Science Newsletter

2024 Volume 2 (Total 49) *Website:https://lib.jsut.edu.cn/2024/0112/c5474a174724/page.htm*
January, 2024

Contents

Editor: Chaoyi Chu（褚朝奕） TEL: 3548 Email: ccy@jsut.edu.cn

Introduction:

There are 3 main elements in the Science Newsletter which is composed. In the first part, we list the most up to date papers about central issues for each discipline in our university, and they are provided with 5 subjects for a time. In the second part, there are papers from the top journals last month, and most of them are from Nature and Science. In the third part, we post information about calling papers for international conferences. Hopefully, some of the information in this manuscript may be useful for those who are dedicating to scientific career. Besides, the journals are also posted on the website of our library, and they are available to be accessed any time at https://lib.jsut.edu.cn/2018/1015/c5474a113860/page.htm . If there are any questions or suggestions, please send e-mails to ccy@jsut.edu.cn in no hesitate.

Ⅰ Topics

The keywords of this month is **Materials**:
We post several papers which are related to the top concerned topics in researches on materials science. The papers are classified in 5 categories, and they are: **Nanomaterials, New Energy Materials, Polymers, Ceramics,** and **Metals AND Alloys**. Also, the listed papers are all arranged in a descending sort of JCR impact factor, and there are also accesses right after each abstract of papers.

NANOMATERIALS

Adv Sci (Weinh) (impact factor: 15.8) 1 区

DNA Adjuvant Hydrogel-Optimized Enzymatic Cascade Reaction for Tumor Chemodynamic-Immunotherapy.

Zhao, Du, et. al

Abstract:
Chemodynamic therapy (CDT) shows immense potential in cancer treatment as it not only directly kills tumor cells but also induces anti-tumor immune responses. However, the efficacy of CDT is hampered by challenges in targeting CDT catalysts specifically to tumors using nanomaterials, along with the limitations of low H2 O2 levels and short catalyst duration within the tumor microenvironment. In this study, DNA adjuvant

hydrogel to arrange a glucose oxidase-ferrocene cascade for continuously generating reactive oxygen species (ROS) from glucose in situ for tumor CDT combined with immunotherapy is employed. By precisely tuning the catalyst spacing with DNA double helix, ROS production efficiency is elevated by up to nine times compared to free catalysts, resulting in stronger immunogenetic cell death. Upon intratumoral injection, the DNA hydrogel system elicited potent anti-tumor immune responses, thereby effectively inhibiting established tumors and rejecting re-challenged tumors. This work offers a novel platform for integrated CDT and immunotherapy in cancer treatment.© 2024 The Authors. Advanced Science published by Wiley-VCH GmbH.

Part Fibre Toxicol (IF: 10) 1 ☒

ROS/mtROS promotes TNTs formation via the PI3K/AKT/mTOR pathway to protect against mitochondrial damages in glial cells induced by engineered nanomaterials.

Lin, Wang, et. al

Abstract:

As the demand and application of engineered nanomaterials have increased, their potential toxicity to the central nervous system has drawn increasing attention. Tunneling nanotubes (TNTs) are novel cell-cell communication that plays a crucial role in pathology and physiology. However, the relationship between TNTs and nanomaterials neurotoxicity remains unclear. Here, three types of commonly used engineered nanomaterials, namely cobalt nanoparticles (CoNPs), titanium dioxide nanoparticles (TiO2NPs), and multi-walled carbon nanotubes (MWCNTs), were selected to address this limitation.After the complete characterization of the nanomaterials, the induction of TNTs formation with all of the nanomaterials was observed using high-content screening system and confocal microscopy in both primary astrocytes and U251 cells. It was further revealed that TNT formation protected against nanomaterial-induced neurotoxicity due to cell apoptosis and disrupted ATP production. We then determined the mechanism underlying the protective role of TNTs. Since oxidative stress is a common mechanism in nanotoxicity, we first observed a significant increase in total and mitochondrial reactive oxygen species (namely ROS, mtROS), causing mitochondrial damage. Moreover, pretreatment of U251 cells with either the ROS scavenger N-acetylcysteine or the mtROS scavenger mitoquinone attenuated nanomaterial-induced neurotoxicity and TNTs generation, suggesting a central role of ROS in nanomaterials-induced TNTs formation. Furthermore, a vigorous downstream pathway of ROS, the PI3K/AKT/mTOR pathway, was found to be actively involved in nanomaterials-promoted TNTs development, which was abolished by LY294002, Perifosine and Rapamycin, inhibitors of PI3K, AKT, and mTOR, respectively. Finally, western blot analysis demonstrated that ROS and mtROS scavengers suppressed the PI3K/AKT/mTOR pathway, which abrogated TNTs formation.Despite their biophysical properties, various types of nanomaterials promote

TNTs formation and mitochondrial transfer, preventing cell apoptosis and disrupting ATP production induced by nanomaterials. ROS/mtROS and the activation of the downstream PI3K/AKT/mTOR pathway are common mechanisms to regulate TNTs formation and mitochondrial transfer. Our study reveals that engineered nanomaterials share the same molecular mechanism of TNTs formation and intercellular mitochondrial transfer, and the proposed adverse outcome pathway contributes to a better understanding of the intercellular protection mechanism against nanomaterials-induced neurotoxicity.© 2024. The Author(s).

Sci Total Environ (IF: 9.8) 2 ☒

Insight into the mechanism of nano-TiO2-doped biochar in mitigating cadmium mobility in soil-pak choi system.

Liu, He, et. al

Abstract:

Soil cadmium (Cd) pollution poses severe threats to food security and human health. Previous studies have reported that both nanoparticles (NPs) and biochar have potential for soil Cd remediation. In this study, a composite material (BN) was synthesized using low-dose TiO2 NPs and silkworm excrement-based biochar, and the mechanism of its effect on the Cd-contaminated soil-pak choi system was investigated. The application of 0.5 % BN to the soil effectively reduced 24.8 % of diethylenetriaminepentaacetic acid (DTPA) Cd in the soil and promoted the conversion of Cd from leaching and HOAc-extractive to reducible forms. BN could improve the adsorption capacity of soil for Cd by promoting the formation of humic acid (HA) and increasing the cation exchange capacity (CEC), as well as activating the oxygen-containing functional groups such as CO and CO. BN also increased soil urease and catalase activities and improved the synergistic network among soil bacterial communities to promote soil microbial carbon (C) and nitrogen (N) cycling, thus enhancing Cd passivation. Moreover, BN increased soil biological activity-associated metabolites like T-2 Triol and altered lipid metabolism-related fatty acids, especially hexadecanoic acid and dodecanoic acid, crucial for bacterial Cd tolerance. In addition, BN inhibited Cd uptake and root-to-shoot translocation in pak choi, which ultimately decreased Cd accumulation in shoots by 51.0 %. BN significantly increased the phosphorus (P) uptake in shoots by 59.4 % by improving the soil microbial P cycling. This may serve as a beneficial strategy for pak choi to counteract Cd toxicity. These findings provide new insights into nanomaterial-doped biochar for remediation of heavy metal contamination in soil-plant systems.Copyright © 2024 Elsevier B.V. All rights reserved.

Adv Mater (IF: 29.4) 1 区

High-Surface Area Mesoporous Sc2 o3 with Abundant Oxygen Vacancies as New and Advanced Electrocatalyst for Electrochemical Biomass Valorization.

Wu, Ma, et. al

Abstract:

Scandium oxide (Sc2 O3) is considered as omnipotent "Industrial Ajinomoto" and holds promise in catalytic applications. However, rarely little attention have been paid to its electrochemistry. Here, we reported the first nanocasting design of high-surface area Sc2 O3 with abundant oxygen vacancies (mesoporous VO -Sc2 O3) for efficient electrochemical biomass valorization. In the case of the electro-oxidation of 5-hydroxymethylfurfural (HMF) to 2,5-furandicarboxylic acid (FDCA), quantitative HMF conversion, high yield and high faradic efficiency of 2,5-furandicarboxylic acid (FDCA) via the hydroxymethylfurancarboxylic acid (HMFCA) pathway were achieved by this advanced electrocatalyst. The beneficial effect of the VO on the electrocatalytic performance of the mesoporous VO -Sc2 O3 was revealed by the enhanced adsorption of reactants and the reduced energy barrier in the electrochemical process. The concerted design, in-situ and ex-situ experimental studies and theoretical calculations shown in this work should shed light on the rational elaboration of advanced electrocatalysts, and contribute to the establishment of a circular carbon economy since the bio-plastic monomer and green hydrogen are efficiently synthesized. This article is protected by copyright. All rights reserved.This article is protected by copyright. All rights reserved.

Adv Mater (IF: 29.4) 1 区

Programming Polarity Heterogeneity of Energy Storage Dielectrics By Bidirectional Intelligent Design.

Chen, Shen, et al

Abstract:

Dielectric capacitors, characterized by ultra-high power densities, are considered as fundamental energy storage components in electronic and electrical systems. However, synergistically improving energy densities and efficiencies remains a daunting challenge. Understanding the role of local polar heterogeneity at the nanoscale in determining polarization response is crucial to the domain engineering of high-performance dielectrics. Here, a bidirectional design with phase-field simulation and machine learning are performed to forward reveal the structure-property relationship and reversely optimize polarity heterogeneity to improve energy storage performance. Taking BiFeO3 -based dielectrics as typical systems, we establish the mapping

diagrams of energy density and efficiency dependence on the volume fraction, size and configuration of polar regions. Assisted by CatBoost and Wolf Pack algorithms, we analyze the contributions of geometric factors and intrinsic features to energy storage performance and find that nanopillar-like polar regions show great potential in achieving both high polarization intensity and fast dipole switching. Finally, a maximal energy density of 188 J cm-3 with efficiency above 95% at an applied electric field of 8 MV cm-1 is obtained in BiFeO3 -Al2 O3 systems. This work provides a general method to study the influence of local polar heterogeneity in multiphase dielectrics on polarization behaviors and proposes effective strategies to enhance energy storage performance by tuning local polarity heterogeneity. This article is protected by copyright. All rights reserved.This article is protected by copyright. All rights reserved.

Angew Chem Int Ed Engl (IF: 16.6) 1 区

Enhanced Charge Carrier Dynamics on Sb2Se3 Photocathodes for Efficient Photolectrochemical Nitrate Reduction to Ammonia.

Ren, Gao, et. al

Abstract:

Ammonia (NH3) is recognized as a transportable carrier for renewable energy fuels. Photoelectrochemical nitrate reduction reaction (PEC NO3RR) offers a sustainable solution for nitrate-rich wastewater treatment by directly converting solar energy to ammonia. In this study, we demonstrate the highly selective PEC ammonia production from NO3RR by constructing a CoCu/TiO2/Sb2Se3 photocathode. The constructed CoCu/TiO2/Sb2Se3 photocathode achieves an ammonia Faraday efficiency (FE) of 88.01% at -0.2 VRHE and an ammonia yield as high as 15.91 μmol h-1 cm-2 at -0.3 VRHE with an excellent onset potential of 0.43 VRHE. Dynamics experiments and theoretical calculations have demonstrated that the CoCu/TiO2/Sb2Se3 photocathode possesses high light absorption capacity, excellent carrier transfer capability, and high charge separation and transfer efficiencies. The photocathode can effectively adsorb the reactant NO3- and intermediate, and the CoCu co-catalyst increases the maximum Gibbs free energy difference between NO3RR and HER. Meanwhile, the Co species enhances the spin density of Cu, and increases the density of states near the Fermi level in pdos, which results in a high PEC NO3RR activity on CoCu/TiO2/Sb2Se3. This work provides a new avenue for the feasibility of efficient PEC ammonia synthesis from nitrate-rich wastewater.© 2024 Wiley-VCH GmbH.

POLYMERS

Nat Chem (IF: 21.8) 1 ☒

Surface stratification determines the interfacial water structure of simple electrolyte solutions.

Litman, Chiang, et. al

Abstract:
The distribution of ions at the air/water interface plays a decisive role in many natural processes. Several studies have reported that larger ions tend to be surface-active, implying ions are located on top of the water surface, thereby inducing electric fields that determine the interfacial water structure. Here we challenge this view by combining surface-specific heterodyne-detected vibrational sum-frequency generation with neural network-assisted ab initio molecular dynamics simulations. Our results show that ions in typical electrolyte solutions are, in fact, located in a subsurface region, leading to a stratification of such interfaces into two distinctive water layers. The outermost surface is ion-depleted, and the subsurface layer is ion-enriched. This surface stratification is a key element in explaining the ion-induced water reorganization at the outermost air/water interface.© 2024. The Author(s).

Angew Chem Int Ed Engl (IF: 16.6) 1 ☒

Dithiophosphoric Acids for Polymer Functionalization.

Bao, Kang, et. al

Abstract:
Dithiophosphoric acids (DTPAs) are an intriguing class of compounds that are sourced from elemental sulfur and white phosphorus and are prepared from the reaction of phosphorus pentasulfide with alcohols. The electrophilic addition of DTPAs to alkenes and unsaturated olefinic substrates is a known reaction, but has not been applied to polymer synthesis and polymer functionalization. We report on the synthesis and application of DTPAs for the functionalization of challenging poly-enes, namely polyisoprene (PI) and polynorbornene (pNB) prepared by ring-opening metathesis polymerization (ROMP). The high heteroatom content within DTPA moieties impart intriguing bulk properties to poly-ene materials after direct electrophilic addition reactions to the polymer backbone introducing DTPAs as side chain groups. The resulting materials possess both enhanced optical and flame retardant properties vs the poly-ene starting materials. Finally, we demonstrate the ability to prepare crosslinked polydiene films with di-functional DTPAs, where the crosslinking density and thermomechanical properties can be directly tuned by DTPA feed ratios.© 2024 Wiley-VCH GmbH.

Waste Manag (impact factor: 8.1) 2 ☒

GCDN-Net: Garbage classifier deep neural network for recyclable urban waste management.

Hossen, Ashraf, et. al

Abstract:

The escalating waste volume due to urbanization and population growth has underscored the need for advanced waste sorting and recycling methods to ensure sustainable waste management. Deep learning models, adept at image recognition tasks, offer potential solutions for waste sorting applications. These models, trained on extensive waste image datasets, possess the ability to discern unique features of diverse waste types. Automating waste sorting hinges on robust deep learning models capable of accurately categorizing a wide range of waste types. In this study, a multi-stage machine learning approach is proposed to classify different waste categories using the "Garbage In, Garbage Out" (GIGO) dataset of 25,000 images. The novel Garbage Classifier Deep Neural Network (GCDN-Net) is introduced as a comprehensive solution, adept in both single-label and multi-label classification tasks. Single-label classification distinguishes between garbage and non-garbage images, while multi-label classification identifies distinct garbage categories within single or multiple images. The performance of GCDN-Net is rigorously evaluated and compared against state-of-the-art waste classification methods. Results demonstrate GCDN-Net's excellence, achieving 95.77% accuracy, 95.78% precision, 95.77% recall, 95.77% F1-score, and 95.54% specificity when classifying waste images, outperforming existing models in single-label classification. In multi-label classification, GCDN-Net attains an overall Mean Average Precision (mAP) of 0.69 and an F1-score of 75.01%. The reliability of network performance is affirmed through saliency map-based visualization generated by Score-CAM (class activation mapping). In conclusion, deep learning-based models exhibit efficacy in categorizing diverse waste types, paving the way for automated waste sorting and recycling systems that can mitigate costs and processing times.Copyright © 2023 Elsevier Ltd. All rights reserved.

CERAMICS

Adv Sci (Weinh) (IF: 15.8) 1 ☒

Enabling Broadband Solar-Blind UV Photodetection by a Rare-Earth Doped Oxyfluoride Transparent Glass-Ceramic.

Jia, Zhang, et. al

Abstract

Oxyfluoride transparent glass-ceramics (GC) are widely used as the matrix for rare-earth (RE) ions due to their unique properties such as low phonon energy, high transmittance, and high solubility for RE ions. Tb3+ doped oxyfluoride glasses exhibit a large absorption cross section for ultraviolet (UV) excitation, high stability, high photoluminescence quantum efficiency, and sensitive spectral conversion characteristics, making them promising candidate materials for use as the spectral converter in UV photodetectors. Herein, a Tb3+ doped oxyfluoride GC is developed by using the melt-quenching method, and the microstructure and optical properties of the GC sample are carefully investigated. By combining with a Si-based photo-resistor,a solar-blind UV detector is fabricated, which exhibits a significant photoelectric response with a broad detection range from 188 to 400 nm. The results indicate that the designed UV photodetector is of great significance for the development of solar-blind UV detectors.© 2024 The Authors. Advanced Science published by Wiley-VCH GmbH.

Sci Total Environ (impact factor: 9.8) 2 区 TOP

Nanoscale Metal-Organic Frameworks-Mediated Degradation of Mutant p53 Proteins and Activation of cGAS-STING Pathway for Enhanced Cancer Immunotherapy.

Sun, Gao, et. al

Abstract

Activating cGAS-STING pathway has great potential to achieve effective antitumor immunotherapy. However, mutant p53 (mutp53), a commonly observed genetic alteration in over 50% of human cancer, will impede the therapeutic performance of the cGAS-STING pathway. Herein, multifunctional ZIF-8@MnO2 nanoparticles are constructed to degrade mutp53 and facilitate the cGAS-STING pathway. The synthesized ZIF-8@MnO2 can release Zn2+ and Mn2+ in cancer cells to induce oxidative stress and cytoplasmic leakage of fragmented mitochondrial double-stranded DNAs (dsDNAs). Importantly, the released Zn2+ induces variable degradation of multifarious p53 mutants through proteasome ubiquitination, which can alleviate the inhibitory effects of mutp53 on the cGAS-STING pathway. In addition, the released Mn2+ further increases the sensitivity of cGAS to dsDNAs as immunostimulatory signals. Both in vitro and in vivo results demonstrate that ZIF-8@MnO2 effectively promotes the cGAS-STING pathway and synergizes with PD-L1 checkpoint blockades, leading to remarkable regression of local tumors as well as distant metastases of breast cancer. This study proposes an inorganic metal ion-based nanoplatform to enhance the cGAS-STING-mediated antitumor immunotherapy, especially to those tumors with mutp53 expression.© 2024 The Authors. Advanced Science published by Wiley-VCH GmbH.

Mater Horiz (IF: 13.3) 1 ☒

Bismuth-based liquid metals: advances, applications, and prospects.

Zhang, Liu, et. al

Abstract

Bismuth-based liquid metals (LMs) are a large group of alloys with melting points slightly above room temperature. They are associated with fewer encapsulation constraints than room temperature LMs such as mercury, sodium-potassium alloys, and gallium-based alloys and are more likely to remain stable in the natural environment. In addition, their low melting point properties enable them to soften and melt via easy control. Bismuth-based alloys can also be modified with metal-based, carbon-based, and ceramic-based micro/nano particles as well as polymeric materials to create a series of novel composites owing to their outstanding functions. Based on these considerations, this review provides a comprehensive overview of bismuth-based LMs. The categories of bismuth and bismuth-based LMs are first briefly introduced to better systematize the physical and chemical properties of bismuth-based LMs. Based on these properties, bismuth-based LMs have been prepared using various methods, and this review briefly categorizes these preparation methods based on their finished forms (lumps, powders, and films). In addition, this review details the research progress of bismuth-based LMs in the fields of printed electronics, 3D printing, thermal management, biomedicine, chemical engineering, and deformable robotics. Finally, the challenges and future opportunities of bismuth-based LMs in the development process are discussed and visualized from different perspectives.

METALS AND ALLOYS

Nat Nanotechnol (IF: 38.3) 1 ☒

Liquid-metal-based three-dimensional microelectrode arrays integrated with implantable ultrathin retinal prosthesis for vision restoration.

Chung, Jang, et. al

Abstract

Electronic retinal prostheses for stimulating retinal neurons are promising for vision restoration. However, the rigid electrodes of conventional retinal implants can inflict damage on the soft retina tissue. They also have limited selectivity due to their poor proximity to target cells in the degenerative retina. Here we present a soft artificial retina (thickness, 10 μm) where flexible ultrathin photosensitive transistors are integrated with three-dimensional stimulation electrodes of eutectic gallium-indium alloy. Platinum nanoclusters locally coated only on the tip of these three-dimensional

liquid-metal electrodes show advantages in reducing the impedance of the stimulation electrodes. These microelectrodes can enhance the proximity to the target retinal ganglion cells and provide effective charge injections (72.84 mC cm-2) to elicit neural responses in the retina. Their low Young's modulus (234 kPa), owing to their liquid form, can minimize damage to the retina. Furthermore, we used an unsupervised machine learning approach to effectively identify the evoked spikes to grade neural activities within the retinal ganglion cells. Results from in vivo experiments on a retinal degeneration mouse model reveal that the spatiotemporal distribution of neural responses on their retina can be mapped under selective localized illumination areas of light, suggesting the restoration of their vision.© 2024. The Author(s).

Small (IF: 13.3) 1 ☒

All-Scale Hierarchical Structuring, Optimized Carrier Concentration, and Band Manipulation Lead to Ultra-High Thermoelectric Performance in Eco-Friendly MnTe.

Zulkifal, Siddique, et. al

Abstract:

MnTe emerges as an enormous potential for medium-temperature thermoelectric applications due to its lead-free nature, high content of Mn in the earth's crust, and superior mechanical properties. Here, it is demonstrate that multiple valence band convergence can be realized through Pb and Ag incorporations, producing large Seebeck coefficient. Furthermore, the carrier concentration can be obviously enhance by Pb and Ag codoping, contributing to significant enhancement of power factor. Moreover, microstructural characterizations reveal that PbTe nanorods can be introduced into MnTe matrix by alloying Pb. This can modify the microstructure into all-scale hierarchical architectures (including PbTe nanorods, enhances point-defect scattering, dense dislocations and stacking faults), strongly lowering lattice thermal conductivity to a record low value of 0.376 W m-1 K-1 in MnTe system. As a result, an ultra-high ZT of 1.5 can be achieved in MnTe thermoelectric through all-scale hierarchical structuring, optimized carrier concentration, and valence band convergence, outperforming most of MnTe-based thermoelectric materials.© 2024 Wiley-VCH GmbH.

Ultrason Sonochem (IF: 8.4) 1 ☒

Intensifying separation of Pb and Sn from waste Pb-Sn alloy by ultrasound-assisted acid leaching: Selective dissolution and sonochemistry mechanism.

Liu, Shi, et. al

Abstract:

Clean and efficient extraction and separation of precious metals from discarded Pb-Sn

alloy is critical to the sustainable utilization of solid waste resources. Dense oxide layer and compact alloy texture in the waste Pb-Sn alloy pose challenges to the effective leaching process. Ultrasonic waves are demonstrated to improve separation efficiency via the favorable physical and chemical effects in solution system. In this study, ultrasound-assisted leaching technology is attempted to rapidly and selectively extract Pb from the waste Pb-Sn alloy, and gives emphasis on ultrasonic electrochemical behaviors. The Eh-pH diagrams of Sn-H2O and Pb-H2O systems were firstly analyzed to lay the selective dissolution foundation. It's indicated that oxidizing HNO3 lixiviant is suitable to realize the selective separation of Pb. Both Sn and Pb can be dissolved to ionic Sn2+ and Pb2+ in the HNO3 solution. However, Sn2+ rapidly oxidizes to Sn4+ and Sn4+ further hydrolyzes to insoluble SnO2, which will agglomerate on unreacted materials to limit internal metal leaching in conventional leaching process. Due to the vibratory stripping of oxide layer by physical effect of ultrasound, the conventional acid leaching time for Pb extraction can be halved with the ultrasound assistance. About 99.12 % Pb and only 0.1 % Sn are dissolved in ultrasound-assisted leaching under the following optimal parameters: 0.5 mol/L HNO3, leaching temperature of 80 °C, time of 30 min, liquid-to-solid ratio of 20 mL/g, and ultrasound intensity of 0.52 W/cm2. Leaching kinetics of Pb, phase transition, microstructure evolution, Pb-Sn galvanic corrosion and dissolution polarization curve were studied to determine the ultrasonic enhanced dissolution mechanism. Notably, Pb and Sn form a microcorrosion galvanic cell in which Sn acts as a cathode and is protected while the Pb undergoes intensifying corrosion as the anode giving rise to the higher Pb dissolution efficiency. Eventually, it's suggested that Pb can be rapidly extracted and separated from the waste Pb-Sn alloy during the ultrasound-assisted HNO3 leaching process via the ultrasound physical and chemical effects, especially the sonochemistry aspect of intensified spot corrosion and galvanic corrosion. The proposed ultrasonic electrochemical corrosion in this work were applicable to the extraction of valuable metals from various waste alloys through leaching method.Copyright © 2024 The Author(s). Published by Elsevier B.V. All rights reserved.

Editor: Chaoyi Chu（褚朝奕） TEL: 3548 Email: ccy@jsut.edu.cn

Ⅱ Concentration

PHYSICS

Exploring large-scale entanglement in quantum simulation

Joshi, Manoj K., et al.

Abstract

Entanglement is a distinguishing feature of quantum many-body systems, and uncovering the entanglement structure for large particle numbers in quantum simulation experiments is a fundamental challenge in quantum information science1. Here we perform experimental investigations of entanglement on the basis of the entanglement Hamiltonian (EH)2 as an effective description of the reduced density operator for large subsystems. We prepare ground and excited states of a one-dimensional XXZ Heisenberg chain on a 51-ion programmable quantum simulator3 and perform sample-efficient 'learning' of the EH for subsystems of up to 20 lattice sites4. Our experiments provide compelling evidence for a local structure of the EH. To our knowledge, this observation marks the first instance of confirming the fundamental predictions of quantum field theory by Bisognano and Wichmann5,6, adapted to lattice models that represent correlated quantum matter. The reduced state takes the form of a Gibbs ensemble, with a spatially varying temperature profile as a signature of entanglement2. Our results also show the transition from area- to volume-law scaling7 of von Neumann entanglement entropies from ground to excited states. As we venture towards achieving quantum advantage, we anticipate that our findings and methods have wide-ranging applicability to revealing and understanding entanglement in many-body problems with local interactions including higher spatial dimensions.

Evidence for chiral supercurrent in quantum Hall Josephson junctions

Vignaud, Hadrien, et al.

Abstract

Hybridizing superconductivity with the quantum Hall (QH) effect has notable potential for designing circuits capable of inducing and manipulating non-Abelian states for topological quantum computation[1,2,3]. However, despite recent experimental progress towards this hybridization[4,5,6,7,8,9,10,11,12,13,14,15], concrete evidence for a chiral QH Josephson junction[16]—the elemental building block for coherent superconducting QH circuits—is still lacking. Its expected signature is an unusual chiral supercurrent flowing in QH edge channels, which oscillates with a specific $2\phi_0$ magnetic flux

periodicity[16,17,18,19] ($\phi_0 = h/2e$ is the superconducting flux quantum, where h is the Planck constant and e is the electron charge). Here we show that ultra-narrow Josephson junctions defined in encapsulated graphene nanoribbons exhibit a chiral supercurrent, visible up to 8 T and carried by the spin-degenerate edge channel of the QH plateau of resistance $h/2e^2 \approx 12.9\,\mathrm{k\Omega}$. We observe reproducible $2\phi_0$-periodic oscillations of the supercurrent, which emerge at a constant filling factor when the area of the loop formed by the QH edge channel is constant, within a magnetic-length correction that we resolve in the data. Furthermore, by varying the junction geometry, we show that reducing the superconductor/normal interface length is crucial in obtaining a measurable supercurrent on QH plateaus, in agreement with theories predicting dephasing along the superconducting interface[19,20,21,22]. Our findings are important for the exploration of correlated and fractional QH-based superconducting devices that host non-Abelian Majorana and parafermion zero modes[23,24,25,26,27,28,29,30,31,32].

Kerr-induced synchronization of a cavity soliton to an optical reference

Moille, Grégory, et al.

Abstract

The phase-coherent frequency division of a stabilized optical reference laser to the microwave domain is made possible by optical-frequency combs (OFCs)[1,2]. OFC-based clockworks[3,4,5,6] lock one comb tooth to a reference laser, which probes a stable atomic transition, usually through an active servo that increases the complexity of the OFC photonic and electronic integration for fieldable clock applications. Here, we demonstrate that the Kerr nonlinearity enables passive, electronics-free synchronization of a microresonator-based dissipative Kerr soliton (DKS) OFC[7] to an externally injected reference laser. We present a theoretical model explaining this Kerr-induced synchronization (KIS), which closely matches experimental results based on a chip-integrated, silicon nitride, micro-ring resonator. Once synchronized, the reference laser captures an OFC tooth, so that tuning its frequency provides direct external control of the OFC repetition rate. We also show that the stability of the repetition rate is linked to that of the reference laser through the expected frequency division factor. Finally, KIS of an octave-spanning DKS exhibits enhancement of the opposite dispersive wave, consistent with the theoretical model, and enables improved self-referencing and access to the OFC carrier–envelope offset frequency. The KIS-mediated enhancements we demonstrate can be directly implemented in integrated optical clocks and chip-scale low-noise microwave generators.

MATERIALS

De Haas–van Alphen spectroscopy and magnetic breakdown in moiré graphene

Matan Bocarsly, Matan Uzan, et al.

Abstract

Quantum oscillations originating from the quantization of electron cyclotron orbits provide sensitive diagnostics of electron bands and interactions. We report on nanoscale imaging of the thermodynamic magnetization oscillations caused by the de Haas–van Alphen effect in moiré graphene. Scanning by means of superconducting quantum interference device (SQUID)–on-tip in Bernal bilayer graphene crystal axis-aligned to hexagonal boron nitride reveals large magnetization oscillations with amplitudes reaching 500 Bohr magneton per electron in weak magnetic fields, unexpectedly low frequencies, and high sensitivity to superlattice filling fraction. The oscillations allow us to reconstruct the complex band structure, revealing narrow moiré bands with multiple overlapping Fermi surfaces separated by unusually small momentum gaps. We identified sets of oscillations that violate the textbook Onsager Fermi surface sum rule, signaling formation of broad-band particle-hole superposition states induced by coherent magnetic breakdown.

Thermodynamically stable plumber's nightmare structures in block copolymers

Hojun Lee, Sangwoo Kwon, et al.

Abstract

Block copolymer self-assembly affords diverse nanostructures, spanning from spheres and cylinders to networks, offering meticulous control over properties and functionalities at the nanoscale. However, creating thermodynamically stable network structures with high packing frustration remains a challenge. In this study, we report a methodology to access diverse network structures such as gyroid, diamond, and primitive phases from diblock copolymers using end group and linker chemistry. The stability of the medial packing of polymer chain ends (plumber's nightmare structure) over skeletal aggregation (gyroid) is attributed to the interplay between the strength of the end-end interactions and the initial shape of the curvature. Our study establishes an approach to develop tailored network structures from block copolymers, providing an important platform for using block copolymers in nanotechnology applications.

Editor: Chaoyi Chu（褚朝奕） TEL: 3548 Email: ccy@jsut.edu.cn

Time-reversal symmetry breaking superconductivity between twisted cuprate superconductors

S. Y. Frank Zhao, Xiaomeng Cui, et al.

Abstract

Twisted interfaces between stacked van der Waals (vdW) cuprate crystals present a platform for engineering superconducting order parameters by adjusting stacking angles. Using a cryogenic assembly technique, we construct twisted vdW Josephson junctions (JJs) at atomically sharp interfaces between Bi2Sr2CaCu2O8+x crystals, with quality approaching the limit set by intrinsic JJs. Near 45° twist angle, we observe fractional Shapiro steps and Fraunhofer patterns, consistent with the existence of two degenerate Josephson ground states related by time-reversal symmetry (TRS). By programming the JJ current bias sequence, we controllably break TRS to place the JJ into either of the two ground states, realizing reversible Josephson diodes without external magnetic fields. Our results open a path to engineering topological devices at higher temperatures.

CHEMISTRY

Dealuminated Beta zeolite reverses Ostwald ripening for durable copper nanoparticle catalysts

Lujie Liu, Jiaye Lu, et. al

Abstract

Copper nanoparticle-based catalysts have been extensively applied in industry, but the nanoparticles tend to sinter into larger ones in the chemical atmospheres, which is detrimental to catalyst performance. Herein we used dealuminated Beta zeolite to support Cu nanoparticles (Cu/Beta-deAl) and showed that these particles become smaller in methanol vapor at 200°C, decreasing from ~5.6 to ~2.4 nanometers, which is opposite to the general sintering phenomenon. A reverse Ostwald ripening process was discovered, where migratable copper sites activated by methanol were trapped by silanol nests, and the copper species in the nests acted as new nucleation sites for forming small nanoparticles. This feature reversed the general sintering channel, resulting in robust catalysts for dimethyl oxalate hydrogenation performed with supported copper nanoparticles in industry.

A stable rhodium-coordinated carbene with a σ0π2 electronic configuration

Chaopeng Hu, Xin-Feng Wang, et. al

Abstract

Isolable singlet carbenes have universally adopted a $\sigma^2\pi^0$ electronic state, making them σ-donors and π-acceptors. We present a rhodium-coordinated, cationic cyclic diphosphinocarbene with a $\sigma^0\pi^2$ ground state configuration. Nuclear magnetic resonance spectroscopy studies show a carbene carbon chemical shift below −30.0 parts per million. X-ray crystallography reveals a planar RhP_2C configuration. Quantum chemical calculations rationalize how σ-electron delocalization/donation and π-electron negative hyperconjugation together stabilize the formally vacant σ orbital and the filled π orbital at the carbene center. In contrast to traditional carbene counterparts this carbene can undergo synthetic transformations with both a Lewis base and a silver salt, producing a Lewis acid/base adduct and a silver π-complex, respectively. Exhibiting ambiphilic reactivity, it can also form a ketenimine through reaction with an isocyanide.

Cobalt-catalyzed synthesis of amides from alkenes and amines promoted by light

Mason S. Faculak , Alexander M. Veatch, et. al

Abstract

Catalytic methods to couple alkene and amine feedstocks are valuable in synthetic chemistry. The direct carbonylative coupling of alkenes and amines holds promise as a perfectly atom-economical approach to amide synthesis, but general methods remain underdeveloped. Herein, we report an alkene hydroaminocarbonylation catalyzed by unmodified, inexpensive cobalt carbonyl under mild conditions and low pressure promoted by light. Silane addition after the reaction enables sequential cobalt-catalyzed amide reduction, constituting a formal alkene hydroaminomethylation. These methods exhibit exceptional scope across both alkene and amine components with high chemo- and regioselectivity and proceed efficiently even in the absence of solvent. The formation of a hydridocobalt through photodissociation of a carbonyl ligand is proposed to enable catalytic activity under mild conditions, which addresses a long-standing challenge in catalysis.

BIOLOGY

Balancing risk-return decisions by manipulating the mesofrontal circuits in primates

Ryo Sasaki, Yasumi Ohta, et al.

Abstract

Decision-making is always coupled with some level of risk, with more pathological forms of risk-taking decisions manifesting as gambling disorders. In macaque monkeys trained in a high risk–high return (HH) versus low risk–low return (LL) choice task, we found that the reversible pharmacological inactivation of ventral Brodmann area 6 (area 6V) impaired the risk dependency of decision-making. Selective optogenetic activation of the mesofrontal pathway from the ventral tegmental area (VTA) to the ventral aspect of 6V resulted in stronger preference for HH, whereas activation of the pathway from the VTA to the dorsal aspect of 6V led to LL preference. Finally, computational decoding captured the modulations of behavioral preference. Our results suggest that VTA inputs to area 6V determine the decision balance between HH and LL.

Microbiota-dependent activation of CD4+ T cells induces CTLA-4 blockade – associated colitis via Fc γ receptors

Bernard C. Lo, Ilona Kryczek, et. al

Abstract

Immune checkpoint inhibitors can stimulate antitumor immunity but can also induce toxicities termed immune-related adverse events (irAEs). Colitis is a common and severe irAE that can lead to treatment discontinuation. Mechanistic understanding of gut irAEs has been hampered because robust colitis is not observed in laboratory mice treated with checkpoint inhibitors. We report here that this limitation can be overcome by using mice harboring the microbiota of wild-caught mice, which develop overt colitis following treatment with anti-CTLA-4 antibodies. Intestinal inflammation is driven by unrestrained activation of IFNγ-producing CD4+ T cells and depletion of peripherally induced regulatory T cells through Fcγ receptor signaling. Accordingly, anti-CTLA-4 nanobodies that lack an Fc domain can promote antitumor responses without triggering colitis. This work suggests a strategy for mitigating gut irAEs while preserving antitumor stimulating effects of CTLA-4 blockade.

Editor: Chaoyi Chu（褚朝奕） TEL: 3548 Email: ccy@jsut.edu.cn

Molecular insights into atypical modes of β-arrestin interaction with seven transmembrane receptors

Jagannath Maharana, Fumiya K. Sano, et. al

Abstract

β -arrestins (βarrs) are multifunctional proteins involved in signaling and regulation of seven transmembrane receptors (7TMRs), and their interaction is driven primarily by agonist-induced receptor activation and phosphorylation. Here, we present seven cryo–electron microscopy structures of βarrs either in the basal state, activated by the muscarinic receptor subtype 2 (M2R) through its third intracellular loop, or activated by the βarr-biased decoy D6 receptor (D6R). Combined with biochemical, cellular, and biophysical experiments, these structural snapshots allow the visualization of atypical engagement of βarrs with 7TMRs and also reveal a structural transition in the carboxyl terminus of βarr2 from a β strand to an α helix upon activation by D6R. Our study provides previously unanticipated molecular insights into the structural and functional diversity encoded in 7TMR-βarr complexes with direct implications for exploring novel therapeutic avenues.

Editor: Chaoyi Chu（褚朝奕） TEL: 3548 Email: ccy@jsut.edu.cn

Ⅲ Calling for papers

COLL 2024

Submission deadline: **Feb 2, 2024**
Conference date: **Jun 9, 2024 - Sep 12, 2024**
Full name: **13th International Colloids Conference**
Location: **Sitges, Spain**
Website: https://www.elsevier.com/events/conferences/international-colloids-conference

The 13th International Colloids Conference will take place 09-12 June 2024 in Sitges, near Barcelona in Spain and provides a forum for researchers from across the world to join in a relaxed atmosphere, to communicate and share the latest developments in colloid and interface science.

A topical programme will bring together an outstanding and diverse line-up of plenary and invited speakers to share their latest results.

Call for papers:

- New materials for energy generation and storage, catalysis, separations, buildings, foods, clothing, packaging
- Advanced soft matter systems, covering functional and adaptive surfactants, polymers, gels and biocolloids
- Designed responsive and functional interfaces, surfaces, films, membranes and composites
- Bio materials, nano-medicines novel drug approaches to delivery and medical diagnostics
- New theory, novel phenomena and advanced experimental techniques

ICMDA 2024

Submission deadline: **Feb 5, 2024**
Conference date: **Apr 9, 2024 - Apr 12, 2024**
Full name: **International Conference on Materials Design and Applications**
Location: **Tokyo Institute of Technology, Japan**
Website: http://www.icmda.org

ICMDA focus on fundamental research and application areas in the field of the design and application of engineering materials, predominantly within the context of mechanical engineering applications such as automobile, railway, marine, aerospace, biomedical, pressure vessel

technology, turbine technology, etc. This includes a wide range of materials engineering and technology, including metals, e.g., lightweight metallic materials, polymers, composites, and ceramics. Advanced applications would include manufacturing in the new or newer materials, testing methods, multi-scale experimental and computational aspects (e.g. micro- and nano-scale techniques).

Topics of Interest :
-Materials Properties, Measuring Methods and Applications
Fracture Mechanics
Mechanical Properties
Electrical Properties

-Materials Science and Materials Processing Technology
Biological Material
Chemical Materials
Smart Materials and Intelligent Systems

-Materials Analyses and Modeling
Metallography
Computational Material Science
Numerical Techniques

For more topics, please visit: http://www.icmda.org/cfp.html

ICAMM 2024

Submission deadline:	**Feb 23, 2024**
Conference date:	**Jul 9, 2024 - Jul 12, 2024**
Full name:	**International Conference on Computer, Control and Robotics**
Location:	**Edinburgh, United Kingdom**
Website:	http://www.icamm.org

ICAMM 2024 is organized after ICAMM 2023 held in Cambridge, ICAMM 2022 & ICAMM 2021 & ICAMM 2020 held virtually, ICAMM 2019 held in Beihang University, Beijing, China. ICAMM 2018 held in Tokyo, Japan during June 11-13, 2018. ICAMM 2017 held in The Hong Kong Polytechnic University, Hong Kong during June 25-27, 2017. ICAMM focuses on the advanced manufacturing and materials research. The applications of advanced manufacturing and materials to such domains as Multi-scale and/or Multi-disciplinary Approaches, Chemistry and Chemical Engineering Fundamentals et al. It is a technical congregation where the latest theoretical and technological

advances are presented and discussed.

Call for Papers:
~ Materials
Composite Materials
New Materials
Materials Properties, Measuring Methods and Applications
Superconducting Materials and technology
Nanotechnology, Nano-Materials and Nano-Composites

~ Manufacturing
Materials Manufacturing and Processing
Casting, Powder Metallurgy
Welding, Sintering, Heat Treatment
Thin & Thick Coatings
Surface Treatment, Machining

*More topics, please go to: http://www.icamm.org/cfp.html

ICMSN 2024

Submission deadline:	**Feb 23, 2024**
Conference date:	**Jul 9, 2024 - Jul 12, 2024**
Full name:	**The 8th International Conference on Materials Sciences and Nanomaterials**
Location:	**Edinburgh, United Kingdom**
Website:	http://www.icmsn.org

Physicist Richard Feynman delivered a talk in 1959 entitled "There's Plenty of Room at the Bottom", in which he commented that there were no fundamental physical reasons that materials could not be fabricated by maneuvering individual atoms. This ground breaking talk opened the gate towards to the marvel nano-world. Over the past decade, nanomaterials have been the subject of enormous interest. These materials, notable for their extremely small feature size, have the potential for wide-ranging industrial, biomedical, and electronic applications. As a result of recent improvement in technologies to see and manipulate these materials, the nanomaterials field has seen a huge increase in funding from private enterprises and government, and academic researchers within the field have formed many partnerships. The variety of nanomaterials is great, and their range of properties and possible applications appear to be enormous. It is clear that researchers are merely on the threshold of understanding and development, and that a great deal of fundamental work remains to be done.

In order to exchange ideas, to promote material science especially focusing nanomaterial and to present sophisticated research works, International Conference on Materials Sciences and Nanomaterials (ICMSN) was initiated. ICMSN 2017 was successfully held in Barcelona, Spain during July 14-16, 2017, ICMSN 2018 was successfully held in University of Liverpool, UK during July 11-13, 2018, ICMSN 2019 was successfully held in University of Oxford, UK during July 22-24, 2019, ICMSN 2020 was successfully held virtually during July 8-10, 2020, ICMSN 2021 was successfully held virtually during July 13-15, 2021, ICMSN 2022 was successfully held in London during July 11-13, 2022, and ICMSN 2023 was successfully held in Cambridge during July 11-13, 2023.

***Call for papers:**
~Nanomaterials
Different Methods for Growth of Nanostructures
Nanoengineering
~Electronic Materials
Semiconductor Materials
Conductive Metal
~Material Chemistry
Classical Analytical Chemistry
Polymer Science
~Materials Processing Engineering
Metallurgy Technology
Metalworking
~Structural Material
Wrought Iron
Reinforced Concrete
For more topics, please visit: http://www.icmsn.org/cfp.html.

WMMM 2024

Submission deadline:	**Feb 15, 2024**
Conference date:	**Apr 24, 2024 - Apr 26, 2024**
Full name:	**Workshop on Materials, Mechanical and Manufacturing Engineering**
Location:	**Cape Town, South Africa**
Website:	http://www.wmmm.net/

On behalf of the Organizing Committee of 2024 Workshop on Materials, Mechanical and Manufacturing Engineering (WMMM 2024), we cordially invite you to participate in this event to

be held in Cape Town, South Africa from April 24-26, 2024, conjunction with ICRoM 2024 as the workshop. It's organized with the support of the Faculty of Engineering and Technology, The Vaal University of Technology (VUT).

Topics of interest

Topic 1. Material Science and Engineering
Composites
Micro / Nano Materials
Steel and Iron
Polymer Materials
New Functional Materials
Materials Physics and Chemistry
Biomaterials and Biomedical Materials
Optical/Electronic/Magnetic Materials
Thin Films
Earthquake Resistant Structures, Materials and Design
Hydrogen and Fuel Cell Science, Engineering and Technology

Topic 2. Mechanical and Manufacturing Engineering
Aerodynamics
Aerospace Structures: Analysis and Design
Aerospace Materials and Manufacturing Processes
Gas Turbine Propulsion Systems
Aircraft Performance, Dynamics, and Design
Robotics and Computer Numerical Control
Introduction to Optimization
Manufacturing Automation
Manufacturing Planning and Quality Control
Simulation Modeling and Facilities Planning
Mechatronics Systems Design

More Topics, please visit at http://www.wmmm.net/

Editor: Chaoyi Chu（褚朝奕） TEL: 3548 Email: ccy@jsut.edu.cn