engineering of nanomaterials (PEN), which focuses on the delicate regulation of atomic arrangements, has emerged as an effective strategy to synthesize novel nanostructures with fascinating physicochemical properties and enhanced performances in various important applications.[1-3] Herein, we report a wet-chemical synthesis of Au@Pd core-shell nanorods (NRs) with well-defined *fcc*-2H-*fcc* heterophase (*fcc*: face-centered cubic; 2H: hexagonal close-packed with an atomic arrangement of "AB"), distinct phase boundary, and expanded Pd shell *via* seed-mediated epitaxial growth. The obtained heterophase *fcc*-2H-*fcc* Au@Pd NRs exhibit superior electrocatalytic ethanol oxidation performance. Experimental results and density functional theory calculations indicate that the enhanced performance of the Au@Pd NRs can be ascribed to the *fcc*-2H-*fcc* heterophase core-shell structure with unconventional 2H phase, 2H/*fcc* phase boundary, and the lattice expansion of the Pd shell. Such delicate phase engineering of nanomaterials paves a novel avenue for developing high-performance electrocatalysts and constructing model nanomaterials for mechanism study.

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Molecular Dynamics Simulation of RNA Cap-analogues in the Cap-binding Site of Zika Virus NS5-methyltransferase-guanylyltransferase

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Abstract

Zika virus NS5-methyltransferase-guanylyltransferase (ZIKV MTase-GTase) is an essential enzyme for viral replication[1] thus understanding its substrate recognition mechanism will be beneficial for the rational design of targeted antivirals. In this study, we have used computational modelling techniques to model the binding of cap-analogues, to reveal the functional role of conserved water molecules on the surface of cap-binding site of ZIKV MTase-GTase. Well-known analogues of guanosine, including acyclovir, ribavirin, 7-methylgruanosine, inosine and their monophosphate variants were simulated to characterize their interactions with protein residues. Based on the simulation trajectories, per-residue energy decomposition analysis were performed to identify possible key protein residues for ligand affinity in this shallow binding site that lacks specific interaction spots. Our results suggested a possible role of the conserved pocket water molecules in the specific recognition of substrates. Subsequent computational experiments that replace or remove the ligand in SAM-pocket, another important pocket of the catalytic cavity of ZIKV MTase-GTase, strongly implied that such alteration would hinder ligand binding in the cap-binding site, demonstrating the complexity of the recognition mechanism of this multifunctional protein. Interactions of the enzyme with regulatory cofactors and other substrates will be investigated next in order to have a more accurate view on the viral RNA-cap formation mechanism.

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Room Temperature Aerobic Peroxidation of Organic Substrates Catalyzed by Cobalt(III) Alkylperoxo Complexes

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Abstract

Room temperature aerobic oxidation of hydrocarbons is highly desirable and remains a great challenge.[1-3] Here we report a series of highly electrophilic cobalt(III) alkylperoxo complexes, Co^{III}(qpy)OOR supported by a planar tetradentate quaterpyridine ligand that can directly abstract H atoms from hydrocarbons (R′H) at ambient conditions (Co^{III}(qpy)OOR + R′H → Co^{II}(qpy) + R′• + ROOH). The resulting alkyl radical (R′•) reacts rapidly with O_2 to form alkylperoxy radical (R′OO•), which is efficiently scavenged by Co^{II}(qpy) to give Co^{III}(qpy)OOR′ (Co^{II}(qpy) + R′OO• → Co^{III}(qpy)OOR′). This unique reactivity enables Co^{III}(qpy)OOR to function as efficient catalysts for aerobic peroxidation of hydrocarbons (R′H + O_2 → R′OOH) under 1 atm air and at room temperature.

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Temperature Dependence of the Local Field Effect in YAG:Ce^{3+} Nanocomposites

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Abstract

The spontaneous emission rate (SER) of a chromophore in a nanoparticle (NP) is determined by the modification of the electric field by its environment. Previous studies of this local field effect have dispersed NPs in non-chemically interacting media of different refractive index (RI) and measured the emission lifetimes. Unfortunately, the applicable solvents cover only a small range of RI so that the test of a theoretical model is limited. We have utilized the variation of temperature to modify RI so that a more comprehensive test of a model can be achieved. Yttrium aluminium garnet (YAG) NPs doped with Ce^{3+} ions were immersed in different alcohols and the lifetime of the electric dipole allowed $5d^1 \rightarrow 4f^1$ transition was measured at different temperatures in each case. In order to clarify and confirm our results we have employed two different dopant concentrations of Ce/Y, near 1.3 at.% and 0.13 at.%. The Ce^{3+} lifetimes were well-fitted to a formula relating the decay rate to the dielectric parameters of the nanocomposite and the volumetric content of the NPs. Two parameters were derived: the SER of the bulk material (found to be effectively constant) and the nonradiative decay rate, which varied as the multiphonon relaxation rate for the more heavily-doped materials. The emission from the YAG:Ce^{3+} NPs was attributed to Ce^{3+} ions with 8-coordination to oxygen in addition to surface Ce^{3+} ions with lower coordination number. The bulk radiative lifetime was determined as 66±3 ns. [1]

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Persistent luminescence of undoped zinc gallogermanates

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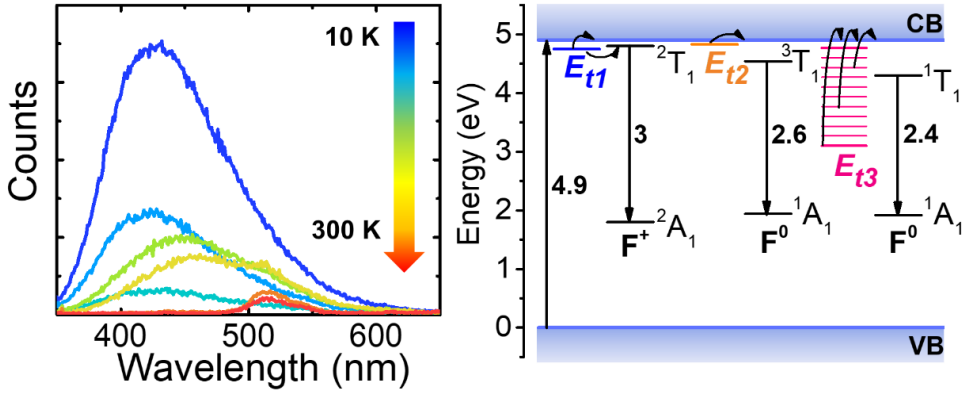
Abstract

Optimization of zinc gallogermanate samples for the best spectroscopic performance has been achieved by zinc depletion. Three overlapping photoluminescence and persistent luminescence emission bands, with very strong temperature dependence, have been identified at 3.0, 2.6 and 2.4 eV. Their origin has been assigned to transitions from F^+ ($^2T_1$ - $^2A_1$) and F^0 ($^3T_1$, $^1T_1$ - $^1A_1$) centres, respectively.[1] Room temperature persistent luminescence at 2.4 eV results from a distribution of traps[2], ranging from 0.1 eV to at least 0.6 eV, which is attributed to the different geometry and distances of traps feeding F^0 centres. The analysis of the persistent luminescence decay curves measured under different charging conditions revealed that the tunneling recombination to F^+ centre leading to emission at 3.0 eV might occur at very low temperatures (10 K). However, it is only possible at low dose rates since the number of traps is much smaller than the number of recombination centres.[3]



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Groups 13 and 14 Complexes Supported by a Sterically Bulky Guanidinate Ligand

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Abstract

A series of Groups 13 and 14 complexes supported by sterically bulky monoanionic guanidinate ligand $[(2,6\text{-}^{i}Pr_2C_6H_3N)C(NHPr^{i})(NPr^{i})]^{-}$ (L) 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 $[Li_2L_2(Et_2O)]$ and potassium complex $[KL]_n$, respectively. Metathesis reactions of an appropriate Groups 13 and 14 metal chloride with $[Li_2L_2(Et_2O)]$ or $[KL]_n$ led to isolation of the corresponding guanidinate complexes.

Acknowledgement

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Enhanced Mass Transfer of Oxygen through a Gas-Liquid-Solid Interface for Photocatalytic Hydrogen Peroxide Production

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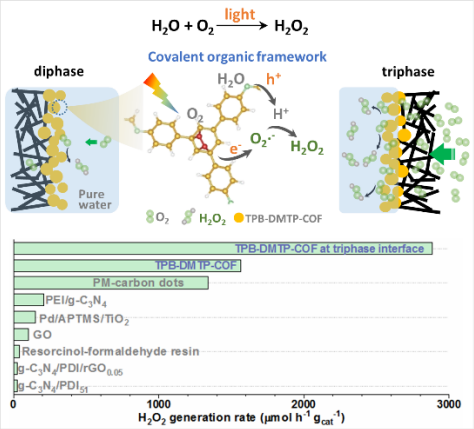
Abstract

Solar-driven photocatalytic oxygen reduction is a potentially sustainable route for the production of hydrogen peroxide.[1] However, this approach suffers from the limited solubility and slow diffusion of oxygen in water. Another problem is that most photocatalytic oxygen reduction systems do not work well with just water. They often require the addition of sacrificial agents such as alcohols.[1, 2]. Here, we report a covalent organic framework (COF)-based photocatalyst that can reduce O_2 to H_2O_2 efficiently in pure water under visible-light irradiation. A solar-to-chemical conversion of 0.76% is achieved for H_2O_2 generation. More importantly, the hydrophobic and mesoporous properties of triphenylbenzene-dimethoxyterephthaldehyde-COF allow the formation of a triphase interface (gas-liquid-solid) when loading this catalyst onto a porous substrate. The H_2O_2 production rate reaches 2.9 mmol g_{cat}^{-1} h^{-1} at the triphase interface by overcoming the mass-transfer limitation of O_2 in water. Notably, this rate is 15 times higher than that in a diphase system (liquid-solid). The photoelectrochemical tests reveal that the increase in yield is closely related to the enhanced mass-transfer rate and the higher interfacial O_2 concentration. Furthermore, the triphenylbenzene part is identified as the reactive site based on theoretical calculations. This work represents a significant advance in sustainable H_2O_2 generation in pure water.



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Ultrafast Broadband Transient Absorption Study on the Excitation Dynamic of Human Telomeric RNA (TERRA) G-quadruplex

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Abstract

Human telomeric RNA (TERRA) is an inhibitor of making telomere,[1] which plays an important role on DNA protection, while cell division in human. As the telomeric sequences are guanine (G)-rich sequences, they can form a special conformation, the G-quadruplex. Human telomeric G-quadruplex also is a well-known material for the targeting of cancer and the probing technique. The excitation dynamics of the human telomeric DNA has been examined in the past few years.[2] However, there is no discussion on the optical properties of the TERRA G-quadruplex. By using the femtosecond broadband transient absorption (fs-TA), we find that there are one monomeric like π-π* state and two charge transfer states. The lifetime of the charge transfer states was found highly depending on the number of stacked G-tetrad of the RNA sequences. This is the first direct observation of the excited state spectra and dynamics for the G-quadruplexes formed from TERRA sequences.

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Acknowledgements

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Ultrafast broadband transient absorption study on the excited state of i-motif formed from $(CCCTAA)_3CCC$ oligomer

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Abstract

Recently, i-motif forming epigenetic modified DNA has raised extensive awareness due to its special gene regulation and expression function. The methylation of cytosine begins with the action of the methylcytosine-binding proteins and the DNA methyltransferase family.[1] Even though only ~6% of the cytosine in CpG island is methylated, epigenetic modified DNA plays an essential role in biological function.[2] These essential biological functions make the methylated cytosine rich sequence important and worthwhile investigated. Their thermal stability, pH properties and the fate of excitation energy after irradiation have become an attractive field of research. Our result shows that the thermal stability, acidity as well as the quantum yield along the mono-/multi-methyl-substituted human telomeric sequences (HTS, $(CCCTAA)_3CCC$) were varied. The transient absorption measurement of these sequences was although similar but a minute difference could be observed.

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Acknowledgements

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Direct observation of dynamics and pathway for ultrafast intersystem crossing in 2'-Deoxy-5-formylcytidine: a femtosecond transient absorption study

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Abstract

2'-Deoxy-5-formylcytidine (5fodCyd) plays a critical role in DNA demethylation and is an epigenetic marker in mammalian genomics.[1] As an important Cytosine derivative, however, there are, unlike Cytosine, only few studies have been carried on its photo-properties.[2-4] Here, by using combined methods of steady state spectroscopy and femtosecond transient absorption (fs-TA), we find that 5fodCyd (i) has significant solvent effect in water due to strong coupling of $^1\pi\pi^*/^1n_O\pi^*$; (ii) shows a sequential two-step nonradiative deactivation pathway after photoexcitation, from $^1\pi\pi^*$ to $^1n_O\pi^*$ *via* internal conversion (IC) with ~0.6 ps and then to a triplet state through intersystem crossing (ISC) at an ultrafast rate of ~1.7 ps. These results provide important insights about the photostability and potential photodamage involved for the nucleobase derivatives.

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Acknowledgements

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Interface Engineered $NiFe_2O_{4-x}/NiMoO_4$ Nanowire Arrays for Electrochemical Oxygen Evolution

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The development of efficient electrocatalysts for oxygen evolution reaction (OER) is a critical task to obtain high purity hydrogen from electrocatalytic water splitting.[1] Interface engineering is one of the most promising strategies for modulating the local electronic structure of active sites to improve catalytic activity.[2] Herein, $NiFe_2O_{4-x}$ nanoparticles were integrated into $NiMoO_4$ nanowires ($NiFe_2O_{4-x}$/NMO) grown on nickel foam to construct an extended interface with strong electronic interactions. The $NiFe_2O_{4-x}$/NMO demonstrates high OER activities as manifested by a low overpotential of 326 mV at a high current density of 600 mA cm^{-2} and excellent long-term stability. The intimate interface between $NiFe_2O_{4-x}$ and $NiMoO_4$ induces the Fe-facilitated phase transition to active γ-NiOOH phase as uncovered by *in situ* Raman spectroelectrochemical analysis. This study outlines how the interface design of integrated nanostructures can optimize the formation of active phases for enhanced catalytic activity.

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Zn-based complex catalyzed chemoselective *O*-acylation over *N*-amidation towards biomass conversion

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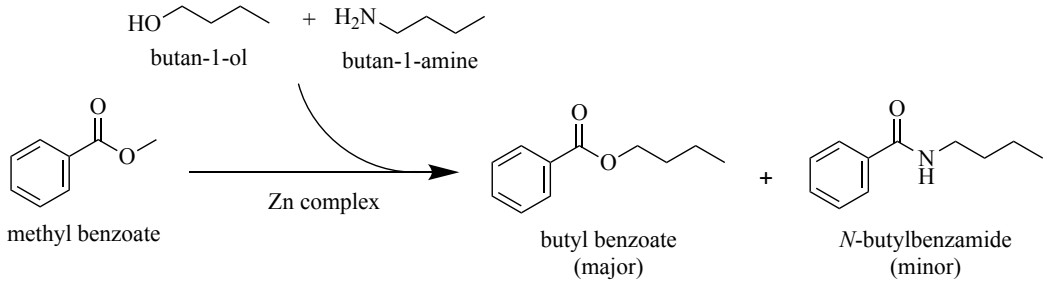
Abstract

Esterification and transesterification constitute a major portion of organic transformation in, for example, biologically active natural product conversion and drugs synthesis. Natural biomass resources, however, consists of complex functional groups hindering the complete conversion through the desired esterification and transesterification.[1] Amino group, in particular, are prevalent resistance to *O*-acylation in crude biomass, leading to competing *N*-amidation with alcohol or ester substrate.[2] Herein, the study on the application of Zn-based complex for transesterification reaction of methyl benzoate with *n*-butanol in the presence of *n*-butylamine is reported and achieved in high *O*-acylation selectivity over *N*-amidation. The Zn-based complex of interest is hence a promising candidate for selective transesterification catalysis, exempting the necessity for protecting groups in complex crude biomass conversions.



Chemoselective *O*-acylation over *N*-amidation catalyzed by Zn-based complex

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Extraction and Acetylation of Cellulose from Coffee Ground for Cellulose Acetate Production

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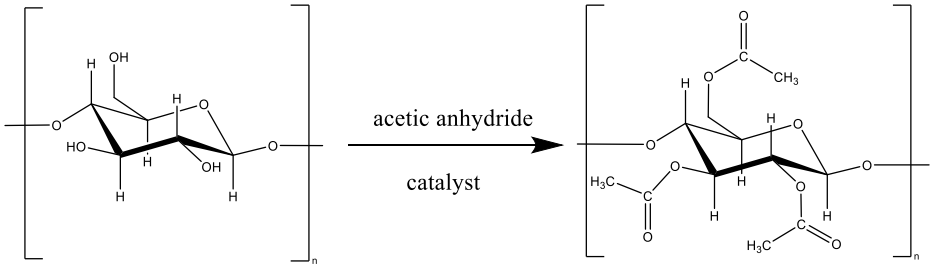
Abstract

Cellulose is the most abundant bio-polymer source on the Earth, and it is one of the major components in coffee ground.[1] Cellulose from coffee ground can be converted into several types useful value-added bio-products including cellulose acetate. However, traditional acetylation of cellulose involves the use of strong acid as catalyst which leads to severe environmental problems.[2] We are interested in investigating green methods for extraction and acetylation of cellulose from coffee ground. Different extraction and pretreatment methods are also investigated for the effect on acetylation. Commercial cellulose is applied as a model for preliminarily study of different acetylation methods.



cellulose cellulose acetate

Reaction scheme for acetylation of cellulose

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Synthesis and Characterization of Mesoporous Material for Green Biodiesel Synthesis

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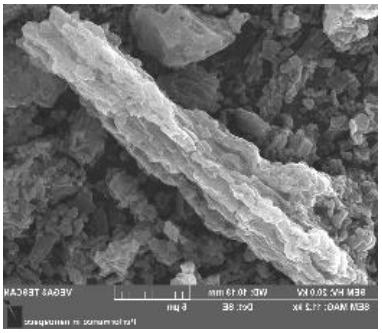
Abstract

The energy crisis due to the depletion of fossil fuels reserves and its potential environmental hazards has motivated scientists to explore novel and renewable energy sources to substitute fossil fuel-related energy source.[1] In previous studies, our group has successfully developed different catalysts for transesterification of high free fatty acids (FFAs) contaminated feedstock.[2] However, the presence of water in alcohol is another difficulty regarding biodiesel synthesis yet to be resolved. Herein, we are interested in designing, synthesizing and characterizing the mesoporous materials for transesterification. Further modifications in incorporating different metals on the mesoporous materials to develop a poly-metal chain is also one of our focuses in order to enhance catalytic selectivity and water tolerance towards biodiesel synthesis.



SEM image of SBA-15

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Reactions of $Re(dppm)_2HI_2$ with Terminal Alkynols

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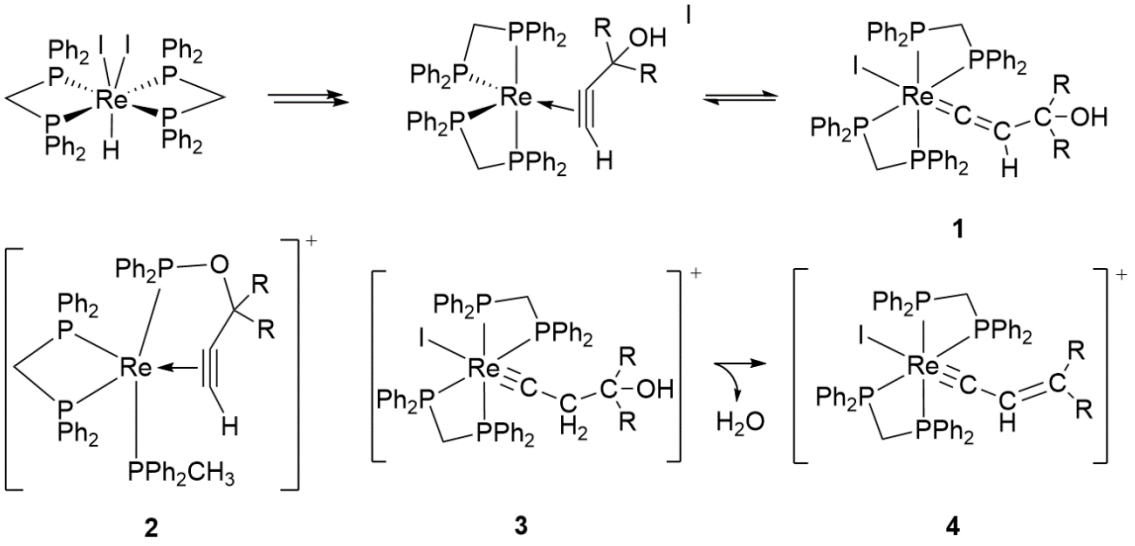
Abstract

The reactions of $Re(dppm)_2HI_2$ with alkynols are discussed. The reactions can lead to the formation of several products, including metal-alkyne complexes, vinylidene complexes, carbyne complexes, metal-alkyne complexes and complexes derived from cleavage of P-C bond in bis(diphenylphosphino)methane ("dppm"). Treatment of $Re(dppm)_2HI_2$ with alkynols in the presence of excess amount of organic base yielded initially the vinylidene complexes **1**, and eventually the P-C bond cleaved metal complexes **2**, possibly via intramolecular nucleophilic attack of oxygen in the alkynol on phosphine. Carbyne complexes **3** and **4** can be obtained as side products from this reaction.



Reactivity of Osmanaphthalyne

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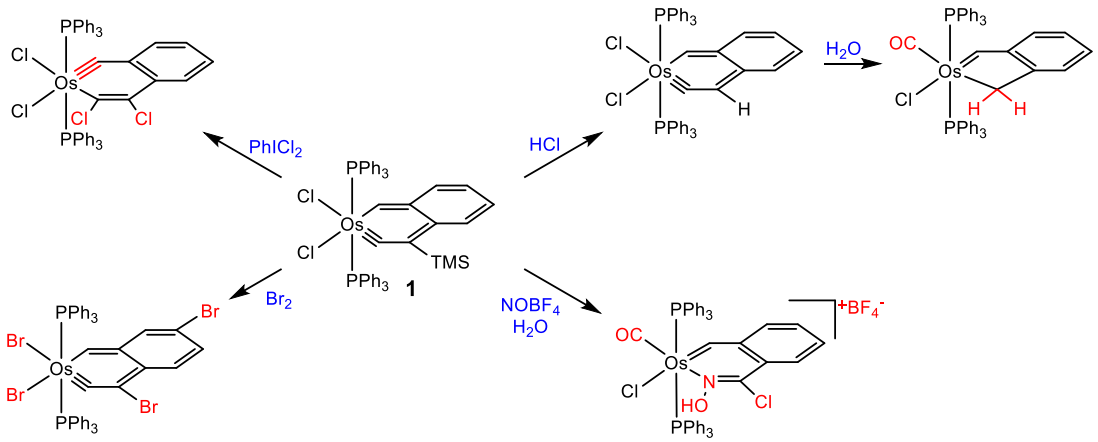
Osmanaphthalyne **1** is derived from formal substitution of one of the carbyne carbons in naphthalyne by the isolobal 14-electron [$OsCl_2(PPh_3)_2$] fragment. Unlike organic arynes, metallaarynes can have a significantly higher stability and therefore allow us to develop their chemistry. Reactions of metallabenzynes have been reported in these two decades, yet those of polycyclic metallaarynes are rare because of the difficulties in their syntheses. Recently we have developed a facile method to synthesize polycyclic osmaarynes using alkyne-functionalized phosphorus ylides.[1] We herein report some examples of the reactivity of the β-osmanaphthalyne **1**. It can undergo reactions similar to its organic counterparts, such as electrophilic substitutions or addition reactions, but with different regioselectivity and products' stability, reflecting its organometallic properties.



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The synthesis of rhenium (VI) η^4-diene complexes by oxidative coupling of rhenium (VII) bis-η^2-vinyl complexes

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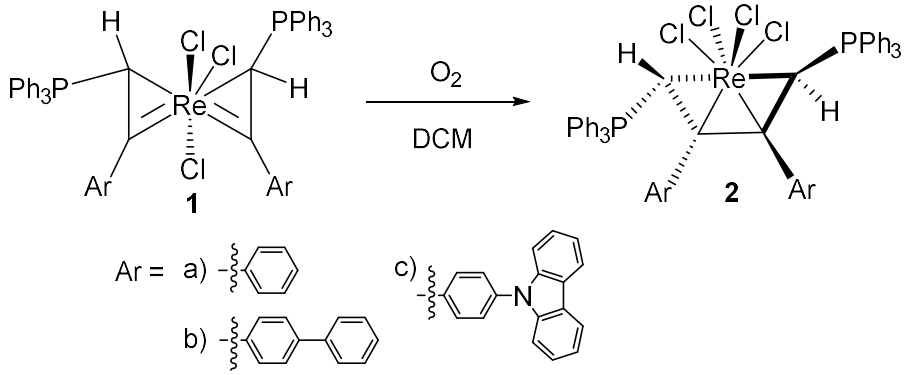
Abstract

η^2-Vinyl organometallic complexes and their reactivity are seldomly reported and studied. One of the examples is the molybdenum η^2-vinyl species and its oxidation catalyzed rearrangement to give a carbyne complex.[1] We have recently founded that the reactions of the rhenium (III) acetonitrile complex $ReCl_3(MeCN)(PPh_3)_2$ with aromatic alkynes give rhenium (VII) bis-η^2-vinyl complexes **1**, which can undergo oxidative coupling to give products **2a-c**. These paramagnetic rhenium (VI) η^4-diene complexes might be yielded from the reactions of complexes **1a-c** involving the oxygen and DCM.



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Reactions of Rhenacyclobutadienes with Ynamines

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Abstract

Based on structural, spectroscopic and reactivity studies, rhenacyclobutadiene complexes $(CO)_4Re\{-C(R^1)=C(CO_2R^2)-C(OR^3)=\}$ can be regarded as metallacyclobutadiene analogues of Fischer-type carbenes. It was reported previously that several interesting products can be formed in the reactions of rhenacyclobutadiene complexes with alkynes, including metallabenzenes[1,2] and cyclopentadienyl complexes.[3] More recently, we have investigated reactions of rhenacyclobutadiene complexes with ynamines R^4-C≡C-NR_2. We found that the complexes **1** can react with ynamine **2** to form the η^5-oxocyclohexadienyl complexes **3**.

1 **2** **3**

		Rhenacyclobutadiene				ynamine		
Entry		R^1	R^2	R^3		R^4	NR_2	
1	1a	Me	Et	Et	2a	Me	NEt_2	3aa
2	1b	$SiMe_3$	Et	Et	2a	Me	NEt_2	3ba
3	1c	Et	Et	*p*-MeC_6H_4	2a	Me	NEt_2	3ca
4	1a	Me	Et	Et	2b	Me	NBn_2	3ab
5	1a	Me	Et	Et	2c	Ph	NEt_2	3ac

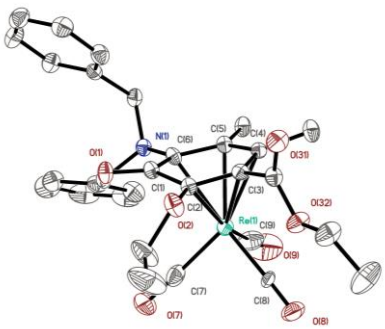

Figure 1. The ORTEP drawing of **3ab** (thermal ellipsoids set at 40% probability).

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Synthesis and Reactivity of Iridium Complexes with a Bis-cyclometalated Tripodal C^N^C Ligand

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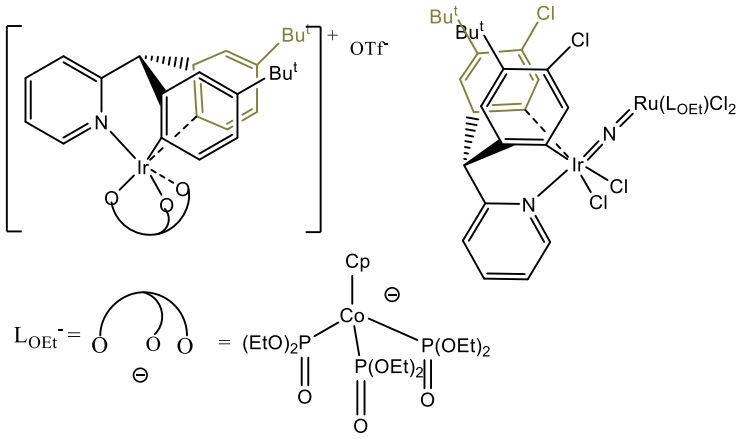
Abstract

Cyclometalated iridium complexes are of interest due to their interesting luminescent properties. A vast majority of reported cyclometalated iridium complexes contain bidentate or planar tridentate pyridyl ligands. Recently, Hierlinger et al. synthesized Ir(III) complexes with tripodal bis-cyclometalated C^N^C ligands, $[Ir(C^N^C)(N^N)]^+$; however, their reactivity has not been explored. In this work, we report the synthesis and reactivity of Ir(III) and (IV) complexes with a tripodal bis-cyclometalated C^N^C ligand.



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Synthesis and Redox Reactivity of Cerium(IV) Complexes with Aryloxide Ligands

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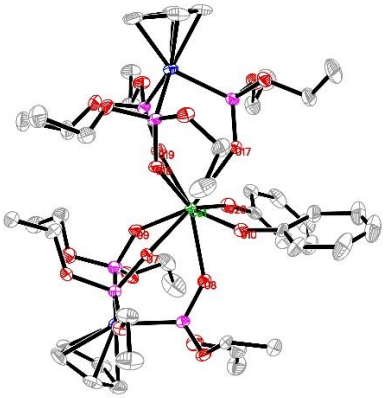
Abstract

Aryloxides (ArO^-) are π-donating ligands that are capable of stabilizing metal ions in high oxidation states. While cerium(IV) complexes with chelating aryloxide ligands such as Schiff base ligands are well documented, there are relatively few cerium(IV) complexes with simple aryloxide ligands, and their redox reactivity has not been studied. Previously, we have synthesized the cerium(IV) alkoxide complexes $[Ce(L_{OEt})_2(OR)_2]$ (L_{OEt}^- = $[CpCo\{P(O)(OEt)_2\}_3]^-$, R = Me, Et, ^{i}Pr) that can oxidize substituted phenols via a proton-coupled electron transfer pathway.[1] In this work, we report the synthesis and crystal structures of related aryloxide complexes $[Ce(L_{OEt})_2(OAr)_2]$. The factors that affect the redox reactivity of $[Ce(L_{OEt})_2(OAr)_2]$ will be discussed.



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Acknowledgement. This work was supported by the Hong Kong Research Grants Council (project no. 16301019).

Understanding the Reaction Rate of a Palladium-Catalyzed Sonogashira Cross-coupling Reaction with Deep Learning Using Tree-like Representation for Phosphine Ligands

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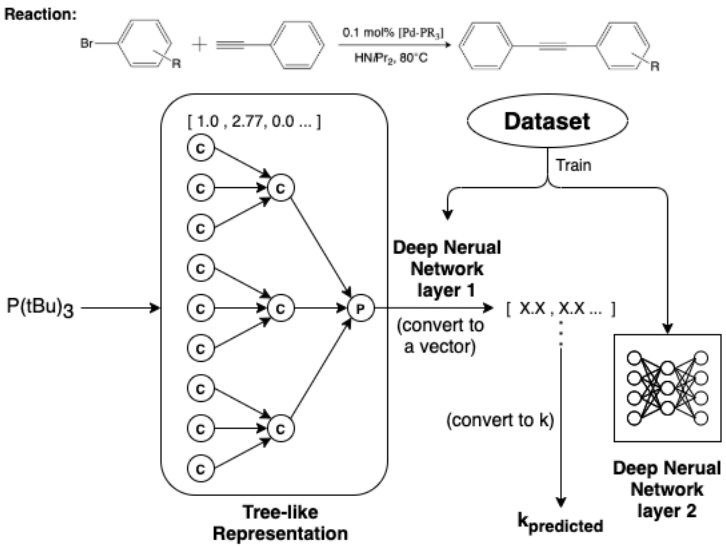
Abstract

In recent years, the application of deep learning on chemistry has been increasingly popular in various areas of chemical research. An ongoing challenge is to translate molecules into inputs for the deep learning algorithms. Many developed models require complex procedures for generating molecular descriptors, such as DFT-calculated HOMO energies,[1] buried volume,[2] Morgan fingerprints,[3] etc. In this work, we considered a palladium-catalyzed Sonogashira cross-coupling reaction of various aryl brimides under different alkyl phosphine ligands,[4] and developed a descriptor model to represent phosphine ligands as tree-like structures. We coupled this newly-developed descriptor model with a neural network for prediction of rate constant. The tree-like representation performed well even with a limited size of training set, and outperformed those models that consider cone angles of phosphine ligands.



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Influence of Carbene Pincer Ligand on Coordination Feature of Transition Metal Complexes

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Abstract

This work studied phosphine coordination in square pyramidal Co(I) complexes with a pincer ligand, and compared the relative stability of Co(III) *trans*-$(H)_2$ complexes with respect to their *cis*-isomers.

In the Co(I) complexes, phosphine prefers to occupy the apical site. Phosphine ligands having strong π accepting and weak σ donating properties were found to be particularly favourable for coordination.

In the Co(III) *trans*-$(H)_2$ complexes, carbene pincer ligands are capable of stabilizing the *trans*-(^{Mes}CCC)Co$(H)_2$.[1] This unexpected observation is explained by hyperconjugation interaction of the Co-H σ bonds with the "empty" p orbitals on the carbene carbons of the carbene pincer ligands. Similar observation is found in other d^6 transition metal *trans*-$(H)_2$ complexes containing a carbene pincer ligand.

The unique chemical bonding features of carbene pincer ligands are expected to have important implication in catalysis.

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Silver Carbene Based Donor–Acceptor Template Catenane

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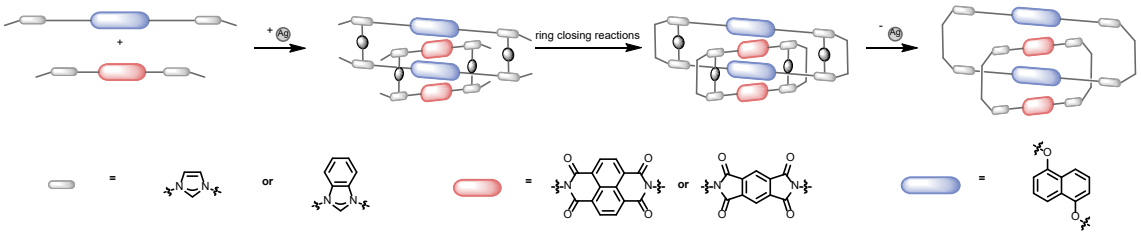
Abstract

A new type of donor–acceptor catenane, containing silver carbene units was designed. In this work, donor-acceptor interaction is used as a template,[1] and the silver carbene is the ring-closed unit. Due to the relatively poor stability of silver carbene, we modified the imidazolium unit that connected to functional groups for ring closing on the nitrogen on the other side, such as aldehyde group for imine condensation,[2] or specific vinyl group for [2+2] photodimerization.[3] Therefore, silver can be removed without destroying the catenane and the flexibility of catenane can be controlled by the presence or absence of silver.



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Synthesis and post-functionalization of a [2]catenane for s-block metal ion binding

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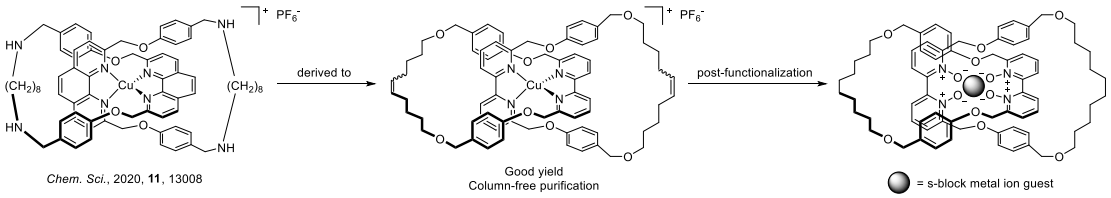
Abstract

Catenanes have been increasingly used as ion-binding host structures due to their co-conformation changes upon binding to generate outputs for recognition, however their synthesis is often low in efficiency and yield.[1, 2] We synthesized a new [2]catenane derived from our previous work,[3] which is further functionalized to be a potential hard metal ion host. Based on the efficient copper(I)-bipyridine template, the [2]catenane can be gained in good yields without column purification. Subsequent mild oxidation of the bipyridyl sites can give various isolable N-oxides, including mono-, di, tri- and tetra-N-oxides, which are anticipated to have ascending binding strengths with s-block metal ions.



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Incrementally local Downfolded Configuration Interaction for low-lying state calculation dressed up with energy

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Abstract

Origin from quantization many-body problem, quantum chemistry methodology development requires extreme efforts to reach chemical accuracy. Here, we present a scheme and algorithm which incrementally finds a state-specific Downfolded Hamiltonian based on Feshbach projection for low-lying state calculation. We construct the many-body Hamiltonian in a localized manner to lower down the scaling that arises from multi-reference. We will discuss the algorithm, technics used in implementation together with the result from DCI.

Solution-synthesized multifunctional Janus nanotree microswimmer

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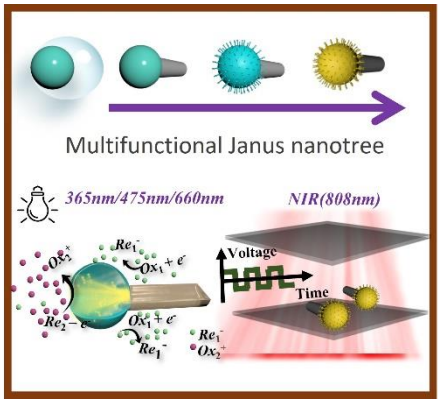
Abstract

Synthetic active matters are perfect model system for non-equilibrium thermodynamics and of great potential for novel biomedical and environmental applications. However, most applications are limited by the complicated and low-yield preparation, while a scalable synthesis for highly functional microswimmers are highly desired. In this paper, we developed an all-solution synthesis method where the gold-loaded titania-silica nanotree can be produced as a multi-functional self-propulsion microswimmer. By applying light, heat, and electric field, the Janus nanotree demonstrated multi-mode self-propulsion, including photochemical self-electrophoresis by UV and visible light radiation, thermophoresis by near-infrared (NIR) light radiation, and induced-charge electrophoresis under AC electric field. Due to the scalable synthesis, we further demonstrated the Janus nanotree as high-efficiency, low-cost, active adsorbent for water decontamination, where the toxic mercury ions can be reclaimed with enhanced efficiency.



Optical Responsive Full Color Shifting Colloidal Ink

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Abstract

Over the years, the design and fabrication of smart-color materials have attracted mounting attentions for their potentialities in many scenarios, such as displays, optical camouflage, sensors, smart devices, etc. In this study, we introduce a programmable, tricolor colloidal ink capable of responding and reproducing the external optical information based on the subtractive color model. Consist of cyan, magenta and yellow dye-sensitized TiO_2 colloids, this tricolor ink will experience an internal vertical stratification of the colloids and form remarkable color texture according to the external light pattern. As a demonstration, a modified commercial projector was applied to bring in the computer-generated textures, inducing a series of colorful patterns and dynamic textures on the tricolor ink. Moreover, with rather simple preparation process, this tricolor ink also holds the possibility of low cost and mass production.

Area: Physical and Inorganic Chemistry (PhyIn)

Title: Development of Ni-based Nano-MOF with Ferrocene Prosthetic Group as Efficient Electrocatalyst for Oxygen Evolution Reaction

Name: Xutao Gao, Jing Liang, Jinxuan Liu* and Edmund C. M. Tse*

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Abstract:

Efficient electrocatalysts are needed for a sustainable society. Metal-organic frameworks (MOFs) is a promising porous material for catalysis, though they exhibit poor electrical conductivity, rendering them unattractive in the field of electrocatalysis. Herein, we developed an electrically conductive MOF by including ferrocene as electron hopping sites in the MOF structure. Two-dimensional (2D) MOFs on nickel foam (NF) was assembled using nickel chloride hexahydrate and 1,1'-ferrocenedicarboxylic acid (NiFc-MOF/NF). The as-synthesized MOF-based nanomaterial exhibits superior oxygen evolution reaction (OER) performance and long-term under alkaline conditions. We further explored the electrocatalytic mechanism through computational means.[1] Multiple OER intermediates on NiFc-MOF/NF was constructed for density functional theory (DFT) calculations. The calculated results reveal that the ferrocene units within the MOF crystalline structure enhance the overall electron transfer capacity, thereby leading to a theoretical overpotential of 0.52 eV, which is lower than that (0.81 eV) of the state-of-the-art NiFe double hydroxides. This work suggests new ideas for developing OER catalysts with two-dimensional MOFs under alkaline conditions.

Reference:

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Supervisor: Dr. Edmund Chun Ming TSE

Name: Wang Wanying

Title: Ruthenium Hybrid Electrocatalysts for Regulating the Proton Removal Steps in Hydrogen Peroxide Oxidation

Abstract

Molecular electrocatalysis that involve proton and electron transfer is fundemanteal in energy devices. In this work, a self-assembled monolayer of Ru complex (Ru_2BTA_2 SAM) is prepared by electro-grafting on a glass carbon (GC) electrode.[1] The performance of the as-prepared Ru_2BTA_2 SAM/GC electrode toward H_2O_2 oxidation is investigated. Mechanistic study suggests a possible reaction pathway that involves the Ru catalyst breaking the oxygen-hydrogen bond, resulting in H_2O_2 oxidation on the electrode. To further study the proton transfer step, a lipid-modified electrode is developed by appending an alkyl phosphate chain to control proton removal. Different proton carriers are incorporated to alter the proton transport rate along with the catalyst activity. By controlling the proton removal kinetics, we control the reaction rate of an oxidation process on a lipid-modified electrode for the first time.

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Molecular Design of Efficient Yellow- to Red-Emissive Alkynylgold(III) Complexes for the Realization of Thermally Activated Delayed Fluorescence (TADF) and Their Applications in Solution-Processed Organic Light-Emitting Devices

Cathay Chai Au-Yeung, Lok-Kwan Li, Man-Chung Tang, Shiu-Lun Lai, Wai-Lung Cheung, Maggie Ng, Mei-Yee Chan,* Vivian Wing-Wah Yam*

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Abstract

A new class of fused heterocyclic alkynyl ligand-containing gold(III) complexes, showing tunable emission colors spanning from the yellow to red region in the solid-state and thermally activated delayed fluorescence (TADF) properties, have been designed and synthesized. These complexes display high photoluminescence quantum yields of up to 0.87 and short excited-state lifetimes in sub-microsecond timescales, yielding high radiative decay rate constants on the order of up to 10^6 s^{-1}. The observation of the drastic enhancement in the emission intensity of the complexes with insignificant change in excited-state lifetime upon increasing temperature from 200 to 360 K indicates an increasing radiative decay rate. The experimentally-estimated energy splitting between the lowest-lying singlet excited state (S_1) and the lowest-lying triplet excited state (T_1), ΔE_{S1-T1}, is found to be as small as ~0.03 eV (250 cm^{-1}), comparable to the value of ~0.05 eV (435 cm^{-1}) obtained from computational studies. The delicate choice of the cyclometalating ligand and fused heterocyclic ligand is deemed as the key to induce TADF through the control of the energy levels of the intraligand (IL) and the ligand-to-ligand charge transfer (LLCT) excited states. This work represents the realization of highly emissive yellow- to red-emitting gold(III) TADF complexes incorporated with fused heterocyclic alkynyl ligands and their applications in organic light-emitting devices.

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Synthesis of Benzo[*b*]phosphole-Based Alkynylgold(I) Complexes with Resistive Memory Properties Modulated by Donor-Acceptor Chromophores

Yat-Hin Cheng, Eugene Yau-Hin Hong, Ming-Yi Leung, Shiu-Lun Lai and Vivian Wing-Wah Yam*

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Abstract:

A class of benzo[*b*]phosphole-based alkynylgold(I) complexes has been synthesized and characterized. These complexes share a similar benzo[*b*]phosphole ligand, in which the phosphole moiety is substituted with various π-conjugated units with different donor strengths, namely phenoxazinylphenyl, tris(di-*tert*-butylcarbazolyl)phenyl and 2,4-dimethylphenyl moieties. These phosphole-containing gold(I) complexes are found to be strongly luminescent in toluene with tunable emission maxima and possess solvatochromic behaviors, suggesting an emission of metal-perturbed intraligand charge-transfer (ILCT) origin. Cyclic voltammetry (CV) studies reveal that the presence of gold(I) metal center strongly perturbs the electronic properties of the phosphole moiety of the resultant complexes, which can be further fine-tuned by the auxiliary ligand on the gold(I) center. In the resistive memory studies, devices based on these alkynylgold(I) complexes exhibit satisfactory binary memory behaviors, demonstrating low threshold voltages in narrow distributions, high durability and low misreading rates. Such performances are believed to be originated from a field-induced charge transfer of the alkynylgold(I) complexes, in which the electron-accepting phosphole-gold(I) unit plays a crucial role in stabilizing the charge transfer state and that led to the observed resistive switching and memory behavior.

Reference

Cheng, Y.-H.; Hong, E. Y.-H.; Leung, M.-Y.; Lai, S.-L., Yam, V. W.-W. *SmartMat*, **2021**, Accepted, doi: 10.1002/smm2.1065

Dithienylethene-Containing Cyclometalated Platinum(II) Complexes with Tuneable Photochromic and Photophysical Properties

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Abstract

A series of dithienylethene-containing cyclometalated platinum(II) complexes with N^C and O^O ligands has been synthesized and characterized. Upon photoexcitation at 420 nm, all the complexes exhibit photochromism with colour changes from yellow to green, as well as the quenching of red phosphorescence with long emission lifetimes. The photophysical and photochromic properties are found to be readily tuneable by varying the ligands. The fatigue resistance and thermal irreversibility of this series of complexes have also been demonstrated by the one of the complexes with no significant drop of the photochromic activity after six photoswitching cycles and a thermal decay half-life of 115 hours even at 308 K. It is envisaged that the study on the structure-property relationship of these complexes may provide deeper insights into the rational design of diarylethene-based photochromic metal complexes.

Judicious Choice of *N*-Heterocycles for the Realization of Sky-Blue- to Green-Emitting Carbazolylgold(III) C^C^N Complexes and Their Applications for Organic Light-Emitting Devices

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Abstract

A new class of sky-blue- to green-emitting carbazolylgold(III) C^C^N complexes containing pyrazole or benzimidazole moieties has been successfully designed and synthesized. Through the judicious choice of the *N*-heterocycles in the cyclometalating ligand and the tailor-made fluorine-containing carbazole moieties, maximum photoluminescence quantum yields of 0.52 and 0.39 have been realized in the green- and sky-blue-emitting complexes respectively. Solution-processed and vacuum-deposited organic light-emitting devices (OLEDs) based on the benzimidazole-containing complexes have been prepared. The sky-blue-emitting device shows an emission peaking at 484 nm with a narrow full-width at half-maximum of 57 nm (2,244 cm^{-1}), demonstrating the potential of this class of complexes in the application of OLEDs with high color purity. In addition, high maximum external quantum efficiencies of 12.3 % and a long operational half-lifetime of over 5,300 hours at 100 cd m^{-2} have been achieved in the vacuum-deposited green-emitting devices.

Reference

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Synthesis, Characterization and Photophysical Studies of Push-Pull Zinc(II) Porphyrin Complexes and Their Applications in Organic Resistive Memory Devices

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Abstract

A series of push-pull zinc(II) porphyrin complexes (D–P–π–A) has been synthesized with different donors and acceptors. These complexes have been characterized by ^{1}H NMR spectroscopy and ESI mass spectrometry. The photophysical and electrochemical properties have been studied. The absorption spectra showed a significant bathochromic shift in solid-state thin film. Binary resistive memory behavior has been realized *via* solution-processed devices. Upon modifying the π-bridge, a tunable switching threshold voltage was achieved. The present study may provide some insights and design strategies for the development of organic resistive memory devices.

Multifunctional Boron(III)-Containing Materials for Applications in Organic Electronics

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Abstract

A series of four-coordinate donor-acceptor fluoroboron emitters with a rigid tridentate 2,2'-(pyridine-2,6-diyl)diphenolate ligand featuring thermally activated delayed fluorescence (TADF) properties and tunable emission colors has been developed.[1] The TADF processes in the excited states have been supported by detailed temperature-dependent and time-resolved photoluminescence studies, as well as computational studies. High external quantum efficiencies of up to 18.0% and long operational stabilities with half-lifetimes of up to 12733 hours at an initial luminance of 100 cd m^{-2} have been achieved for the green-emitting organic light-emitting diodes. In addition, another series of acceptor donor acceptor small-molecule non-fullerene acceptors bearing the difluoroboron(III) β-diketonate (BF_2bdk)-based acceptor moiety for solution-processed bulk heterojunction organic solar cells has been developed.[2] Chemical modifications on the central donor moiety and the terminal BF_2bdk-based acceptor moiety have shown to greatly affect their photophysical and electrochemical properties. By blending this series of compounds with polymeric electron donors, good photovoltaic responses have been achieved. Moreover, binary logic memory performances of organic resistive memory devices fabricated with some of the compounds as active materials have also been realized. All these findings are believed to provide more insights into designing multi-functional boron(III)-containing materials for applications in organic electronics.

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Incorporation of Fluorene and Its Heterocyclic Spiro Derivatives to Realize High Performance and Stable Sky-Blue-Emitting Arylgold(III) Complexes

Lianne Hei-Yin Lo,[a] Man-Chung Tang,[a] Shiu-Lun Lai,[a] Wai-Lung Cheung,[a] Lok-Kwan Li,[a] Maggie Ng,[a] Hin-Ting Chan,[a] Mei-Yee Chan[a] and Vivian Wing-Wah Yam[a]**

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Abstract

A series of tridentate diphenylpyridine ligand-containing arylgold(III) complexes incorporated with fluorene and its heterocyclic spiro derivatives, spiro[fluorene-9,9′-xanthene] and spiro[acridine-9,9′-fluorene], as auxiliary ligands have been successfully synthesized and characterized. This class of complexes exhibits high decomposition temperatures of up to 387 °C, excellent film morphologies in solid-state thin films with root-mean-square roughness of ≤ 0.20 nm, as well as high photoluminescence quantum yields in solid-state thin film of up to 0.72. Solution-processed organic light-emitting devices (OLEDs) based on these complexes as dopants show intense electroluminescence in the sky-blue region with maximum external quantum efficiencies of 10.0 %. Taking advantages of their high thermal stability, vacuum-deposited OLEDs based on this series of complexes have also been fabricated and satisfactory operational lifetime of ~300 hours have been recorded.

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Molecular Alignment of Alkynylplatinunm(II) Bis(benzimidazole-2′-yl)pyridine Double Complex Salts and the Formation of Well-Ordered Nanostructures Directed by Pt···Pt and Donor–Acceptor Interactions

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Abstract

A new class of alkynylplatinum(II) bzimpy (bzimpy = bis(benzimidazole-2′-yl)pyridine) double complex salts (DCSs) containing the donor and acceptor moieties on the alkynyl ligand has been reported to display distinct morphological properties when compared to their precursor alkynylplatinum(II) complexes, with capability of being aligned by the directional Pt···Pt and/or π–π stacking interactions. The incorporation of donor and acceptor units on the alkynyl ligands has been found to significantly perturb the alignment of the oppositely-charged complex ions in the DCSs to stack in a twisted head-to-head manner, attributed to the additional driving forces of electrostatic and donor–acceptor interactions. The modulation of the Pt···Pt distances and the extent of aggregate formation has been demonstrated by altering the charge matching between the platinum(II) bzimpy moieties and the donor or acceptor moieties on the alkynyl ligand.

Platinum(II)-Based Host–Guest Coordination-Driven Supramolecular Co-Assembly Assisted by Pt···Pt and π–π Stacking Interactions: A Dual-Selective Luminescence Sensor for Cations and Anions

Yip-Sang Wong, Maggie Ng, Margaret Ching-Lam Yeung, Vivian Wing-Wah Yam*

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Abstract

A cationic water-soluble dipicolylamine-containing alkynylplatinum(II) terpyridine complex has been synthesized and demonstrated to exhibit a strong binding affinity towards Zn^{2+} whereas its zinc-bound adduct is found to demonstrate the capability of recognizing PPi. Notably, the orchestrated sequential addition of Zn^{2+} and PPi to a solution of the complex has been shown to trigger the emergence of the respective triplet metal-to-ligand charge transfer (^{3}MLCT) emission (at *ca.* 600 nm) and triplet metal−metal-to-ligand charge transfer (^{3}MMLCT) emission (at *ca.* 770 nm). One of the distinct features of this current platinum(II)-based probe is that it can exhibit emission in the near-infrared (NIR) region, which is advantageous with regard to autofluorescence and interference issues as well as better penetration in body tissue. More interestingly, as evidenced by molecular modeling and various spectroscopic and spectrometric studies, a PPi anion is found to be capable of bridging two zinc-bound complex molecules in a clip-shaped fashion, which is further oligomerized through intermolecular Pt···Pt and π−π stacking interactions to form nanofibers with a hexagonal columnar phase. This work provides important insights into not only the construction of aesthetically pleasing supramolecular architectures but also the multifunctional probes, which offer great promise to the fields of biosensing and chemical sensing.

References

1. Wong, Y.S.; Ng, M.; Yeung, M.C.L.; Yam, V.W.W. *Journal of the American Chemical Society*, **2021**, *143*, 973 – 982.

Concentration- and Substituent-Mediated Structural Transformation of Polynuclear Gold(I)-Sulfido Complexes

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Abstract: A series of polynuclear gold(I) sulfido complexes has been synthesized and characterized. A rather small variation in the conformation of the bis(diphenylphosphino)amine or 1,3-bis(diphenylphosphino)benzene ligands has led to distinct differences in the identity of the polynuclear gold(I) sulfido complexes formed. For the bis(diphenylphosphino)amine ligands, a mixture of both the dodecanuclear and decanuclear gold(I) complexes was isolated for the first time. Moreover, unprecedented concentration-dependent reversible cluster-to-cluster transformation between a dodecanuclear gold(I) sulfido complex ($\mathbf{L^{Me}\text{-}Au_{12}}$) and a hexanuclear gold(I) sulfido complex ($\mathbf{L^{Me}\text{-}Au_{6}}$) has been observed.[1] For the 1,3-bis(diphenylphosphino)benzene ligands, a novel substituent-mediated transformation from pentagold(I) to octadecagold(I) complexes has been observed. It was found that the electron-withdrawing substituent on the 1,3-bis(diphenylphosphino)benzene ligand played a key role in regulating the cluster transformation process. For instance, the Au_5 clusters with electron-withdrawing substituents such as –F and –CN could transform to Au_{18} clusters in solution.[2] These studies demonstrate that a precise tuning of the steric effect and electronic nature of the substituent of the phosphine ligand can play a critical role in the regulation of the structure of gold(I) sulfido complexes. Our findings offer a simple and effective cluster-to-cluster transformation strategy for the development of novel luminescent gold(I)-sulfido clusters with controlled structures.

Reference

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Solvent-Dependent Supramolecular Host–Guest Assemblies of Multi-Addressable Platinum(II) Tweezers and Guest System: From Discrete Molecules to High-Ordered Aggregates

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Abstract

A series of multi-addressable platinum(II) calix[4]arene-based molecular tweezers was synthesized. The studies of the host–guest association with a neutral cyclometalated platinum(II) neutral complex showed a drastic color change and the turning on of near-infrared emission resulting from Pt···Pt and π–π interactions. Control of the host–guest assembly process by varying the solvent composition can lead to a change from discrete host–guest molecules to high-ordered host–guest aggregates, resulting in a three-state multi-addressable supramolecular host–guest system. The present study provides insights into the systematic design of solvent-responsive multi-addressable molecular materials using molecular tweezers-directed host–guest assembly.

Third-order many-body expansion of OSV-MP2 wavefunction for low-order scaling analytical gradient computation

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Abstract

We present a many-body expansion (MBE) formulation and implementation for efficient computation of analytical energy gradients from the orbital-specific-virtual second-order Møllet-Plesset perturbation theory (OSV-MP2) based on our earlier work[1]. The third-order MBE(3) expansion of OSV-MP2 amplitudes and density matrices was developed to adopt the orbital-specific clustering and long-range termination schemes, which avoids term-by term differentiations of the MBE energy bodies. Compared to the work presented in the poster of the last symposium, we have achieved better efficiency by exploiting the algorithmic sparsity that allows to prune out insignificant fitting integrals and OSV relaxations without significant sacrifice of accuracy. Moreover, the MPI-3-based parallelism through shared memory one-sided communication is further developed for improving parallel scalability and memory accessibility by sorting the MBE(3) orbital clusters into independent tasks that are distributed on multiple processes across many nodes, supporting both global and local data locations in which selected MBE(3)-OSV-MP2 intermediates of different sizes are distinguished and accordingly placed. The accuracy and efficiency level of our MBE(3)-OSV-MP2 analytical gradient implementation is illustrated in some applications.

Reference

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Quantum chemical study of the combustion kinetics for the reaction H + O_2 → HO_2 towards supercritical condition

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The radical reactions H + O_2 → HO_2 and OH + HO_2 → H_2O + O_2 are of great importance in the water formation chemistry of the interstellar medium and plays a significant role both in atmospheric and combustion chemistry.[1] The latter is a prototypical reaction between two non-atom radical species which not only work as a dominant pathway as an additional sink for hydroxy radicals but also serves in many catalytic cycles involving key atmospheric species.[2] Therefore, the accurate information regarding the rate constants for such reactions and their kinetic behavior are desired. Despite a recent significant progress, the temperature and pressure dependence of these reactions remains unambiguous, particularly at supercritical conditions.

In this work, we present a comprehensible investigation of the rate-coefficients for these radical-involving reactions by both the canonical variational theory (CVT) and quasi-classical trajectory (QCT) approach.[3] We use the permutation invariant polynomial-neural network (PIP-NN) method to construct the globally accurate potential energy surfaces of the ground triplet state for the reactions, performing density functional theory investigations at both B2PYLP/cc-pVTZ and CASCI level of theory. Finally, our CVT and QCT based rate coefficients are benchmarked with experimental results and provide a quantitative as well qualitative consistency against the available literature.

References

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2. Gonzalez, C.; Theisen, J.; Zhu, L.; Schlegel, H. B.; Hase, W. L.; Kaiser, E. W. *J. Phys. Chem.*, **1991**, *95*, 6784-6792.
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Understanding a novel protein-ligation process with energy decomposition

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Supervisor: Dr. Jun Yang

Abstract:

This computational work provides a deeper understanding of a novel protein ligation method. We explained the role of each solvent in catalyzing this reaction: acetic acid catalyst the serine type ligation, while pyridine catalyst the cysteine type ligation. We pointed out that the pyridine catalyst route is favored than the acetic acid catalyst route because of the lower energy barrier: the transition state of the pyridine catalyst route does not relate to solvent, which obviate the intermolecular energy barrier such as Pauli Repulsion and Nuclear preparation. We also suggest that the C-terminal residual differences relate to the geometry preparation for solvent to get close to peptide. This work also suggests that the intramolecular interaction energy could be analyzed by the local energy decomposition (LED) analysis, which is mainly used in the intermolecular interaction energy analyzation.

Summary of Presentation and Participant Distribution

		Presentations					Participants
		Poster (in different subject areas*)			Oral	Sub-total	
		AEB	OM	PI			
Institution**	CityU	7	0	15	1	23	140
	HKBU	17	6	4	1	28	51
	CUHK	1	13	2	1	17	105
	PolyU	13	9	7	1	30	76
	HKUST	7	18	8	1	34	140
	HKU	21	16	21	1	59	184
Sub-total		66	62	57	6	191	696
No. of Awards		2	2	2	3	9	

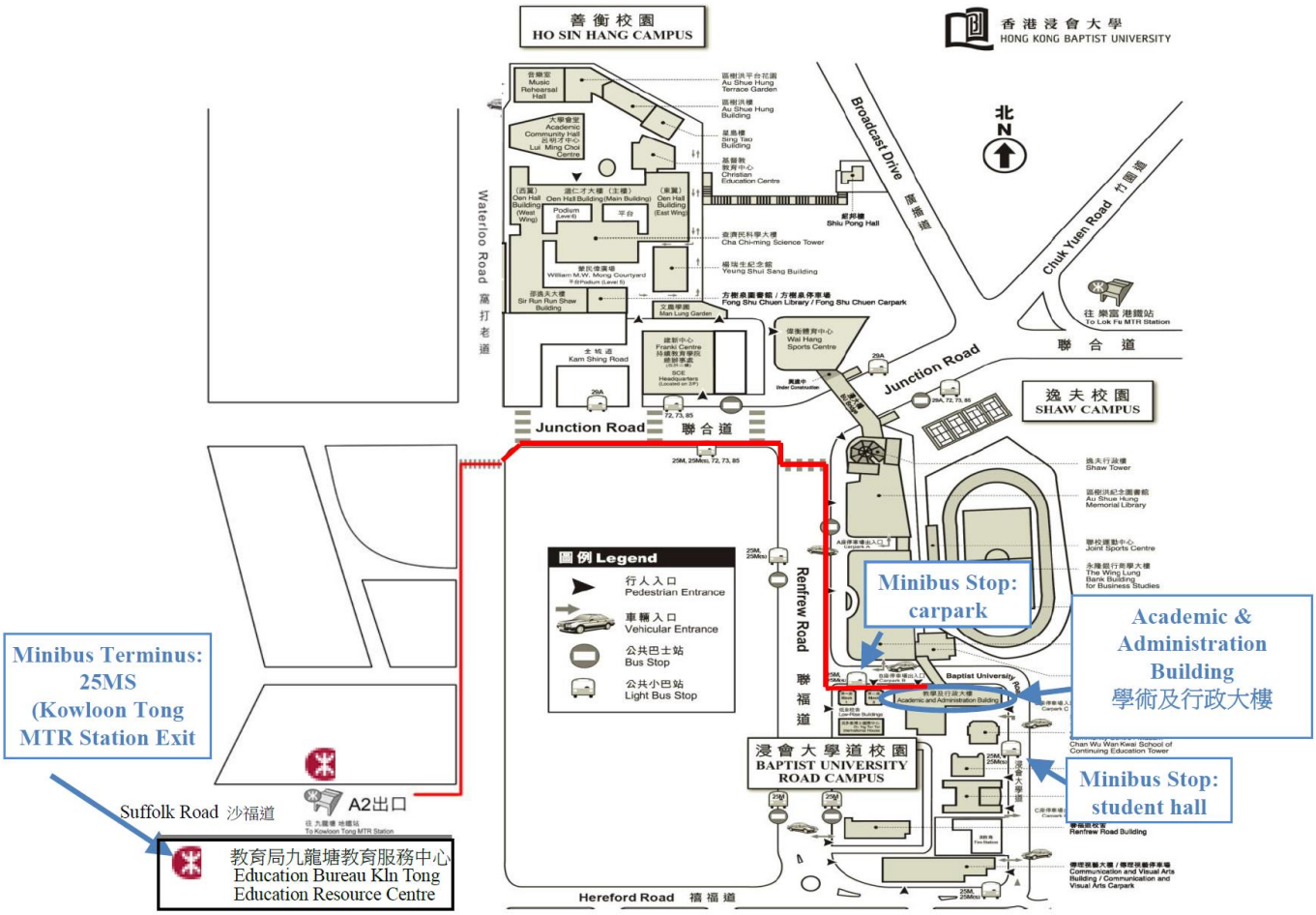
*Subject Area Codes:

AEB	Analytical, Environmental, and Biochemistry
OM	Organic and Materials Chemistry
PI	Physical and Inorganic Chemistry

**Institution Abbreviations:

CityU	City University of Hong Kong
HKBU	Hong Kong Baptist University
CUHK	The Chinese University of Hong Kong
PolyU	The Hong Kong Polytechnic University
HKUST	The Hong Kong University of Science and Technology
HKU	The University of Hong Kong

Location Map: Academic and Administration Building (AAB)



Transport Guide

The Academic and Administration Building is located on the new BU campus, east of the People's Liberation Army Kowloon East Barracks (解放軍東九龍軍營).

By MTR + Minibus

- Kowloon Tong Station, Exit ***D***

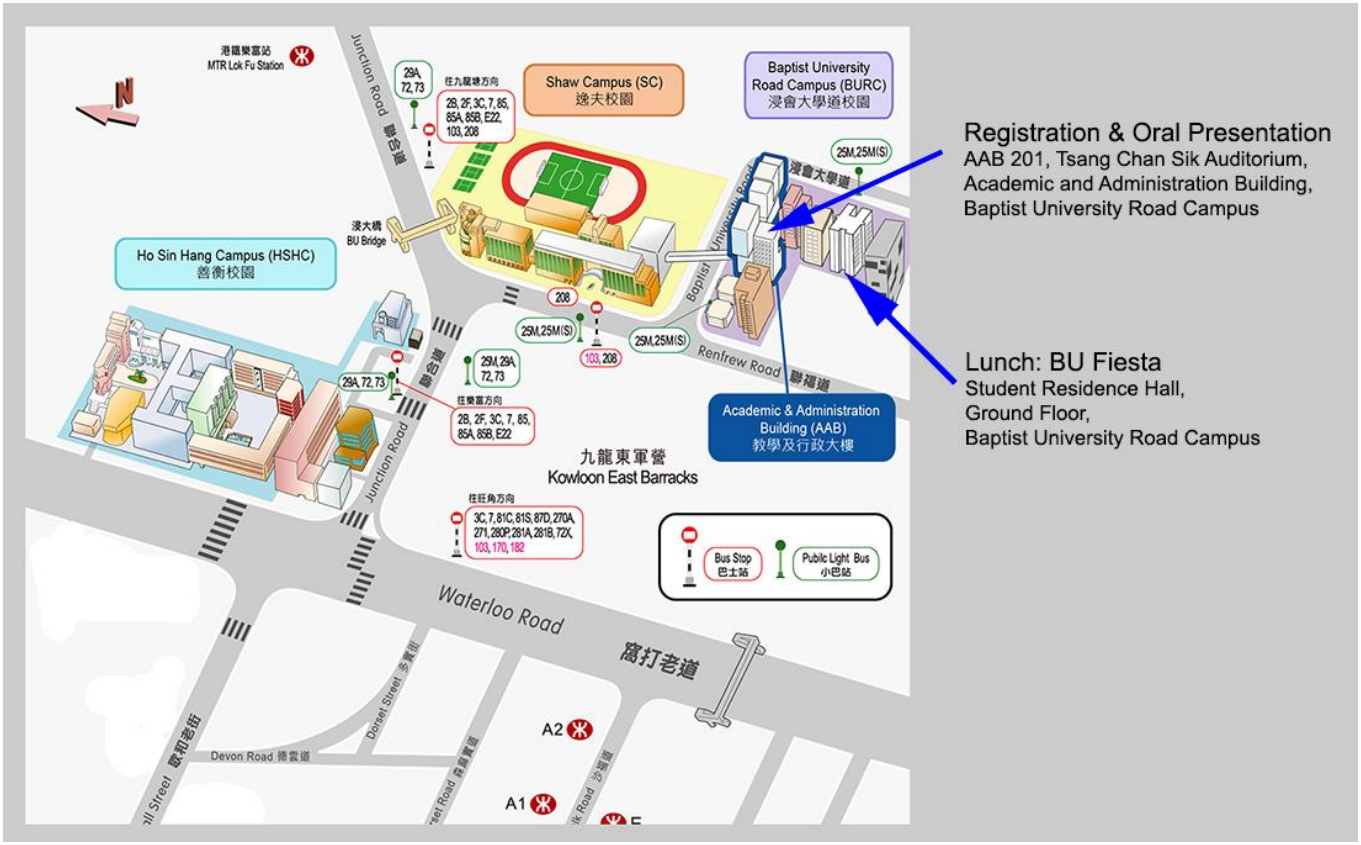
You may take minibus ***25MS*** at the Transport Interchange below the Education Bureau building. The ride will take about 5 minutes. You may get off at "***student hall***" or "***carpark***" as indicated on the map above.

By MTR + on foot

- Kowloon Tong Station, Exit ***A2***

You may also go to the venue on foot by following the red line starting from Exit A2 on the map. The walk will take about 10-15 minutes.

Symposium venue map



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