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Conductive polymers for stretchable supercapacitors

Aqueous organic redox flow batteries

Vertically-aligned nanostructures for electrochemical energy storage


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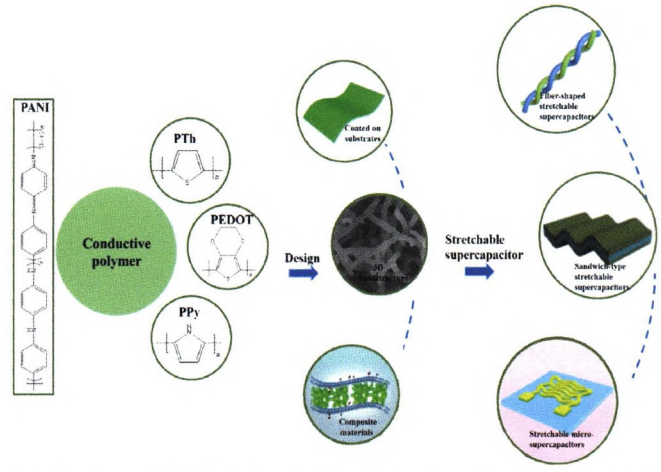
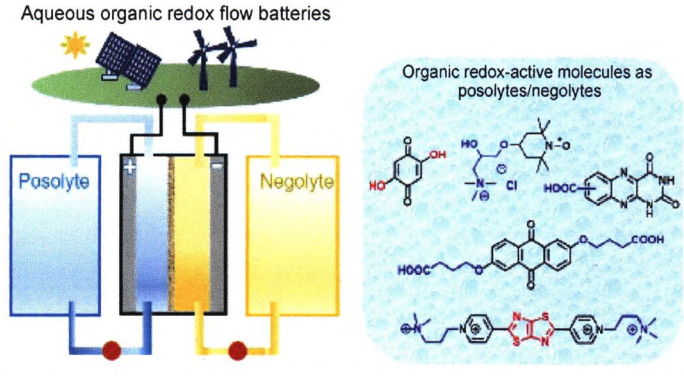


This review summarizes the material and structural design for conductive polymer-based stretchable supercapacitors and discusses the challenge and important directions in this emerging field.



Recent developments in aqueous organic redox flow batteries, including the molecular design and the corresponding cycling performance as these organic redox molecules are employed as either the negolyte or posolyte. New strategies using nanotechnology and our perspective for the future development of this rapidly growing field are included.

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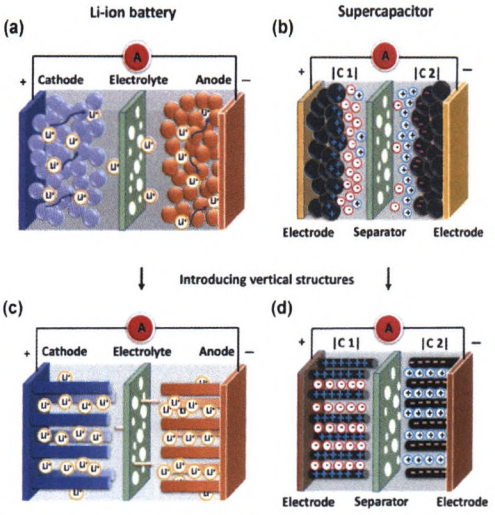
Vertically-aligned nanostructures for electrochemical energy storage

Xue Wang[1,2], Tianyang Wang[2], James Borovilas[2], Xiaodong He[1,*], Shanyi Du[1,*], and Yuan Yang[2,*]

[1] Harbin Institute of Technology, China
[2] Columbia University, USA

2002–2017



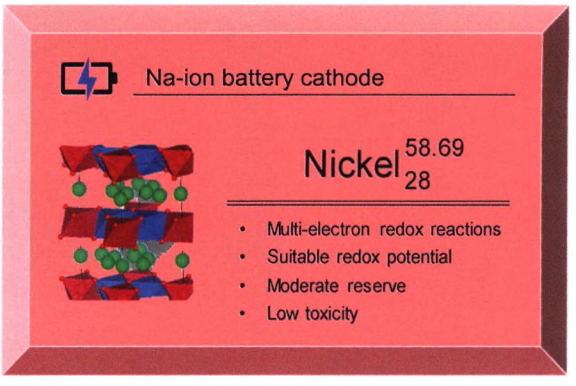
This review summarizes battery kinetics to illustrate the importance of low tortuosity in electrodes, and then introduces various methods to create vertically aligned nanostructures, such as direct growth, templating and microfabrications.

Ni-based cathode materials for Na-ion batteries

Chenglong Zhao[1,2], Yaxiang Lu[1,2,*], Liquan Chen[1], and Yong-Sheng Hu[1,2,3,*]

[1] Institute of Physics, Chinese Academy of Sciences, China
[2] University of Chinese Academy of Sciences, China
[3] Yangtze River Delta Physics Research Center Co. Ltd, China

2018–2030



The potential strategies on designing layered oxide cathodes of Na-ion batteries have been introduced through the discussion of Ni-based cathode materials.

Crystal phase engineering on photocatalytic materials for energy an environmental applications

Song Bai[1,2,*], Chao Gao[2], Jingxiang Low[2], and Yujie Xiong[2,*]

[1] Zhejiang Normal University, China
[2] University of Science and Technology of China, China

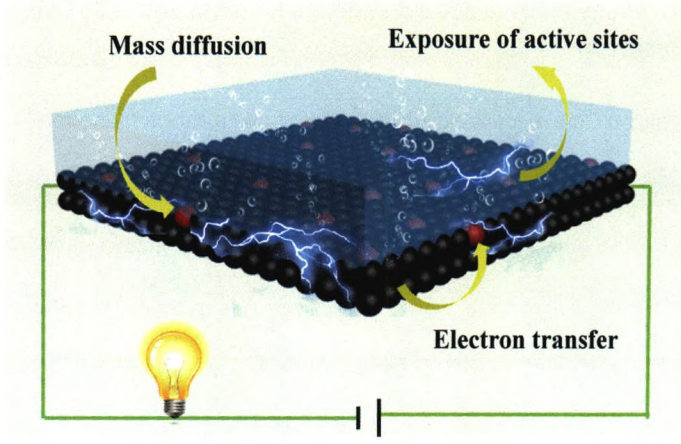
2031–2054

Phase design of photocatalytic materials has shown great promise for enhanced performance in energy and environmental applications. This review summarizes the state-of-the-art progress on the phase-engineered photocatalytic materials with fundamental mechanisms.

Rational design of three-phase interfaces for electrocatalysis

Yuqing Wang, Yuqin Zou*, Li Tao, Yanyong Wang, Gen Huang, Shiqian Du, and Shuangyin Wang*

Hunan University, China

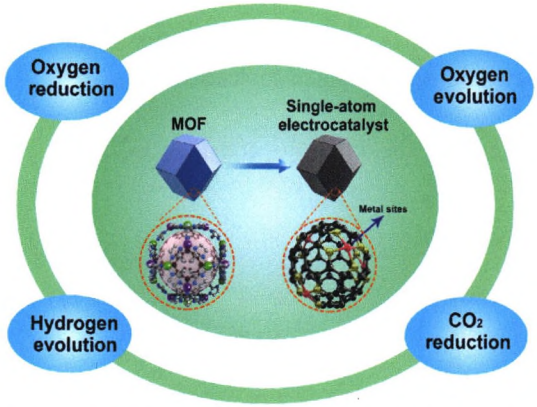


This review covers a summarization of design principles and synthetic strategies for triple-phase interfaces to optimize electrocatalytic performance of gas-involving electrocatalysis.

Metal organic frameworks derived single atom catalysts for electrocatalytic energy conversion

Tingting Sun[1], Lianbin Xu[2], Dingsheng Wang[1,*], and Yadong Li[1]

[1] Tsinghua University, China
[2] Beijing University of Chemical Technology, China

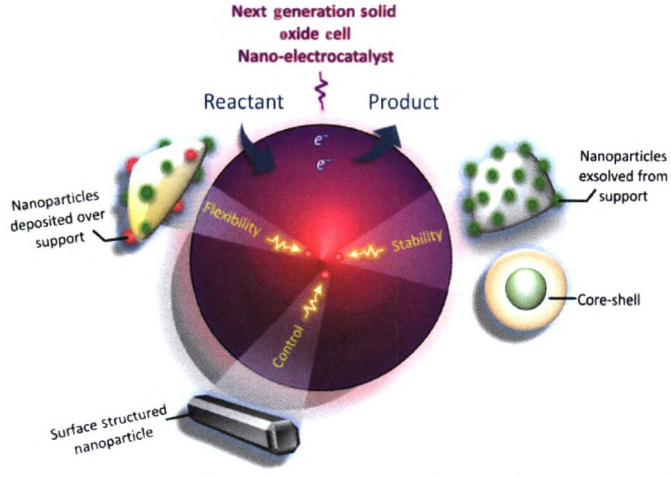


We summarize the recent progress in the synthesis and characterization of metal-organic framework (MOF)-derived single atom catalysts, mainly focusing on their electrocatalytic applications in the oxygen reduction reaction (ORR), hydrogen evolution reaction (HER), oxygen evolution reaction (OER), and CO_2 reduction.

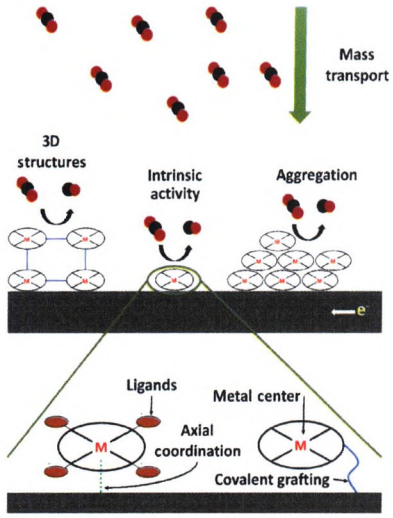
Nanoengineering of solid oxide electrochemical cell technologies: An outlook

Juliana Carneiro and Eranda Nikolla*

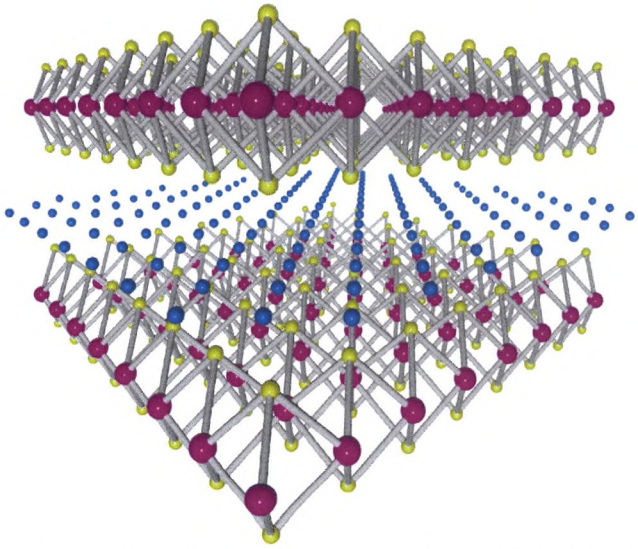
Wayne State University, USA



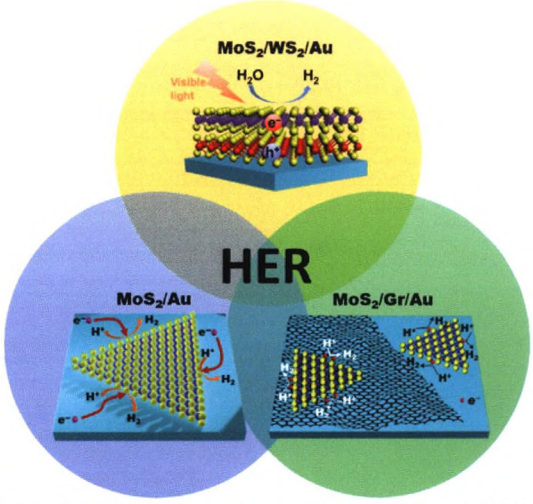
In this perspective, we discuss the progress in nanoengineering electrodes for solid oxide electrochemical cells (SOCs), highlighting the advantages and challenges of the use of nano-electrocatalysts. We suggest approaches that merge important nanoengineering strategies in order to obtain nano-structured electrodes with optimal electrocatalytic activity, selectivity and stability.



Molecular catalysts immobilized onto electrodes are discussed for electrocatalytic CO_2 reduction. The various underlying factors and design strategies contributing to observed performance are discussed to provide an overview of the field.



This review outlines the recent progress on the *in situ* studies of the electrochemical intercalation in transition metal dichalcogenides.

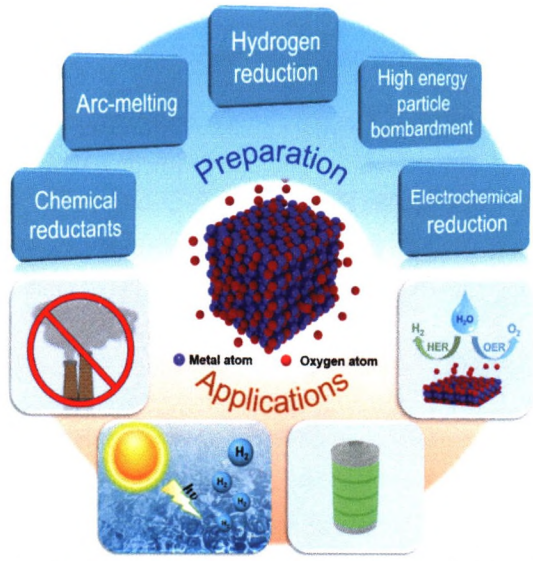


The model systems of MoS_2/Au, MoS_2/graphene (Gr)/Au and MoS_2/WS_2/Au constructed for hydrogen evolution reaction are comprehensively introduced. The underlying catalytic mechanisms based on the on-site scanning tunneling microscopy/spectroscopy investigations are also discussed.

Oxygen-deficient metal oxides: Synthesis routes and applications in energy and environment

Di Zu, Haiyang Wang, Sen Lin, Gang Ou, Hehe Wei, Shuqing Sun*, and Hui Wu*

Tsinghua University, China

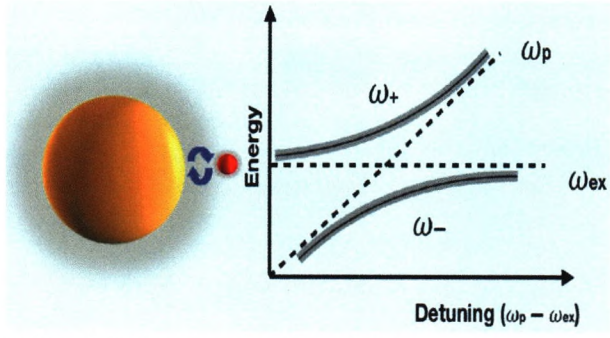


We have summarized recent progress of oxygen-deficient metal oxide nanomaterials in preparation methods and applications in energy and environment fields.

Plasmon-exciton interaction in colloidally fabricated metal nanoparticle-quantum emitter nanostructure

Yi Luo and Jing Zhao*

University of Connecticut, USA

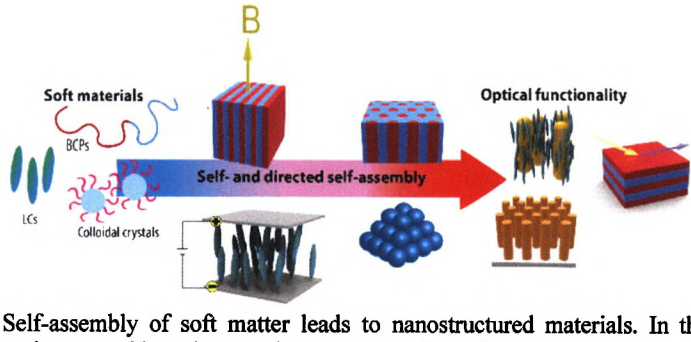


Colloidal methods have been applied to hybrid nanostructures composed of plasmonic nanoparticle and quantum emitters. Unique optical features of these nanostructures arise from the energy exchange between plasmons and excitons in the weak, semi-strong and strong coupling regimes.

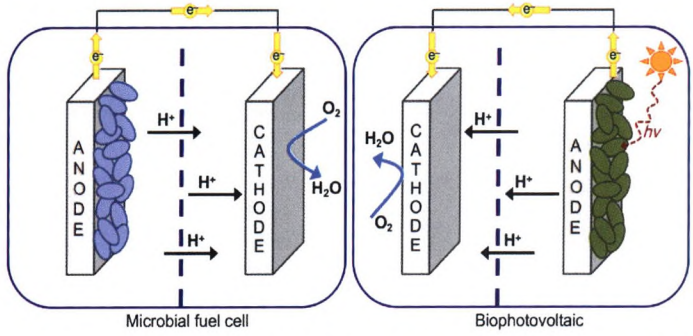
Optical materials and metamaterials from nanostructured soft matter

Uri R. Gabinet and Chinedum O. Osuji*

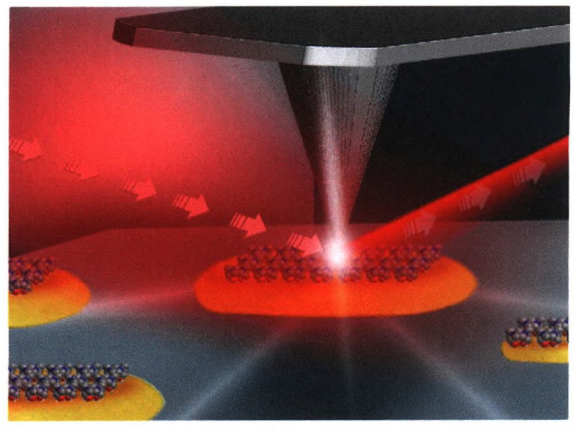
University of Pennsylvania, USA



Self-assembly of soft matter leads to nanostructured materials. In this review we address how such systems can be utilized to advance myriad optical and metamaterial applications.

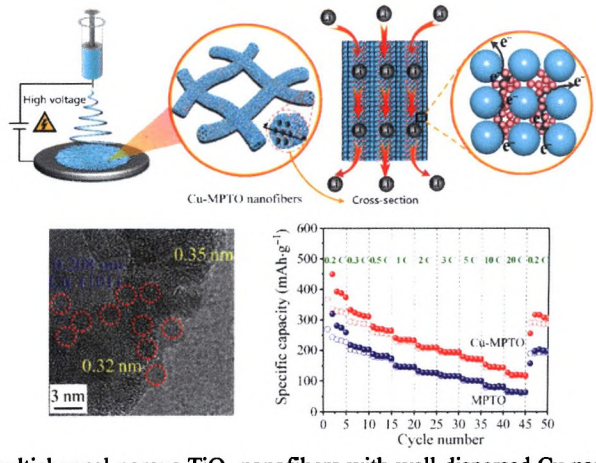


Interfacing biological parts with nanoparticles is a promising approach to increase the overall efficiency of microbial fuel cells and biophotovoltaics.

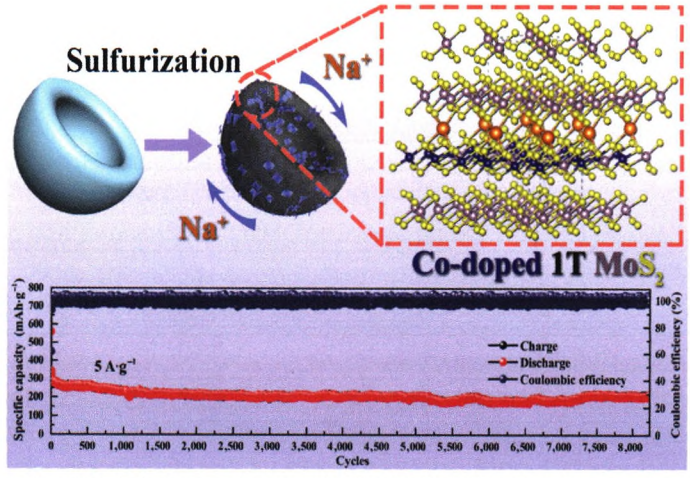


Infrared (IR) nanospectroscopy enables the extraction of detailed chemical information at the nanoscale. As described in this review paper, these measurements provide the capabilities to identify the ways by which local properties influence the global performances of energy materials, such as solar cells and heterogeneous catalysts.

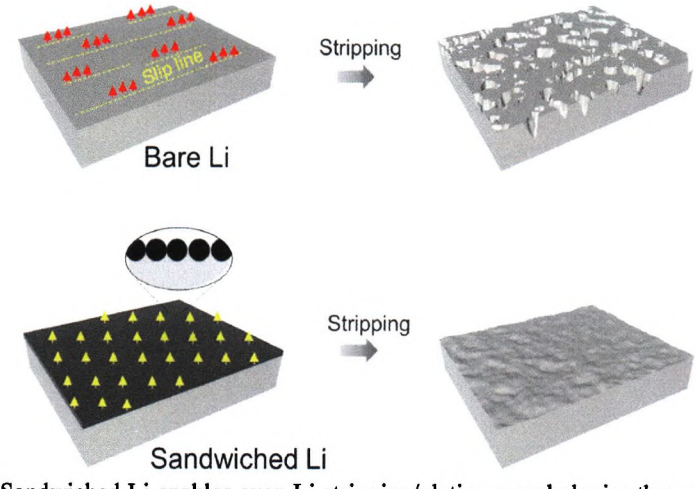
Research Articles



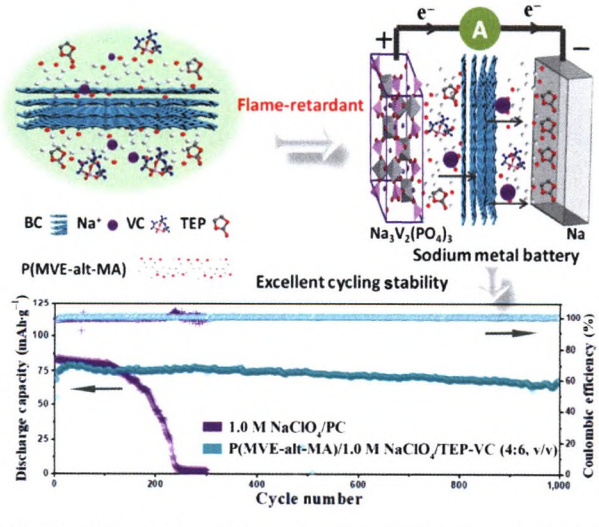
The multichannel porous TiO_2 nanofibers with well-dispersed Cu nanodots and Cu^{2+}-doping derived oxygen vacancies (denoted as Cu-MPTO) have been fabricated via electrospinning. When used as anode material for sodium ion batteries, an outstanding rate performance (120 $mAh \cdot g^{-1}$ at 20 C) and a superior cycling stability for ultralong cycle life (120 $mAh \cdot g^{-1}$ at 20 C and 96.5% retention over 2,000 cycles) could be obtained.



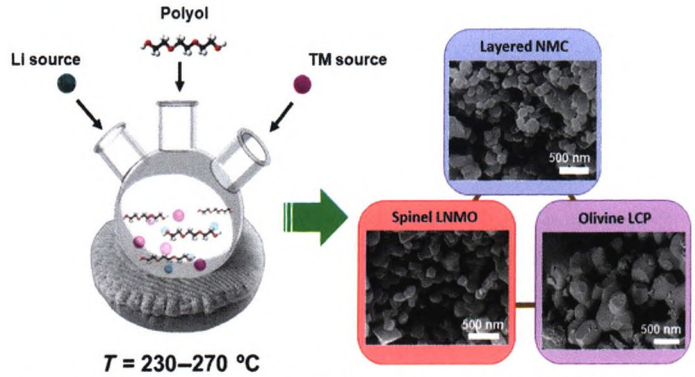
Co-doped 1T-MoS_2 nanosheets embedded in N, S-doped carbon nanobowls show extraordinary rate and cycling capability in sodium-ion batteries.



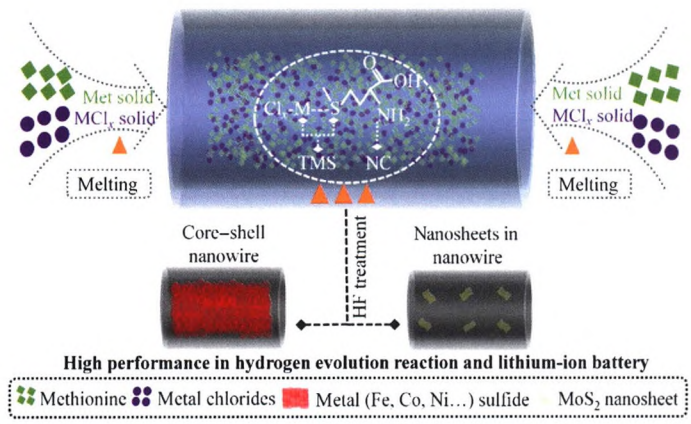
Sandwiched Li enables even Li stripping/plating morphologies through diminishing the metallurgical nonuniformity effects (slip lines) on stripping as well as by providing rich nucleation sites for Li plating.



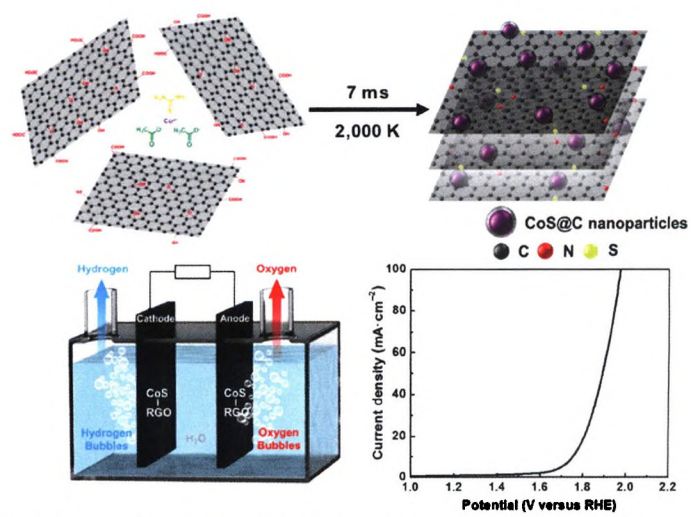
The as-obtained flame-retardant quasi-solid polymer electrolyte consisted of poly(methyl vinyl ether-alt-maleic anhydride) (P(MVE-alt-MA)) as host, bacterial cellulose as reinforcement, and triethyl phosphate/vinylene carbonate/sodium perchlorate (TEP/VC/$NaClO_4$) as plasticizer, which endows $Na_3V_2(PO_4)_3$/Na metal batteries with superior long-term cycling stability.



A novel polyol synthesis method has been developed for layered $LiNi_{0.4}Mn_{0.4}Co_{0.2}O_2$ (NMC), spinel $LiNi_{0.5}Mn_{1.5}O_4$ (LNMO), and olivine $LiCoPO_4$ (LCP) cathode materials. Reaction mechanism has been studied in detail with combination of *in situ* and *ex situ* techniques.



Ordered mesoporous transitional metal sulfide@N-doped carbon composites with ultrahigh surface areas, unique chemical stoichiometries and variable nano-architectures are synthesized by using a solvent-free nanocasting approach. The structure evolution over the synthesis process is depicted. The obtained materials are promising for electrochemical applications.

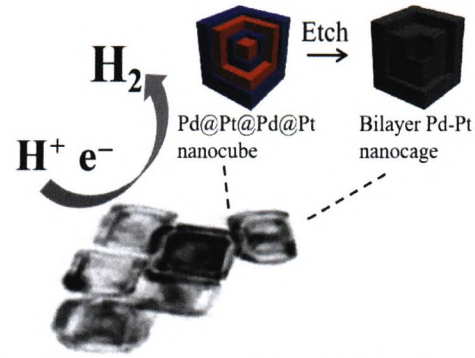


This work reports an ultrafast (~ 7 ms), *in-situ* synthesis technique for transition metal chalcogenides@ultrathin graphene core-shell electrocatalyst assisted by high temperature treatment. It is demonstrated that the cobalt sulfide (~ 20 nm in diameter)@ultrathin graphene (~ 2 nm in thickness) core-shell nanoparticles embedded in RGO nanosheets exhibit remarkable bifunctional electrocatalytic activity and stability for overall water splitting.

Fabrication of bilayer Pd-Pt nanocages with sub-nanometer thin shells for enhanced hydrogen evolution reaction

Yihe Wang, Lei Zhang, Congling Hu, Shengnan Yu, Piaoping Yang, Dongfang Cheng, Zhi-Jian Zhao, and Jinlong Gong*

Tianjin University, China

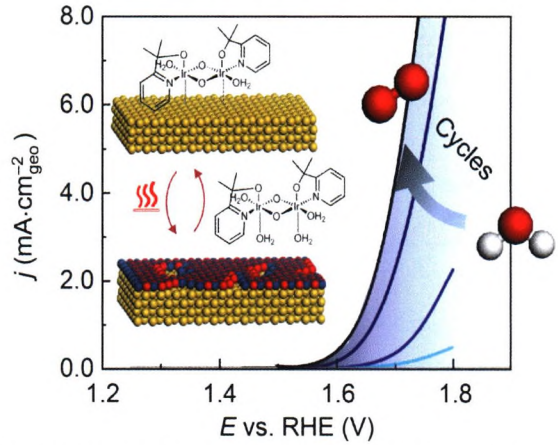


This paper describes the fabrication of bilayer Pd-Pt nanocages by etching away the Pd templates of multishelled nanocubes. These nanocages with high dispersion of the active atoms reduce hydrogen evolution reaction (HER) overpotentials and maintain long-term stability.

Towards maximized utilization of iridium for the acidic oxygen evolution reaction

Marc Ledendecker[1,*], Simon Geiger[1], Katharina Hengge[1], Joohyun Lim[1], Serhiy Cherevko[3], Andrea M. Mingers[1], Daniel Göhl[1], Guilherme V. Fortunato[1,5], Daniel Jalalpoor[2], Ferdi Schüth[2], Christina Scheu[1], and Karl J. J. Mayrhofer[1,3,4,*]

[1] Nanoanalytics and Interfaces Max-Planck-Institut für Eisenforschung GmbH, Germany
[2] Max-Planck-Institut für Kohlenforschung, Germany
[3] Forschungszentrum Jülich, Germany
[4] Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany
[5] Universidade Federal de Mato Grosso do Sul, Brazil

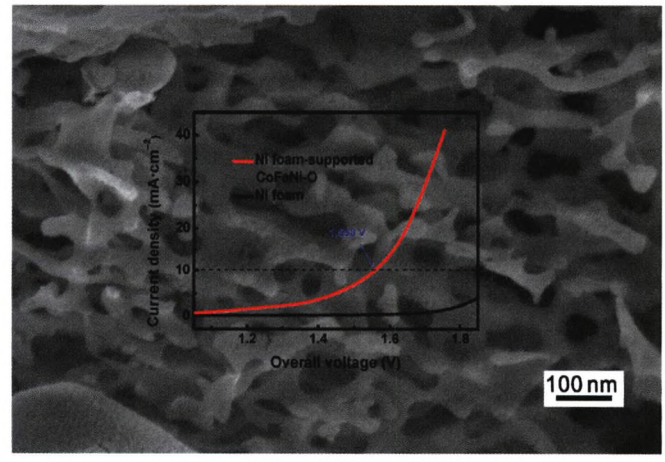


Strategies how to obtain stable and active catalysts with maximized iridium utilization for the oxygen evolution reaction are discussed.

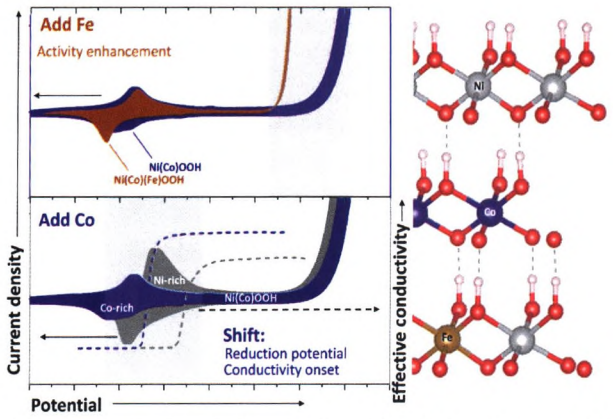
Ternary mesoporous cobalt-iron-nickel oxide efficiently catalyzing oxygen/hydrogen evolution reactions and overall water splitting

Lulu Han[1], Limin Guo[2,3,*], Chaoqun Dong[1], Chi Zhang[4], Hui Gao[1], Jiazheng Niu[1], Zhangquan Peng[3,4,*], and Zhonghua Zhang[1,4,*]

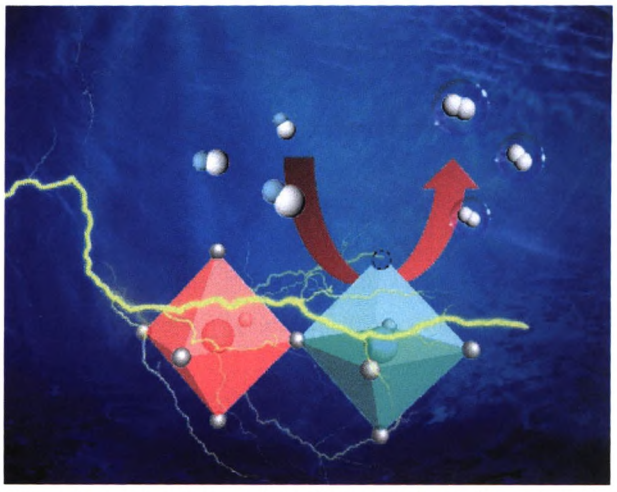
[1] Shandong University, China
[2] Jilin Engineering Normal University, China
[3] Changchun Institute of Applied Chemistry, Chinese Academy of Sciences, China
[4] Wuyi University, China



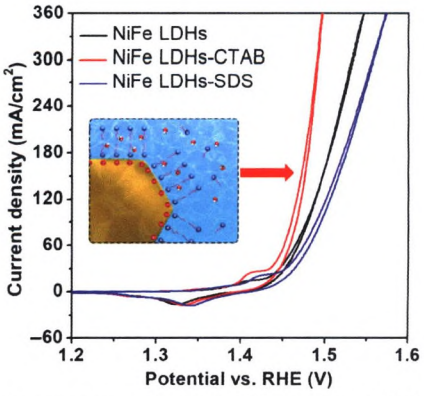
CoFeNi-O with hierarchical bimodal channel structure was prepared via dealloying and it shows superior performance for oxygen evolution reaction (OER)/hydrogen evolution reaction (HER) with extremely low overpotentials. Overall water splitting is featured with a low voltage of 1.558 V@10 mA·cm^{-2} for 25 h. Catalytic performance was enhanced because of the Co-Fe-Ni alloying effect and metallic Ni residual.



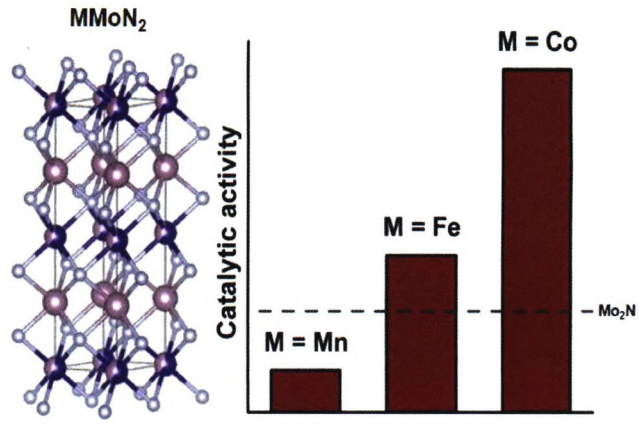
The electronic/electrochemical properties and activity of ternary Co-Ni-Fe oxyhydroxide oxygen evolution electrocatalysts are shown to be tunable based on composition. The addition of Co to Ni oxyhydroxide shifts the onset of electrical conductivity to more-negative potentials while the addition of Fe dramatically enhances activity. Calculations further show strong electronic hybridization between all the metal cations and oxygen at the valence band edge.



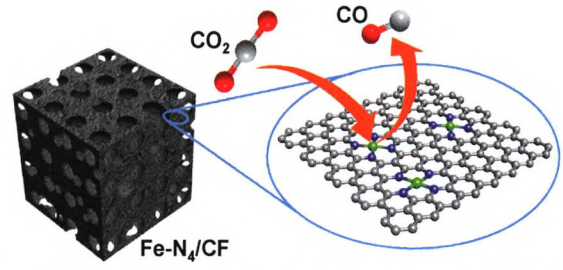
Ligancy engineering of perovskite electrocatalyst with ordered oxygen vacancies and excellent electric conductivity accelerates electrochemical evolution of O_2 in alkaline solution.



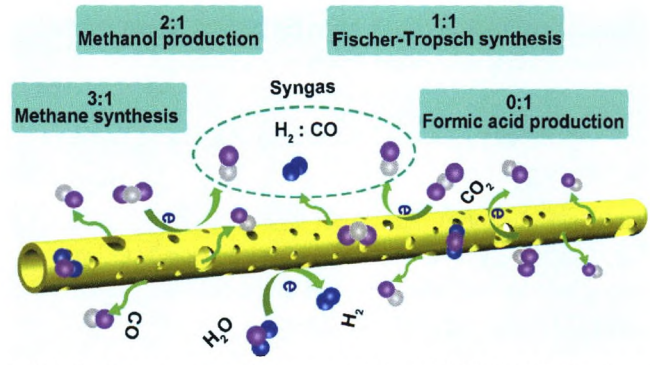
Superaerophobic nanoarray electrodes have shown their advantage in bubble releasing behavior in various gas evolution reactions. Herein we introduce cationic surfactants on the electrode surface to further enhance the water splitting performance, which pave a new way for better electrolysis system design.



More electronegative 3d metals yield improved oxygen reduction reaction (ORR) activity in acidic environments for 3d metal substituted molybdenum and tungsten nitride catalysts.



A multiscale carbon foam confining single iron atoms was synthesized with the assistant of SiO_2 template. The optimized catalyst achieves a maximal CO Faradaic efficiency of 94.9% at a moderate potential of –0.5 V vs. RHE, and maintains stable over 60 h.

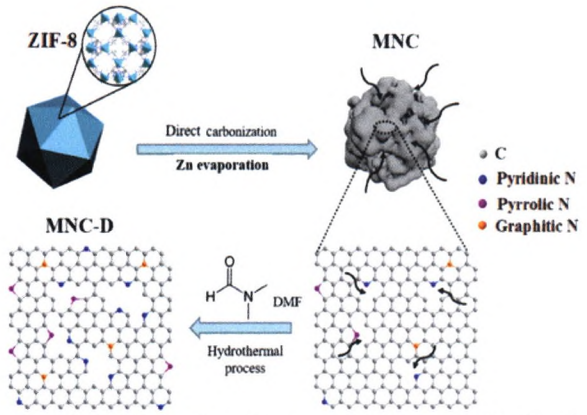


Fe and N doping porous carbon nematosphere (FeNPCN) is developed as the excellent carbon dioxide reduction (CO_2RR) electrocatalyst in aqueous electrolyte, which possesses great potential application in CO_2 reduction and syngas related industry.

Enhanced N-doping in mesoporous carbon for efficient electrocatalytic CO_2 conversion

Min Kuang, Anxiang Guan, Zhengxiang Gu, Peng Han, Linping Qian, and Gengfeng Zheng*

Fudan University, China

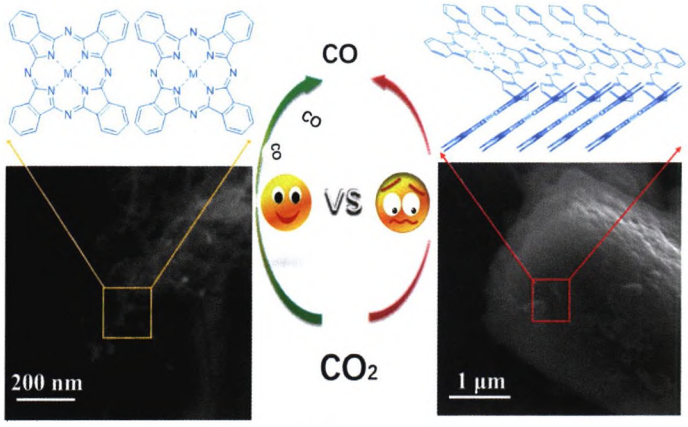


We developed a facile strategy to generate mesoporous N-doped carbon frameworks with tunable configurations and contents of N dopants, by using a secondary doping process via the treatment of a N,N-dimethylformamide (DMF) solvent. After the DMF treatment, the obtained N-doped carbon catalyst possesses a much increased density of pyridinic N and defects, which enhance the activation and adsorption of CO_2 molecules, thus increasing the activity of CO_2 reduction reaction (CO_2RR).

Revealing the hidden performance of metal phthalocyanines for CO_2 reduction electrocatalysis by hybridization with carbon nanotubes

Zhan Jiang[1,2], Yang Wang[1,2,*], Xiao Zhang[2], Hongzhi Zheng[2], Xiaojun Wang[2], and Yongye Liang[2,*]

[1] Harbin Institute of Technology, China
[2] Southern University of Science and Technology, China

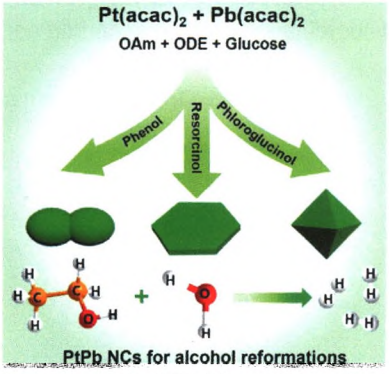


Metal phthalocyanine/carbon nanotube hybrids are prepared to study their cata-lytic performance for CO_2 electroreduction. These hybrids show higher activity, better stability and unambiguous performance compared to molecules directly loaded on electrode with significant aggregation.

Enhancing catalytic H_2 generation by surface electronic tuning of systematically controlled Pt-Pb nanocrystals

Bin E[1,3,4], Bolong Huang[2], Nan Zhang[1], Qi Shao[1], Yujing Li[3,4], and Xiaoqing Huang[1,*]

[1] Soochow University, China
[2] The Hong Kong Polytechnic University, Hong Kong, China
[3] Beijing Institute of Technology, China
[4] China University of Petroleum, China

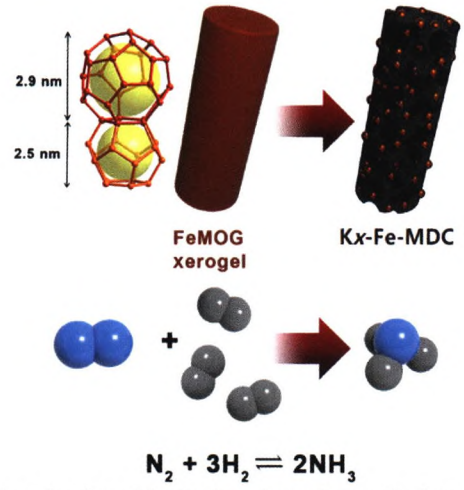


Well-defined PtPb nanocrystals (NCs) have been selectively synthesized via an effective method, and the optimized PtPb octahedra nanocrystals (ONCs)/C is the most active catalyst for the ethanol reforming to H_2. X-ray photoelectron spectroscopy (XPS) reveals that the high Pt(0)/Pt(II) ratio in PtPb NCs/C enhances the alcohols reforming. The density functional theory (DFT) studies show the PtPb ONCs possess the highest surface averaged electronic occupation for unit Pt-atom, matching well with XPS results.

Highly efficient K-Fe/C catalysts derived from metal-organic frameworks towards ammonia synthesis

Pengqi Yan[1], Wenhan Guo[1], Zibin Liang[1], Wei Meng[1], Zhen Yin[2], Siwei Li[1], Mengzhu Li[1], Mengtao Zhang[1], Jie Yan[1], Dequan Xiao[3], Ruqiang Zou[1,*], and Ding Ma[1,*]

[1] Peking University, China
[2] Tianjin Polytechnic University, China
[3] University of New Haven, USA

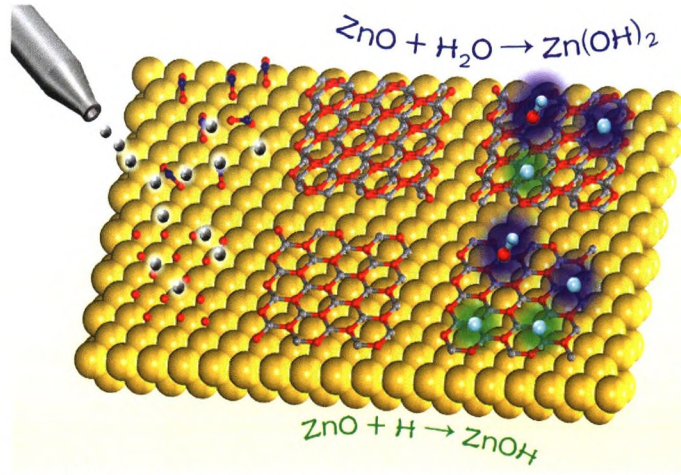


K-Fe/C catalyst developed by Fe-based metal-organic framework (MOF) gel shows high efficiency and thermal stability on ammonia synthesis. The promotion of potassium was studied.

Controlled growth of uniform two-dimensional ZnO overlayers on Au(111) and surface hydroxylation

Hao Wu[1,2], Qiang Fu[1,*], Yifan Li[1,2], Yi Cui[3], Rui Wang[3], Nan Su[1,2], Le Lin[1], Aiyi Dong[1], Yanxiao Ning[1], Fan Yang[1], and Xinhe Bao[1,2]

[1] Dalian Institute of Chemical Physics, Chinese Academy of Sciences, China
[2] University of Science and Technology of China, China
[3] Suzhou Institute of Nano-Tech and Nano-Bionics, Chinese Academy of Sciences, China

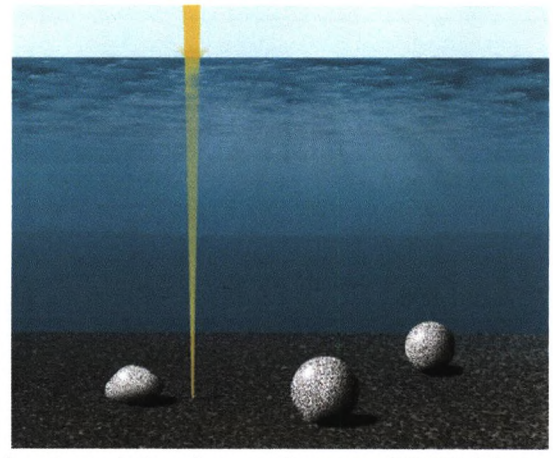


Controlled growth of uniform monolayer and bilayer ZnO nanostructures on Au(111) has been achieved using O_3 and NO_2, respectively, and strong hydroxylation of the two-dimensional ZnO overlayers was observed in milli-bar water vapor or with atomic hydrogen species.

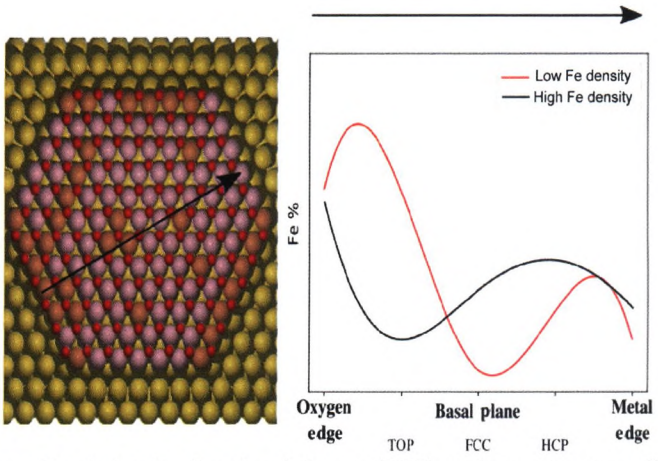
Assessment of oxide nanoparticle stability in liquid phase transmission electron microscopy

Mark J. Meijerink, Krijn P. de Jong, and Jovana Zečević*

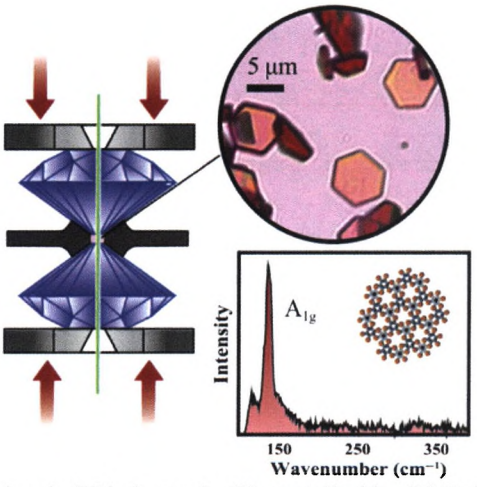
Utrecht University, The Netherlands



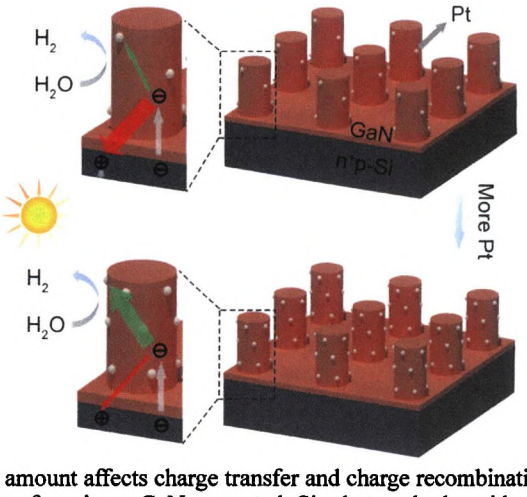
Liquid phase transmission electron microscopy (LP-TEM) has a power to provide unique insight in nanoscale dynamic processes involving oxides nanomaterials, but material stability during imaging remains a challenge. Here we demonstrate that there is a correlation between oxide stability in LP-TEM and Gibbs free energy of hydration, which can aid in assessment of oxide suitability for LP-TEM.



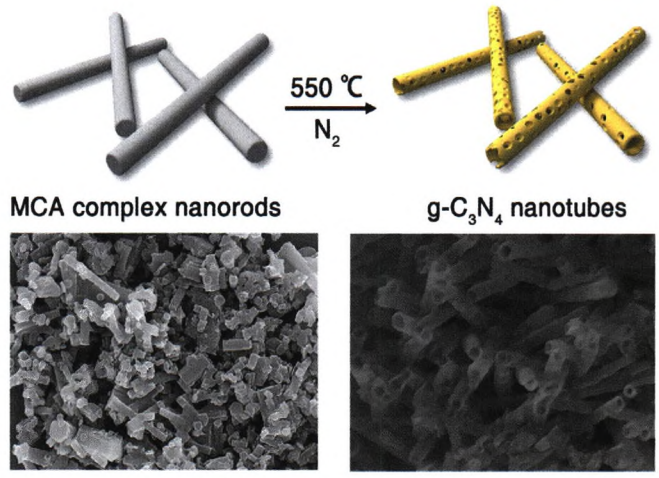
A combined density functional theory (DFT) and scanning tunneling microscopy (STM) approach is used to predict the Fe-dopant distribution and clustering of Fe-doped CoO nanoisland. We find an anisotropic Fe-dopant incorporation pattern throughout the nanoisland with the most favorable Fe incorporation site at the oxygen edge and a change in Fe incorporation site preference upon clustering occurring at high Fe-dopant densities.



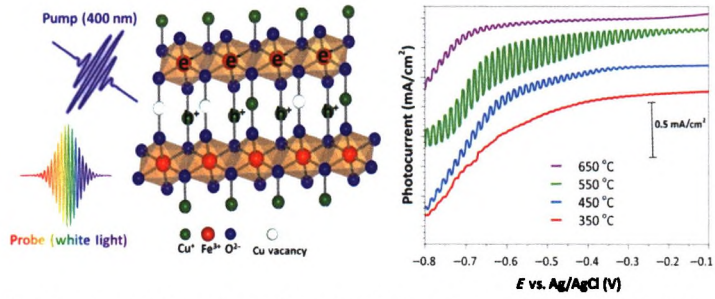
Two-dimensional (2D) layered silicon telluride (Si_2Te_3) and Mn-intercalated Si_2Te_3 nanoplates were compressed to 12 GPa using diamond anvil cell techniques and Raman spectroscopy. A semiconductor to metal phase transition is identified.



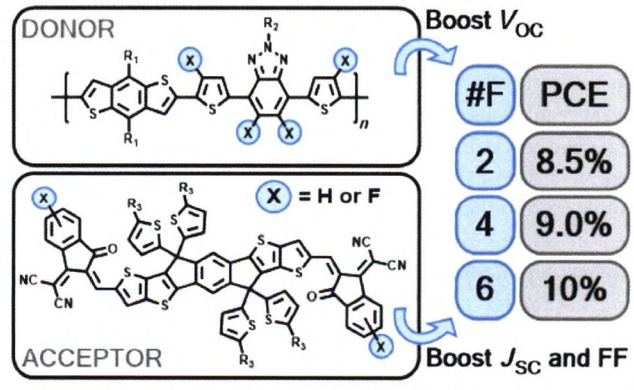
Pt loading amount affects charge transfer and charge recombination at the Si/GaN interface in a GaN-protected Si photocathode with a buried junction.



A simple one-step thermal polymerization method has been developed for synthesis of holey graphitic carbon nitride (g-C_3N_4) nanotubes, which showed enhanced photocatalytic H_2 production activity under visible-light irradiation compared to traditional g-C_3N_4 samples obtained by direct calcination of melamine or urea alone.



In this work we investigate the role of phase impurities and lattice defect states on the electron dynamics and photochemical efficiency of $CuFeO_2$. Visible light transient absorption and density functional theory (DFT) calculations provide insight on effects of Cu vacancies, O interstitials, and CuO/$CuFeO_2$ heterostructures on the competition between charge separation and recombination dynamics in this material.



More fluorination leads to higher overall efficiency yet the trade-off between V_{oc} and J_{sc} still exists.

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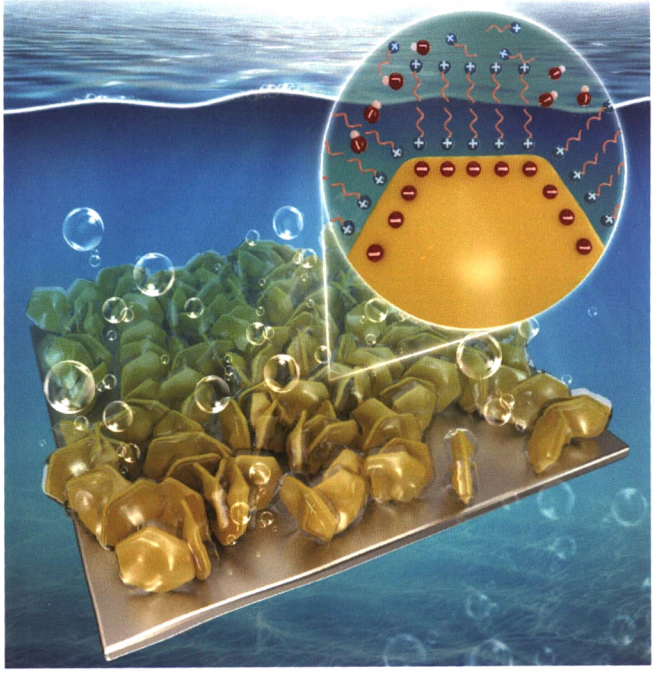

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